16th IGAC Scientific Conference

September 12-20, 2021
igacproject.org

16th IGAC Scientific Conference

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Dear IGAC Colleagues

Welcome to the 16th IGAC Scientific Conference. We are excited to finally have an opportunity to come together as a community after having to delay our in-person conference in Manchester last year.

It has been over a year and a half since our collective lives were first disrupted by COVID-19. While we have all learned to function within the associated restrictions and reduced personal contact, it is inevitable that some of you will have experienced some of the more devastating impacts among yourselves or family members. We hope that this meeting brings some comfort through the connections you make with old friends and new acquaintances.

To that end, we have tried to create a virtual conference that emphasizes interaction, using an application that provides the feel of attending an in-person conference. Please take full advantage of the Gather platform to socialize and discuss your research. The space will be open through the end of September, providing additional opportunities to interact. For instance, if you are unable to connect to a poster presenter whose work is of interest, consider leaving them a message and connecting at a later time.

While physical travel will not be part of your experience, you may still feel a little jet-lagged with sessions tending to occur outside your normal work hours. We have done our best to avoid sleeping hours for the majority of participants, so we hope that you will adjust your schedules to participate in as much of the meeting as possible.

To highlight how you might have a more sustained participation in IGAC, the conference is organized around the IGAC-sponsored Activities and Working Groups. The data you provided with your abstract submissions provided an important assessment of how our current structure aligns with the needs of the community. We encourage you to provide feedback on how your research is aligned with the current IGAC structure and how it might be improved through the formation of new activities.

We are grateful for the advice and input from the IGAC SSC and the efforts of the IGAC Activity and Working Group leads for working to organize the content of the oral and poster sessions. Most of all, we appreciate the hard work and dedication of Langley DeWitt, who in her first year as the new IGAC Director, navigated all of the logistical complexities of organizing a large online conference and kept us all moving forward to the goal.

We welcome you to IGAC 2021 and hope you enjoy the conference and associated activites. ❋

16th IGAC Scientific Conference

Gather Guidelines

URL

https://gather.town/app/UgpdO37nd4JXdlBR/IGAC2021

Requirements
Join from your computer on any OS (Windows, Mac OS, Linux).

Mobile devices are not fully supported (**https://support.gather.town/help/mobile-support**).

Web browser

Installing software is not required to use Gather.
We recommend using Chrome or Firefox browsers for Gather.
Safari is supported in beta.

Desktop Version

There is also a desktop version of Gather for both Windows and Mac. See **https://gather.town/download**

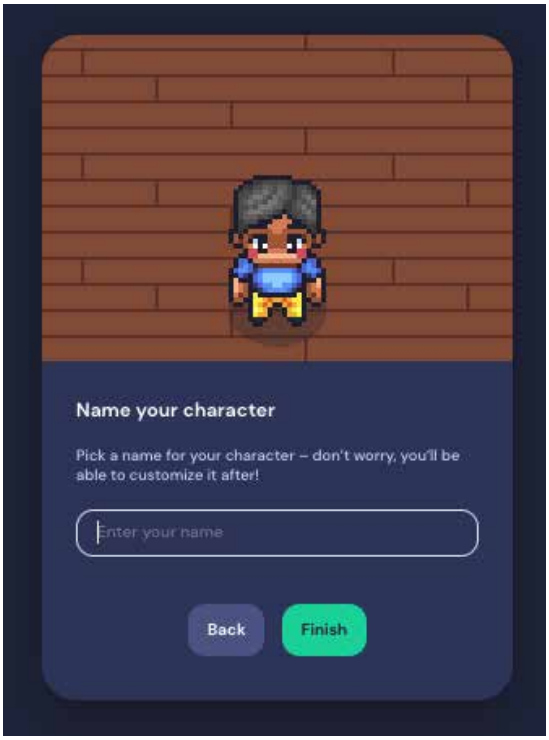
Getting Started

Please contact INFO@IGACPROJECT.ORG if you have any issues joining Gather.

Character Style & Name

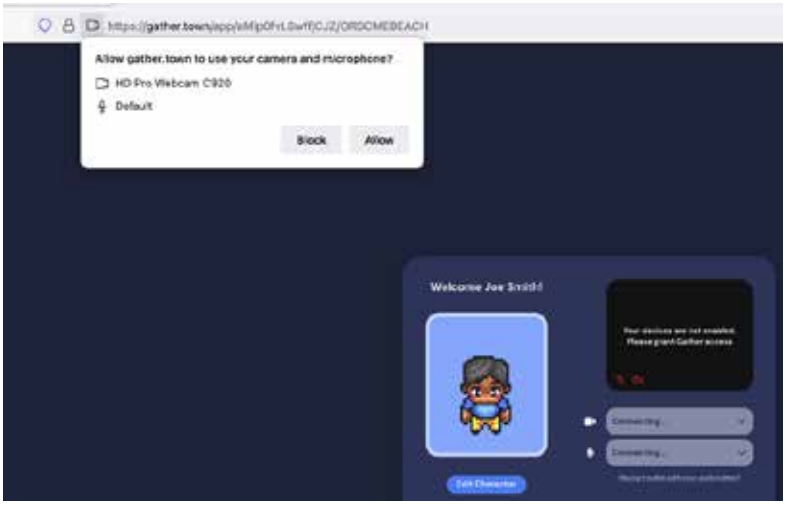
Before you enter the Pathways 2021 Gather space, you will choose and customize your character.

You will also name your character.



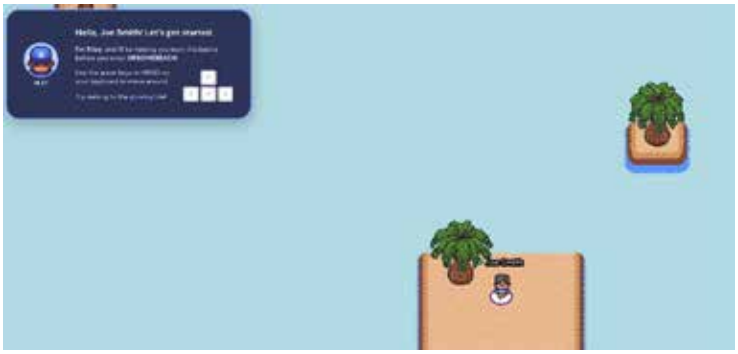
Browser Settings and Permissions

Gather must request permission to use your mic and camera from the web browser. To work properly, ***Gather should be allowed access to the microphone and camera.***

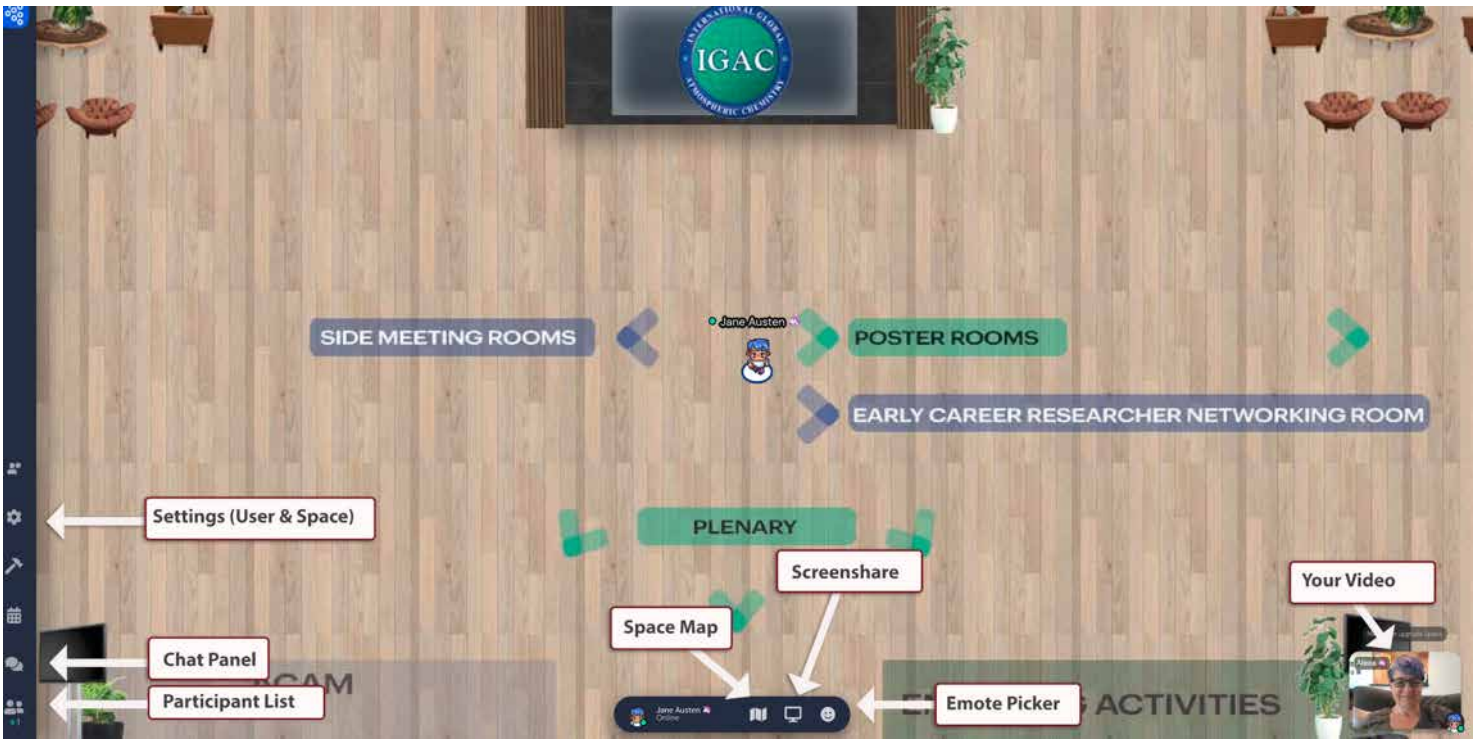


Tutorial

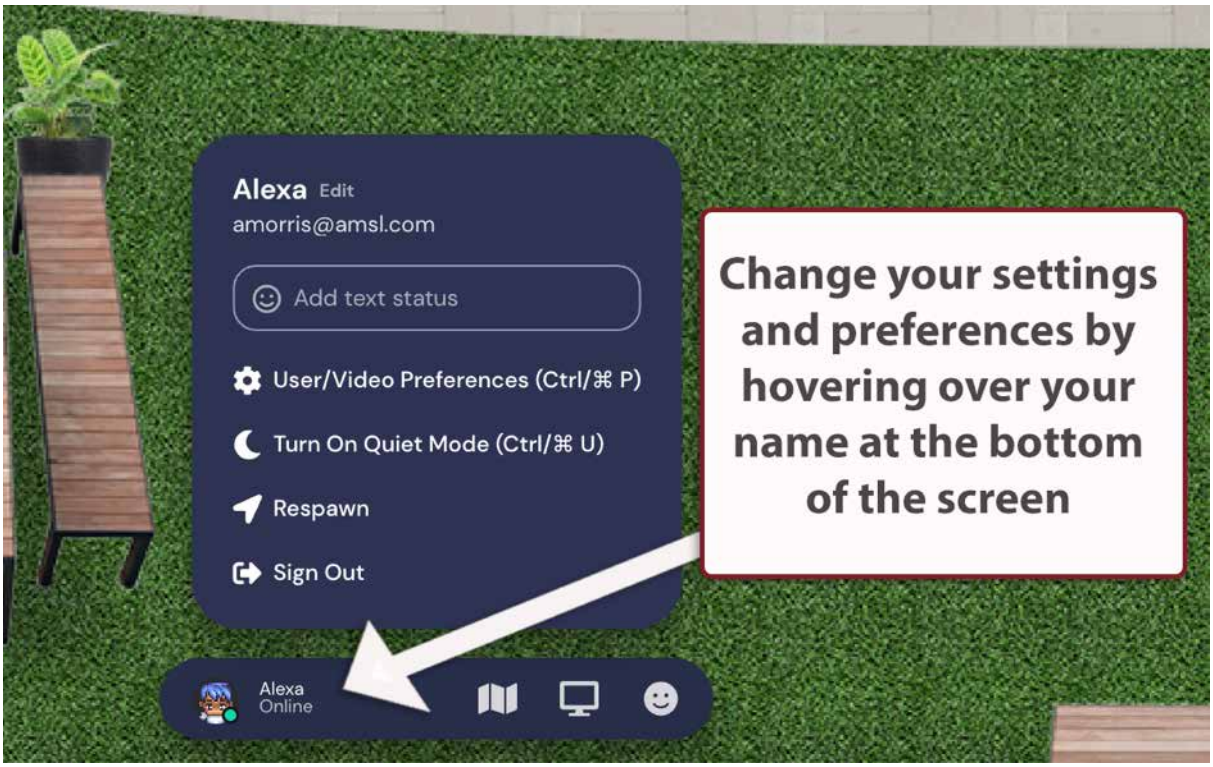
If you've never used Gather before, you will see a tutorial. We strongly recommend you do this tutorial, it is very brief.



Gather Screen Tour

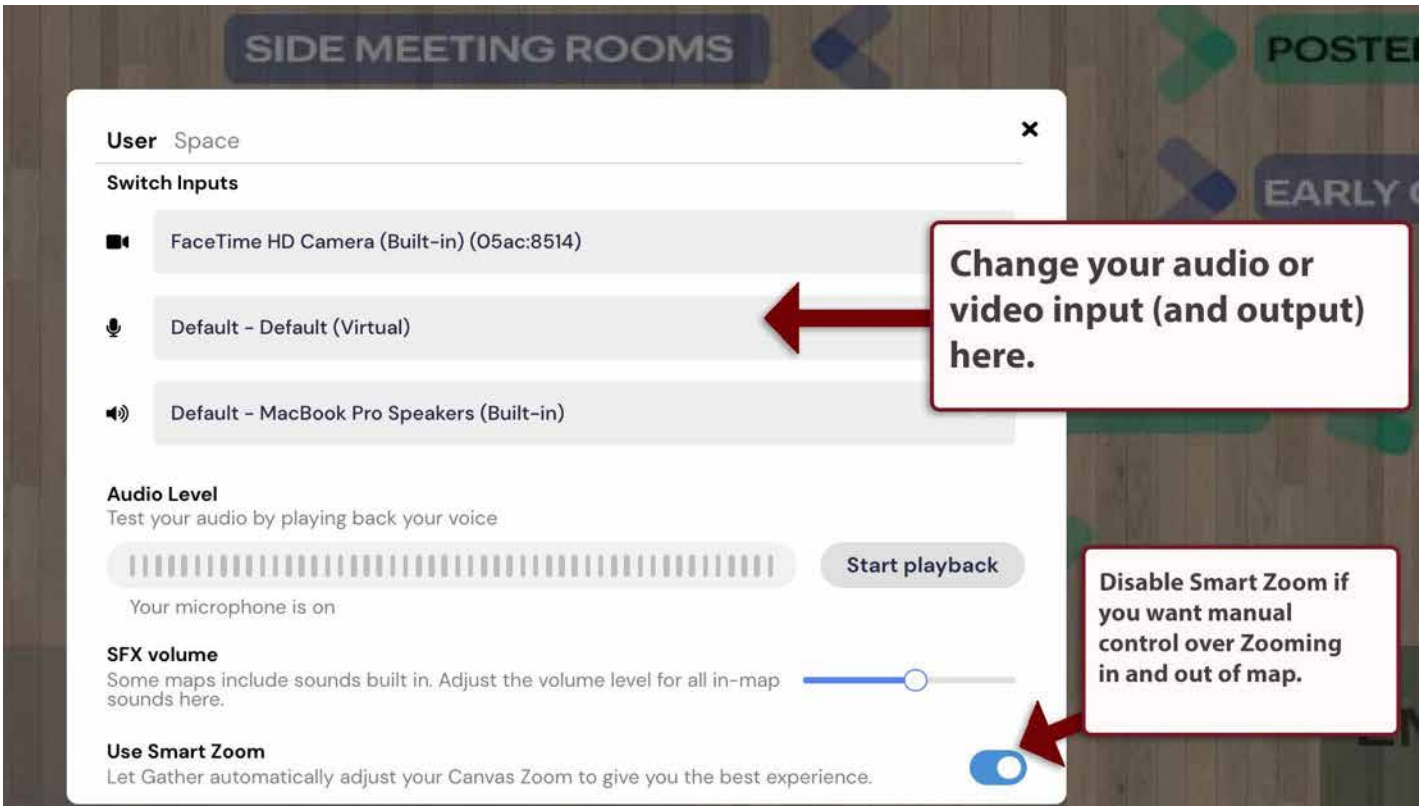


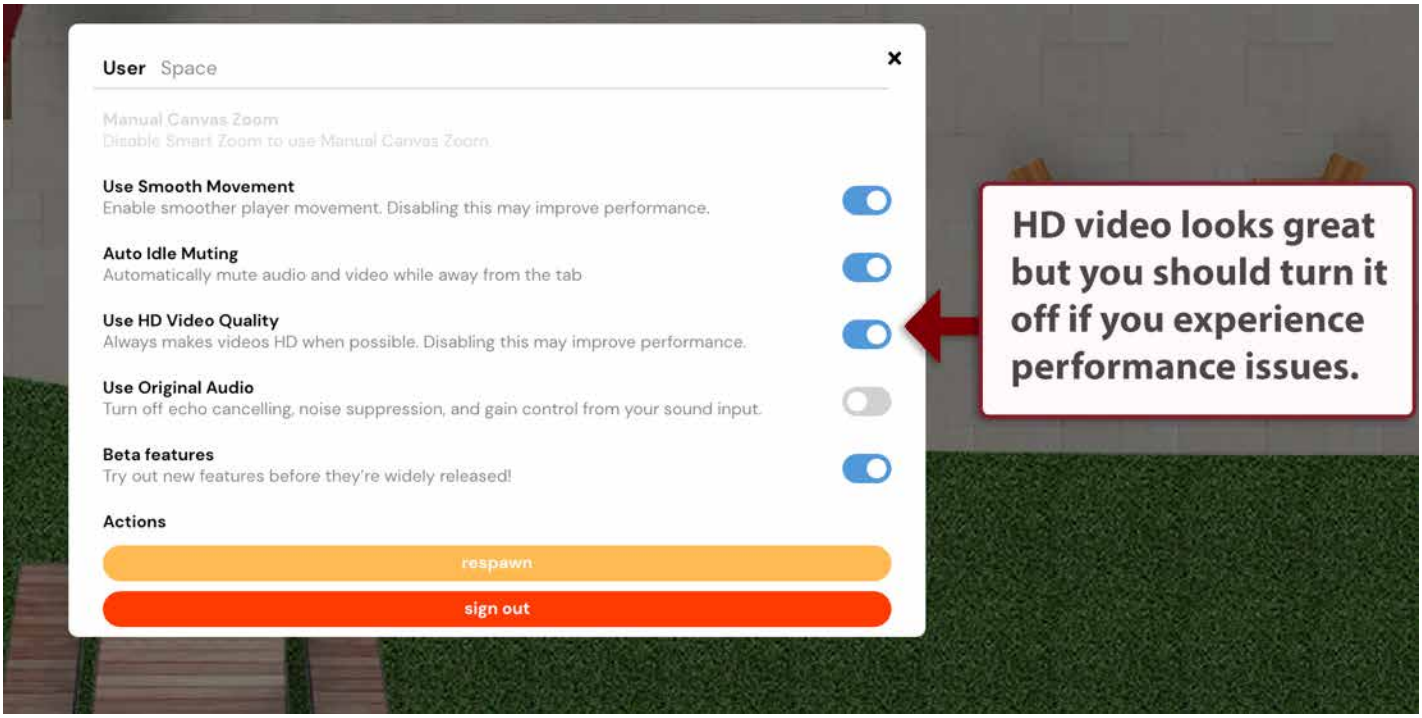
Preferences



User/Video Preferences

User/Video Preferences (Ctrl/⌘ P)





Exploring

Navigation

Use the arrow keys or WASD keys to move in Gather.

Please note: When using the WASD keys the W key is used as an up arrow, A as the left arrow, S as the down arrow, and the D as the right arrow key.

Move to Map Point

Using your mouse, double click on a location in the map to automatically move there. When using this feature, Gather will try to avoid taking you through private spaces.

Zoom

- On a Mac, hold the command key and press the – key to zoom out and the + key to zoom in (***Note:*** Smart Zoom must be disabled for this to work).
- On a PC hold the CTRL key and press the – key to zoom out and the + key to zoom in (***Note:*** Smart Zoom must be disabled or this to work).

Map

The Minimap will show you the entire room you are in currently. Click "X" in the upper right corner to exit the map.

Emotes

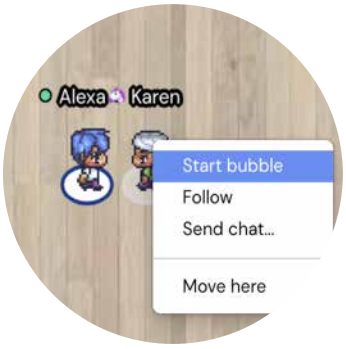
Show people how you are feeling with an Emote.

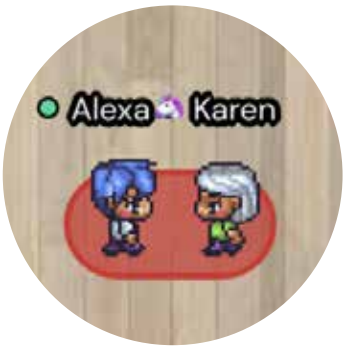
Conversations

As you navigate around Gather you will see other people. When you are far away the other characters look faded. As you get closer, the characters become more vivid and their video and audio will appear. However, if you once again navigate your avatar away, you will quickly lose your colleague's video and audio.

If there are many other people, you can toggle between their videos.

Conversation Bubbles





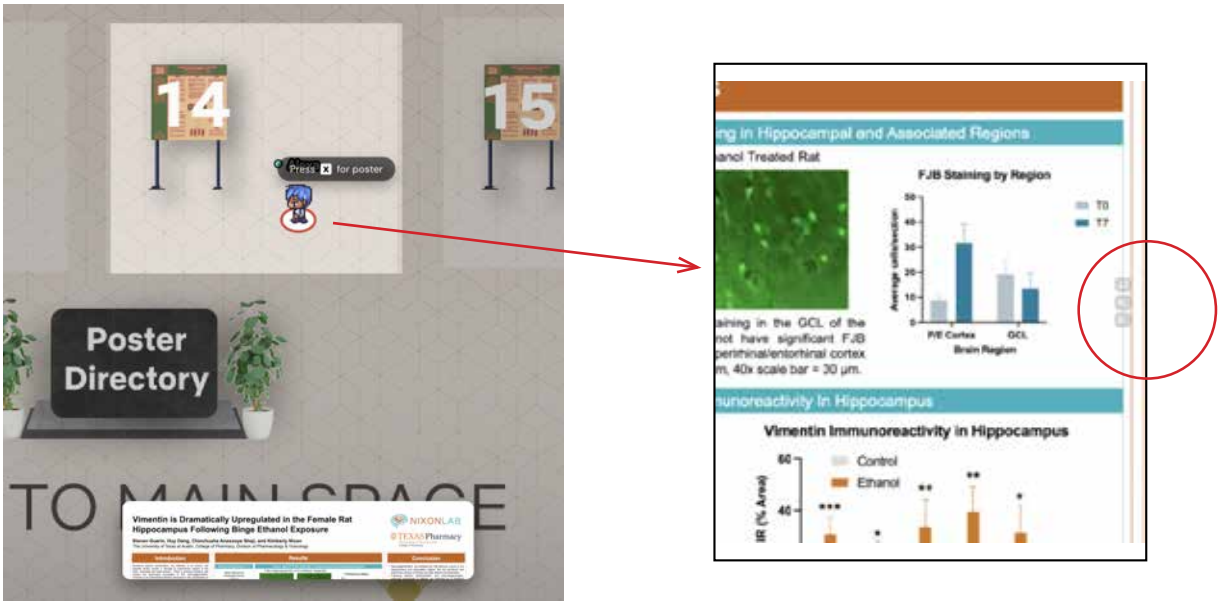
You can right click (or two-finger click) on another participant to start a conversation bubble with them. People outside your bubble will still be able to hear you, albeit very softly (and with transparent video). You can join and leave bubbles freely, even across private spaces. To leave the bubble, simply move your avatar away by using the arrow keys or WASD keys.

Private Areas

Private areas are places in the map where participants can only see and hear each other. All WG activity, networking tables and poster squares are private areas.

Text will notify you when you enter a private area, and the background of the private area will be lighter than the surrounding area.

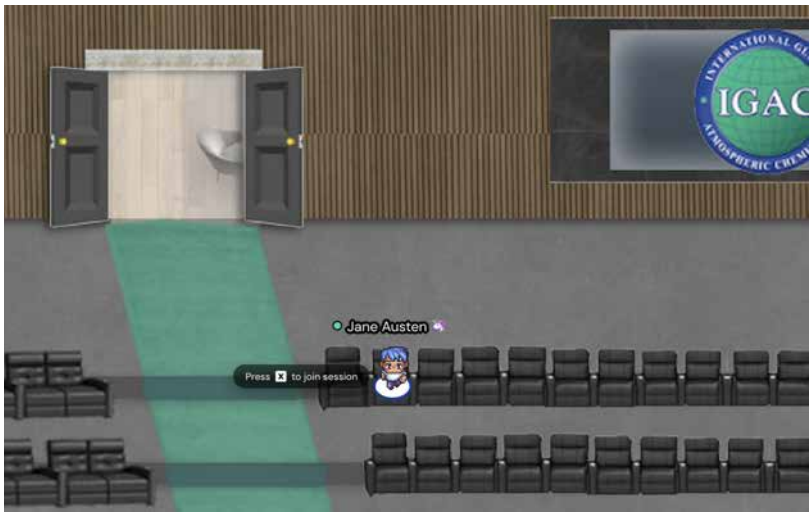
Poster Sessions



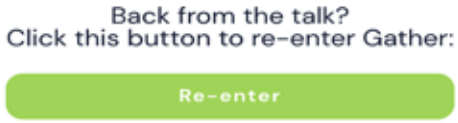
When you enter a poster area, you will see a preview of the poster and be prompted to Press X for poster."

Zoom in closer to the poster using the controls on the right side of the poster.

When you enter the Plenary room, please take a seat and click the x button on your keyboard to join the oral session.

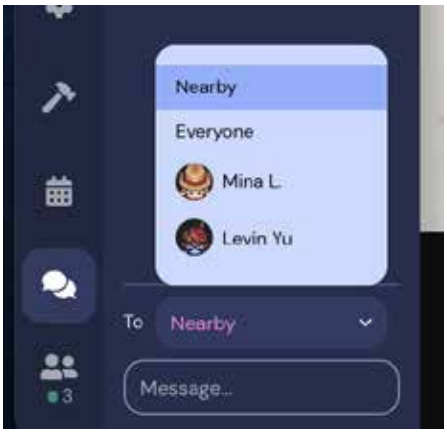


You will then be prompted to click on an external. Click on the link and join the oral session. After the session is over, close the tab.



After you close the external tab, the Gather tab will remain. Click on the Re-enter button to return back to Gather.

Chat

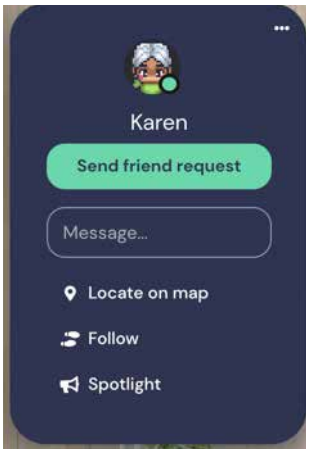


You can chat with people who are nearby, or with everyone in the entire space.

You can also select an individual participant and chat privately with them.

Locate & Follow

Find another participant by using "Locate on map" and Gather will draw a line to them.



If you select "Follow" Gather will move you automatically to the person you are following.

Portal Between Spaces

Becauses of the anticipated attendance numbers, the IGAC venue is composed of several different Gather spaces. When you come to a doorway that takes you to a different space, you will see the following prompt.

Ghost Mode

If you get surrounded by other characters and can't move, you can press "G" to turn into a ghost and move through other participants.

UTC	Sunday Sept 12	Monday Sept 13	Tuesday Sept 14	Wednesday Sept 15	Thursday Sept 16	Friday Sept 17
0						Models, In Situ, and Remote Sensing (MIRA) Side Meeting
1						
2						
3						
4			**Mango Session**	Side Meeting: Mango		
5						
6					**Southern Hemispheres Working Group Session B**	
7						
8			Side Meeting: Upcoming Investigations in the Southern Ocean and Antarctica			
9						**A Posters + Networking in gather.town**
10		**Japan National Committee Session**	**ACAM Session**	**ANGA Working Group Session**	**China Working Group Session**	**B posters + Networking in gather.town**
11						**C posters + Networking in gather.town**
12			**GEIA Session**	**MAP-AQ Session**	**TOAR-II Session**	**CATCH Session**
13		**Papers that Shaped Tropospheric Chemistry** (invited plenary by Paul Monks)				
14	**Social time and Intro to gather.town**	**A Posters + Networking in gather.town**	**A Posters + Networking in gather.town**	**B Posters + Networking in gather.town**	**CCMI Session**	**PACES Session**
15		**B posters + Networking in gather.town**	**COVID-19 and Air Quality Special Session**	**AMIGO Session**		
16		**C posters + Networking in gather.town**			**C Posters + Networking in gather.town**	**CATCH Side Meeting**
17						
18						
19			**Americas Working Group Session**		Americas Working Group Side Meeting	
20						
21						
22				**Southern Hemispheres Working Group Session A**		
23						

Japan National Committee

Japan National Committee Session
September 13 2021, 1000-1200 GMT (1900-2100 JST)

Time (UTC)	Speaker	Title
10:00-10:02	Yugo Kanaya	**Introduction**
	Part A. GOSAT-GW and international collaboration	
10:02-10:07	Hiroshi Tanimoto	Observing anthropogenic emissions of greenhouse gases and air-pollutants with the GOSAT-GW satellite: Scientific targets and policy contributions
10:07-10:12	Tamaki Fujinawa	First Concurrent Observations of NO_2 and CO_2 from Power Plant Plumes by Airborne Remote Sensing
10:12-10:17	Takashi Sekiya	A comparison of the impact of TROPOMI and OMI tropospheric NO_2 on global chemical data assimilation and emission inversion
10:17-10:22	Yousuke Yamashita	A chemistry-transport modeling to support satellite observations of NO_2 and CO_2 emitted from megacities
10:22-10:27	Tomohiro Oda	Errors and uncertainties associated with mobility and traffic activity data for estimating fossil fuel CO_2 emissions during the COVID-19 pandemic
10:27-10:32	Prabir Patra	Understanding of the space-time variations of hydroxyl (OH) using methyl
10:32-10:46		Discussion
	Part B. Asian regional air pollution and international collaboration	
10:47-10:52	Chunmao Zhu	Light absorption properties of brown carbon aerosols in the Asian outflow: Implications from a combination of filter and ground remote sensing observations at Fukue Island, Japan
10:52-10:57	Yongjoo Choi	Investigation of the wet removal rate of black carbon in East Asia: validation of a below- and in-cloud wet removal scheme in FLEXible PARTicle (FLEXPART) model v10.4
10:57-11:02	Adedayo Adedeji	Modelling the sources of air pollution over the East China Sea
11:02-11:07	Daizhou Zhang	Aerosol soluble iron production under clean, haze and fog conditions at a coastal site of China
11:07-11:12	Kazuyo Yamaji	Model analysis of the atmospheric aerosol concentrations and depositions by ship-onboard observations over the Eastern Indian Ocean
11:12-11:26		Discussion

	Part C. Lightning talks from ECS	
11:27-11:31	Kenta Kanegae	Evaluation of a Low-Cost Mobile $PM_{2.5}$ Sensor and Application to the Measurements along the Japan National Route 1
11:31-11:35	Yange Deng	Temperature and acidity dependence of secondary organic aerosol formation from α-pinene oxidation: implication for SOA models
11:35-11:39	Afsana Sonia	Chemical characteristics of of humic-like substance (HULIS) organic aerosol in a cool-temperate forest area of Japan
11:39-11:43	Sakiko Ishino	Oxidation of methanesulfonate into sulfate at inland Antarctica evidenced by 17O-excess signature
11:43-11:47	Kohei Ono	Investigation of adhesivity of marine organic aerosols by atomic force microscopy
11:47-12:00		Overall discussion for future collaboration (mention other posters/ presentations)

Monsoon Asia and Oceania Networking Group (MANGO) Session
September 14 2021, 0400-0600 UTC

Time UTC	Speaker	Title
04:00 - 04:05	Hiroshi Tanimoto Manish Naja, Liya Yu Abdus Salam	**Introduction**
04:05 - 05:00		**Session I**: Recent Highlights in MANGO
	Sachin Ghude	Integrated air quality forecasting system for Delhi and entire South Asia
	Vanisa Surapipith	Biogenic volatile organic compounds (BVOCs) and roles on air quality (Ozone and $PM_{2.5}$) over northern Thailand
	Dan Jaffe	NOx and 03 trends at US. non-attainment areas for 1995-2020: Influence of COVID-19 reductions and wild/and.fires
	Shih-Chun Candice Lung	Recent findings of Health Investigation and Air Sensing for Asian Pollution (HiASAP) - A project endorsed by Future Earth in Asia
05:00 - 05:40		**Session II**: Flash Talks by Early-Career Scientists]
	Shahid Uz Zaman Adil	Indoor air quality indicators and toxicity potential at the hospitals 'environment in Dhaka, Bangladesh
	William Daniels	Using climate mode indices to forecast carbon monoxide variability in fire-prone Southern Hemisphere regions
	Sreyashi Debnath	Investigating the performance of WRF-Chem in simulating the Indian Summer Monsoon and associated chemistry-feedback processes
05:40 – 05:55		Questions & Answers for all flash talks/Discussions
06:00		Adjourn

Atmospheric Composition and the Asian Monsoon (ACAM) Session, September 14 2021, 1000-1200 UTC

Time (UTC)	duration (min)	Speaker	Title
10:00	5	Hans Schlager & Mian Chin	Introduction of ACAM
		Asian summer monsoon transport and UTLS response	
10:05	15	**Barbel Vogel (invited)**	**Transport of air in the region of the Asian monsoon anticyclone and its impact on the stratosphere**
10:20	8	Bhupendra Bahadur Singh	Linkage of water vapor distribution in the lower stratosphere to organized Asian summer monsoon convection
10:28	8	Prashant Singh	Transport of black carbon from the planetary boundary layer to free troposphere during the summer monsoon over South Asia
10:36	8	Meike Rotermund	Organic, inorganic and total bromine in the extratropical tropopause and lowermost stratosphere in fall 2017: Origins, transport pathways and consequences for ozone
10:44	8	Pooja Pawar	Comparisons between satellite and CTM model derived total columns of ammonia over South and East-Asia
		Aerosol-clouds-monsoon interactions and air quality	
10:52	15	**Zhanqing Li (invited)**	**Aerosol structure, absorption and interactions with the PBL and impact on surface pollution**
11:07	8	Imran Girach	Ozone and carbon monoxide over the northern Indian Ocean during winter and monsoon: influence of chemistry and dynamics
11:15	8	Mingchen Ma	The impact of land cover change and biogenic emissions from urban green space on summer ozone formation over North China Plain
11:23	8	Claire Robinson	Compositional Analysis of Cloud Droplet Residuals by High Resolution Time-of-Flight Aerosol Mass Spectrometry: A CAMP2Ex Case Study
11:31	8	Joshua DiGangi	Observations of Regional Biomass Burning and Urban Trace Gas Enhancement Ratios in Southeast Asia and their Relationship with Aerosol Composition and Air Quality
		Future opportunities for ACAM studies	
11:39	10	James Crawford	Airborne and Satellite Investigation of Asian Air Quality (ASIA-AQ) and Asian Monsoon Impact: Opportunities for International Collaboration
11:49	11	All	Discussion

Global Emissions Initiative (GEIA) Session
September 14 2021, 1200-1400 UTC

Time UTC	Speaker	Title
12:00-12:05	Cathy Liousse	**Introduction**
12:05 - 12:50	Ikeda et al.	Evaluation of black carbon emissions in East Asia: Comparisons of six inventories and constraints from surface observations and model simulations.
	French et al.	Modeling and Mapping Biomass Burning for High Northern Latitudes with the Wildland Fire Emissions Inventory System (WFEIS)
	Doumbia M. et al.	Road Traffic Emission Inventory in an Urban Zone of West Africa: Case of Yopougon City (Abidjan, Côte d'Ivoire)
	Mukherjee et al.	Estimating Road Transportation Emissions using CNNs and Satellite Imagery in the US.
	Chaudhary et al.	Municipal solid waste burning is a neglected source of highly reactive VOCs that fuel ozone formation over rural India
	Doumbia T. et al.	COVID-19 adjustmeNt Factors fOR eMissions (CONFORM): A dataset for atmospheric models
	Klovenski et al.	Understanding the Effect of Drought on Biogenic Isoprene and the Biosphere-Atmosphere-Chemistry Relationship with NASA GISS/MEGAN Simulations
	Wang et al.	Annual changes of ship emissions around China under gradually promoted control policies from 2016 to 2019
	Osses et al.	Forecasting policy, innovation and new technologies for reducing transport emissions in Chile 2020-2050
12:50 - 13:20	GEIA SSC members	**Summaries of the posters**
	Greet Janssens-Maenhout	Global and regional anthropogenic emission inventories
	S. Keita	Urban emission inventories
	B. McDonald	VOC emissions
	M. Guevara	Biomass burning emissions
	A. Steine	Other emissions
13:20 - 13:45	Greg Frost	Panel discussion with all the speakers
13:45 - 14:00	Greg Frost	Summary of the session

COVID Oral Session
September 14, 2021 1500 – 1700 UTC

Time UTC	Speaker	Title
15:00	Georgios Gkatzelis	Knowns and unknowns on the impacts of COVID-19 lockdowns on urban air quality
15:10	Mei Zheng	Impacts of COVID-19 on Black Carbon in Two Representative Regions in China Based on Online Measurement in Beijing and Tibet
15:20	Lei Liu	Chemistry of Atmospheric Fine Particles during the COVID-19 Pandemic in a Megacity of Eastern China
15:30	Egide Kalisa	The Impact of COVID-19 Lockdowns and Car Free-day Policy on Levels of Air Pollution in Kigali, Rwanda
15:40	Michael Giordano	Exploring Changes in Air Quality Across Africa from COVID-19 in 2020 and 2021: Observations from the AfriqAir Network
15:50	Marc Guevara	Quantification of the Emission Changes in Europe During 2020 Due to the COVID-19 Mobility Restrictions
16:00	Prajjwal Singh Rawat	Lockdown influences on Ozone, NO_2, and CO over Asia: Some contrary affects
16:10	Naomi Asimow	Mapping Urban CO with BEACO2N and Bayesian Inversions
16:20	Hannah Clark	The effects of the COVID-19 lockdowns on air-quality throughout the troposphere as seen by IAGOS in-situ data
16:30	Jenny Stravakou	Impact of COVID-19 on NOx and VOC levels over China based on multi-species satellite data and modeling
16:40	Kazuyuki Miyazaki	Global tropospheric ozone responses to reduced NOx emissions linked to the COVID-19 world-wide lockdowns
16:50	Jiani Yang	From COVID-19 to Future Electrification: Assessing Traffic Impacts on Air Quality by a Machine Learning Model

Americas Working Group (AWG) Session
September 15 2021, 1900-2000 UTC

Time UTC	Speaker	Title
19:05	René Parra	Effect of Global Atmospheric Datasets in Modeling Meteorology and Air Quality in the Andean Region of Ecuador
19:13	Sergio Ibarra-Espinosa	Direct and indirect effects of aerosols on meteorology and air pollutant concentrations during dry and wet periods on Southeast Brazil
19:21	Andrea Paz Orfanzo-Cheuques	New tropospheric ozone dataset from OMPS/NPP and the detection of enhanced tropospheric ozone above South American megacities
19:29	Laura Gallardo Klenner	Ozone trends at Tololo (30.17° S, 70.80° W, 2154 m a.s.l.) GAW monitoring station in Chile: an update and attribution study.
19:37	Julian Gelman Constantin	EC/OC content in $PM_{2.5}$ in five Latin American cities and megacities: air quality and radiative forcing
19:45	Angela Cristina Vargas Burbano	Understanding aerosol composition in an inter-Andean valley impacted by sugarcane- intensive agriculture and urban emissions.
19:53	Beatriz Herrara	Ammonia temporal variability from urban ground-based FTIR measurements
20:01	Ediclè Fernandes	Modeling amd assimilation of atmospheric aerosols over São Paolo, Brazil wih the regional chemistry transport Eurad-inverse model on high resolution
20:09	Duncan Quevedo	Investigating Air Quality and Emissions Changes from COVID-19 Lockdown Measures in Mexico City with Satellite Observations
20:17	Ana Maria Yañez-Serrano	Amazonian biogenic volatile organic compounds under global change
20:25	Maarten Krol	An atmospheric perspective on Amazon fire emissions
20:33	Tomas Rafael Bolaño Ortíz	Impact of biomass burning aerosol from Amazon associated with changes of snow albedo over the Central Andes mountains using satellite remote sensing data
20:41	Revathi Muralidharan	Changes in Mortality in Response to Decreases in Ozone and $PM_{2.5}$ Concentrations Across the United States from 1990 to 2019
20:49	Lara Bishop	Assessing population exposure to air pollution in Metropolitan Lima and Callao, Peru: Creating a high-resolution spatial emissions inventory with limited data, supported by air quality monitoring

African Group on Atmospheric Sciences (ANGA) Session September 15 2021, 1000-1200 UTC

Time UTC	Speaker	Title
10:00	Youba Sokona	The Africa Integrated Assessment of Air Pollution, Climate Change and Sustainable Development
10:10	Veronique Yoboue	Air pollution in West African cities and some strategies for particulate pollutant emissions reduction
10:20	Sekou Keita	Urban emissions inventories development for air quality modelling in Abidjan and Korhogo cities
10:25	Ezekiel Nyaga	HDM-4 Model Calibration and Estimation of Vehicular Emissions in Nairobi, Kenya
10:30	Mounia Tahri	Assessment of Atmospheric Particulate Matter ($PM_{2.5}$ and $PM_{2.5-10}$) and Source Apportionment in the Ambient Air of Kenitra City, Morocco
10:35	Leonard Kirago	14C-based Source Apportionment of Black Carbon in $PM_{2.5}$ aerosols in Urban Nairobi
10:40	Anne Wambui Mutahi	Atmospheric Particulate Matter and gases at high altitude: a case study at 4760 m on Mt. Kenya
10:45	Samuel Mwaniki Gaita	Optical Properties of Water-Soluble Carbonaceous Aerosols at the Rwanda Climate Observatory
10:50	Raeesa Moolla	Occupational exposure and spatial distribution of BTEX concentrations at Lanseria International Airport
10:55	Simone Thirstrup Andersen	Renoxification on Aerosol Particles over the Atlantic Ocean
11:00	Evelyne Touré	Evidence of Long-Term Trend of Visibility in the Sahel and Coevolution with Meteorological Conditions and Vegetation Cover during the Recent Period
11:05	Timothy Glotfelty	How Has Sub-Saharan Africa's Air Quality and Climate Been Altered by Recent Land Use and Land Cover Change and Emissions Changes?
11:10	Andriannah Mbandi	Learning the lessons of more than 150 years of air quality management: recommendations for future efforts to reduce air pollution
11:15	Cathy Liousse	Characterization of aerosol oxidative potential over African cities: a metric for relating air pollution and health effects
11:20		Discussion
12:00		End of session

Monitoring, Analysis, and Prediction of Air Quality (MAP-AQ) Session
September 14 2021, 1200-0200

Time UTC	Speaker	Title
		First Part, Guy Brasseur: Chair
12:00-12:05		**Introduction**
12:05-12:15	Evelyn Martinez	Air quality modeling with WRF-Chem / DART system for Central Mexico
12:15-12:18	Louisa Emmons	Development of a MUlti-Scale Infrastructure for Chemistry and Aerosols – MUSICA
12:18-12:21	Sylvain Gnamien	Chemical characterization and source apportionment of $PM_{2.5}$ in two West African cities (Korhogo and Abidjan in Cote d'Ivoire)
12:21-12:24	Vanessa Surapipith	Biogenic Volatile Organic Compounds (BVOCs) and roles on Air Quality (Ozone and $PM_{2.5}$) over Northern Thailand
12:24-12:27	Caelos Santo-Olivera	Exploring strategies to improve source apportionment in urban areas: Combination and cross-validation of traditional (EPA-PMF) and new (Multi-Isotopic Fingerprint) models.
12:27-12:30	Alexandros Poulidis	A cross-model examination of the impact of orography and model resolution on pollutant transport
12:30-12:33	Chi Nguyen	Trace metals associated with atmospheric fine particulate matters in the two most populous cities in Vietnam
12:33-12:36	Singdha Aziz	Polycyclic Aromatic Hydrocarbons (PAHs) in the Atmospheric Suspended Particulate Matter from Fertilizer Industries in Bangladesh
12:36-12:39	Omar Amador-Munoz	Impact of air quality management programs on non-criteria and criteria primary atmospheric pollutants in the Metropolitan Zone of Mexico Valley
12:39-12:42	Mounia Tahri	Assessment of Atmospheric Particulate Matter ($PM_{2.5}$ and $PM_{2.5-10}$) and Source Apportionment in the Ambient Air of Kenitra City, Morocco
12:42-12:45	Savita Datta	A new air quality index to measure the impact of urban trees on air quality, human health and secondary pollutant formation
12:45 – 01:00		Discussion

	Second Part, Rajesh Kumar: Chair	
01:00 – 01:10	Habineza Theobard	Rwanda Air pollution assessment and forecasting
01:10 – 01:13	Yvonne Boose	The AQ-WATCH Project - Worldwide Analysis and Forecasting of Atmospheric Composition for Health
01:13 – 01:16	Ruud Janssen	Towards high resolution air quality modeling using large eddy simulation: a case study for Eindhoven, the Netherlands
01:16-01:19	Melisa Diaz Resquin	Assessing the role on two anthropogenic emission inventories on the outcomes of air quality simulations for the metropolitan area of Buenos Aires
01:19-01:22	Aissatou Faye	Assessing nitrogen dioxide intra-urban spatial variability in the West African city of Dakar, Senegal
01:22-01:25	Ariel Scagliotti	Uncertainties propagated from optical properties in aerosol classification schemes
01:25 – 01:28	Ho Wun	Characteristics of Volatile Organic Compounds over Hong Kong Waters in a Pilot Ship Measurement Campaign During Ozone Episode
01:28 – 01:31	Taegyung Lee	Diagnosis and prognosis of air quality in South Korea using the UKESM1 modeling
01:31 – 01:34	Gaurav Gvardhan	Decision support system for air-quality management in Delhi and the surrounding region
01:34 – 01:37	Ying Zhang	Contribution of brown carbon to the light absorption and radiative effect of carbonaceous aerosols from biomass burning emissions in Chiang Mai, Thailand
01:37 – 01:40	Kyle Shores	Towards an automated algorithm for surface $PM_{2.5}$ estimation using stacked machine learning
01:40 – 01:43	Michael Giordano	From Low-Cost Sensors to High-Quality Data: the Importance of Collocated Calibration Model Development
01:43- 01:58		Discussion
01:58 – 02:00		Conclude the session

Analysis of eMIssions using Observations (AMIGO) Session September 15 2021,1500-1700 UTC

Time (UTC)	Speaker	Title
15:00 - 15:05	Hans Schlager & Mian Chin, co-chairs	**Introduction**
	Oral contributions, chair: Claire Granier	
15:05 - 15:10	Karn Vhora	Long-term air quality trends in fast-growing future megacities in the tropics
15:10 - 15:15	Astrid Mueller	How well can satellite derived XCO_2 determine seasonal and interannual changes of CO_2 over oceans? Evaluation by integrated ship and aircraft observations
15:15 - 15:20	Benjamin Gaubert	Meteorology-aerosol-chemistry multiphase data assimilation system improves estimation of wildfire carbonaceous emissions and transport
15:20 - 15:25	Anne Caroline Lange	Improving national emission inventories by advanced spatio-temporal inversion
15:25 - 15:30	Money Guillaume Ossohou	Trends and seasonal variability of ammonia across major biomes inferred from long-term series of ground-based and satellite measurements
15:30 - 15:35	Eloise Marais	Agricultural emissions of ammonia estimated with satellite observations and GEOS-Chem
15:35 - 15:40	Santiago Parraguez	Improving OMI-NO_2 resolution based on deep learning over central and southern Chile
15:40 - 15:45	Xiaomeng Jin	Direct estimates of biomass burning NOx emissions and lifetime using daily observations from TROPOMI
15:45 - 15:50	Jian Liu	A top-down method of estimating NO_2 emissions over South, Southeast and East Asia based on OMI NO_2 observations
15:50 – 15:55	Daniel Goldberg	Satellite-derived NOx emissions for 80 global megacities between 2005 and 2019
	Presentations of poster summaries, chair: Jenny Stavrakou	
15:55 – 16:00	Jennifer Kaiser	AMIGO-A: 102, 34, 142, 272, 369, 481, 515 and 569
16:00 – 16:05	Daven Henze,	AMIGO-A: 637, 663, 699, 775, 814, 434, 377
16:05 - 16:10	Kazuyuki Miyazaki	AMIGO-B: 87, 211, 319, 444, 500, 567, 605
16:10 - 16:15	Dylan Jones	AMIGO-B: 642, 672, 771, 791, 818, 583, 556
16:15: 16:20	Ave Arellano	AMIGO-C: 134, 335, 456, 505, 613, 648, 675, 793, 149, 667
16:20 – 16:25	Claire Granier	AMIGO-D (i.e. posters also in other sessions): 140, 307, 321, 479, 521, 522, 531, 578, 798
	Questions/Answers Session, chair: Ave Arellano	
16:25 – 16:50	All speakers will be panelists, and questions from the chat will be discussed.	
If time remains	Conclusion by the panelists	

Southern Hemisphere Working Group Session

Part A: September 15 2021, 2200-2300 UTC

Part B: September 16 2021, 0600-0700 UTC

Part C: September 2, 2021, 1100 UTC

The Southern Hemisphere Working Group session presents key issues in atmospheric composition research that particularly impact the Southern Hemisphere (such as biogenic emissions, fires and the Southern Ocean).

The session will take the format of two dedicated one-hour poster sessions in Gather.town followed by a wrap-up discussion of the science at the start of the side-meeting.

Part A: September 15 2021, 2200-2300 UTC

Time UTC	Posters	Title
		Highlighted posters in Part A
2200	Pablo Medina, Sergio Luppo, Sergio Camargo, Lino Condorí	Update of Tropospheric Ozone trends at Ushuaia GAWStation.
	Ramiro Espada, Pablo Lichtig, Melisa Diaz Resquin, Cristina Rössler, Laura Dawidowski, Guy Brasseur	Dust emissions modelling over the semi-arid Argentinian territory.
	Pablo Lichtig, Facundo Baraldo, Julián Gelman Constanin, Julio Murillo Hernández, José Herrera Murillo, Darío Gómez, Laura Dawidowski	Quantification and characterization of $PM_{2.5}$ in Buenos Aires, Argentina.
	Valter Duo Filho, Dulcilena Castro e Silva	Mass spectrometry system (MALDI-TOF) validation in the identification of Aspergillus Nigri Section species of atmospheric air from São Paulo, Brazil.
	Gregori Moreira, Marcia Marques, Maria Andrade, Eduardo Landulfo	The influence of ventilation coefficient on carbon monoxide concentration in São Paulo city: An observation from lidar data.
	Nicolas Huneeus, Paula Castesana, Laura Dawidowski, Mauricio Osses, Enrique Puliafito, Marcelo Alonso, Maria de Fatima Andrade, Laura Gallardo, Camilo Menares, Nestor Rojas, Odón Sánchez-Ccoyllo, Sebastián Tolvett, Rita Ynoue	Anthropogenic air pollutant emission inventories for South America.

	Victória Peli, Rosana Astolfo, Adalgiza Fornaro	Particulate matter mass concentration in different size fractions related to meteorological variables in the Metropolitan Area of São Paulo.
	Constanza Urbina, Laura Gallardo, Rodrigo Seguel	AVOC and BVOC sensitivity study for ozone pollution in Santiago, Chile combining observations and a box model.
	Maria Ruggeri, Tomás Bolaño-Ortiz, Víctor Vidal, Salvador Puliafito, Francisco Cereceda-Balic	Black Carbon atmospheric emissions from biomass burning in the Amazon reaching the Chilean Central Andes: evidence from a multi-technical approach.
	William Daniels, Rebecca Buchholz, Helen Worden, Fatimah Ahamad, Dorit Hammerling	Using Climate Mode Indices to Forecast Carbon Monoxide Variability in Fire-Prone Southern Hemisphere Regions.
	Kristina Pistone, Paquita Zuidema, Rob Wood, Michael Diamond, Arlindo da Silva, Gonzalo Ferrada, Pablo Saide, Ju-Mee Ryoo, Rei Ueyama	Biomass burning smoke and coincident water vapor over the southeast Atlantic stratocumulus region: results from observations and models.

Part B: September 16 2021, 0600-0700 UTC

Time UTC	Speaker	Title
		Highlighted posters in Part B
0600	Rabbison Banda, Patrick Hayumbu, Nandi Mumba	Radon Dosimetry in Nchanga Underground Mine on The Copperbelt Province.
	Sive Xokashe, Kurt Spence, Katye Altieri	Prediction of Aerosol acidity in the remote marine boundary layer of the southern ocean during summer.
	Sean Lam	Development of a regional airshed chemical transport model for priority airsheds in Western Australia.
	Lily Sheridan, Jenny Fisher	Intercontinental Air Pollution Transport in the Southern Hemisphere.
	Jhonathan Ramirez, Jenny Fisher, Kathryn Emmerson	Identifying the factors driving the Biogenic VOC uncertainty in CTM models in south-east Australia.
	Clare Murphy (Paton-Walsh)	An Overview of the COALA-2020 campaign at Cataract (Characterising Organics and Aerosol Loading in Australia).
	Kathryn Emmerson, Malcolm Possell, Michael Aspinwall, Sebastian Pfautsch, Mark Tjoelker	Temperature response measurements from eucalypts give insight into the impact of Australian isoprene emissions on air quality in 2050.

Shyno Susan John, Nicholas Deutscher, Clare Paton-Walsh, David Griffith, Voltaire Velazco, Tianjia Liu, Loretta Mickley	Can we see the impact of indigenous fire management on the interannual variability of carbon monoxide?
Adhitya Sutresna, Melita Keywood, Clare Murphy, Ruhi Humphries, Peter Rayner, Robyn Schofield	Mapping the sources of organic PM1: A case study from the COALA campaign in Southeast Australia. Jack Simmons,
Ruhi Humphries, Melita Keywood, Sean Gribben, Ian McRobert, Jason Ward, Paul Selleck, Sally Taylor, James Harnwell, Connor Flynn, Gourihar Kulkarni, Gerald Mace, Alain Protat, Simon Alexander, Greg McFarquhar	Southern Ocean latitudinal gradients of Cloud Condensation Nuclei.

Relevant posters high-lighted in other sessions:

Ediclê Duarte, Philipp Franke, Anne Lange, Fábio Lopes, Elmar Friese, Cláudio Silva, Hendrik Elbern, Judith Hoelzemann, Jean Reis	AMERICAS-6C. Modelling and assimilation of Atmospheric Aerosols over Sao Paulo – Brazil with regional chemistry transport EURAD-Inverse model on high-resolution.
Laura Gallardo, Camilo Menares, Carmen Vega, Claudia Villarroel, Nikos Daskalakis, Maria Kanakidou, Charlie Opazo, Rodrigo Seguel	AMERICAS-9C. Ozone trends at Tololo (30.17° S, 70.80° W, 2154 m a.s.l.) GAW monitoring station in Chile: an update and attribution study.
Karn Vohra, Eloise Marais, William Bloss, Erin McDuffie, Martin Van Damme, Lieven Clarisse, Pierre Coheur	AMIGO-5B. Long-term air quality trends in fast-growing future megacities in the tropics.
Timothy Glotfelty, Diana Ramírez-Mejía, Jared Bowden, Adrian Ghilardi, Ashley Bittner, Andrew Grieshop, Robert Bailis, J. Jason West	ANGA-12C. How Has Sub-Saharan Africa's Air Quality and Climate Been Altered by Recent Land Use and Land Cover Change and Emissions Changes?
Jessica Burger, Kurt Spence, Julie Granger, Katye Altieri	CATCH-10A. The importance of alkyl nitrates and sea ice emissions to atmospheric NOx sources and cycling in the summertime Southern Ocean marine boundary layer.
Srishti Dasarathy, Jesse Wilson, Jeff Bowman	CATCH-11B. A Southern Ocean-wide examination of Multi-year Trends in Sea Ice, Chlorophyll Concentration, and Marine Aerosol Optical Depth

Peter Neff, Vasilii Petrenko, David Etheridge, Andrew Smith, Edward Crosier, Benjamin Hmiel, David Thornton, Lenneke Jong, Ross Beaudette, Christina Harth, Ray Langenfelds, Blagoj Mitrevski, Mark Curran, Christo Buizert, Lee Murray, Cathy Trudinger, Michael Dyonisius, Jessica Ng, Jeff Severinghaus, Ray Weiss	CATCH-12C. 14CO in Glacial Ice from Law Dome, Antarctica as a Tracer of Changes in Atmospheric OH Abundance from 1870 AD to Present.
Maria Pérez-Peña, Jenny Fisher, Scott Kable	FF-16A. An evaluation of the unexplored generation of hydrogen from the photolysis of aldehydes using two photochemistry models.
Mauricio Osses, Cecilia Ibarra, Kevin Basoa, Sebastian Tolvett, Laura Gallardo, Nicolas Huneeus	GEIA-11B. Forecasting policy, innovation and new technologies for reducing transport emissions in Chile 2020-2050.
Kevin Basoa, Camilo Menares, Laura Gallardo, Nicolás Huneeus Mauricio Osses, Peter Wind, Alvaro Valdebenito	MAPAQ-18C. Black carbon dispersion in central and southern Chile in winter and summer 2016.
René Parra	MAPAQ-29B.Effect of Global Atmospheric Datasets in Modeling Meteorology and Air Quality in the Andean Region of Ecuador.
Carlos Souto-Oliveira, Leonardo Kamigauti, Marly Babinski, Maria Andrade	MAPAQ-44B. Exploring strategies to improve source apportionment in urban areas: Combination and cross-validation of traditional (EPA-PMF) and new (Multi-Isotopic Fingerprint) models.
Ariel Scagliotti, Josefina Urquiza, Sebastián Diez	MAPAQ-48C. Uncertainties propagated from optical properties in aerosol classification schemes.
Sergio Espinosa, Gyrlene Mendes da Silva, Amanda Rehbein, Angel Vela, Edmilson De Freitas	MAPAQ-4A. Direct and indirect effects of aerosols on meteorology and air pollutant concentrations during dry and wet periods on Southeast Brazil
Florence Brown, Stephen Sitch, Gerd Folberth, James Haywood	TOAR-40A. Multimodel evaluation of present-day and climate-driven changes in surface ozone over Africa and South America.

Part C: September 20 2021, 1100 UTC
Side-Meeting Agenda

Time UTC	Speaker	Science wrap-up/discussion Questions/Discussion will follow each area of interest
1100	Clare Murphy	**Introduction**
	Kathryn Emmerson	Biogenics
	Rebecca Buchholz	Fires
	Ruhi Humphries	Southern Ocean
	Nicholas Huneas	Air Quality
	Melita Keywood	Composition/Chemistry
	Gustavo	Demonstration of the Zotero library including how to search for papers and how to add papers
		What else do people want from this group?
		Leadership rotation plans

China Working Group (CWG) Session
September 16 1000-1200 UTC

Time UTC	Speaker	Title
10:00	Tong Zhu	Health Effects of Global Air Pollution on Reproduction: from Fertility Rate Reduction in United States, to Pregnancy Loss in Africa, and Preterm Births in Beijing China
10:20	Athanasios Nenes	**Invited talk** (20 min) Aerosol Acidity and Water Content as a Driver of Aerosol Formation, Intense Haze Events and Nutrient Deposition
10:40	Mingjin Tang	Hygroscopicity of fresh and aged mineral dust aerosol
10:48	Huan Liu	Atmospheric Environmental Impacts of Freight Transportation
10:56	Yingjun Liu	Dibasic Esters Observed as Potential Emerging Indoor Air Pollutants in New Apartments in Beijing, China
11:04	Cheng Liu	Stereoscopic remote sensing of atmospheric trace gases
11:12	Jie Li	Effects of Regional Transport on Haze in the North China Plain: Transport of Precursors or Secondary Inorganic Aerosols
11:20	Shengrui Tong	The researches of unstable reactive oxidants in the atmosphere
11:28	Yang Gao	The impact of climate change and extreme weather events on ozone formation
11:36	Jian Zhen Yu	Terpene-derived Nitrooxy Organosulfates
11:44	Keding Lu	Study on the ozone photochemistry in China
11:52	Chunxiang Ye	First comprehensive measurements on atmospheric photochemistry over the Tibetan Plateau

TOAR
tropospheric
ozone
assessment
report

Troposphereic Ozone Assessment Report (TOAR-II) Session September 16 2021, 1200-1400 UTC

Time (UTC)	Speaker	Title
12:00	Owen Cooper, Martin Schultz	**Introduction**
	Block 1 – Assessing ozone induced health impacts	
12:03	Paul Brewer	Implementation of a New Value of the Ozone Absorption Cross-section per Molecule at 253.65 nm (air) for Global Atmospheric Ozone Measurement
12:13	Jason West	Global Surface Ozone Concentration Mapping Through Data Fusion at Fine Resolution for 1990 to 2017 to Support Health Impact Assessment
12:23	Andrea Paz Orfanoz-Cheuquelaf	New tropospheric ozone dataset from OMPS/NPP and the detection of enhanced tropospheri cozone above South American megacities
12:33	Raeesa Moolla	Discussion
	Block 2 – Assessing ozone induced vegetation impacts	
12:41	Tamara Emmerichs	Global direct and in-direct effects of heat-stressed vegetation on ozone extremes
12:51	Meiyun Lin	Vegetation feedbacks during drought exacerbate ozone air pollution extremes inEurope
13:01	Vinod Kumar	High ozone over the bread basket of India ramped up by isoprene andacetaldehyde
13:11	Baerbel Sinha	Discussion
	Block 3 – Assessing climate impacts due to ozone	
13:19	Maria Tsivlidou	Distribution and seasonal variability of ozone and carbon monoxide over the tropics with 20 years of measurements
13:29	Xiaolin Wang	Trends of Surface and Tropospheric Ozone over Southeast Asia and their drivers during 2005 to 2014
13:39	Flossie Brown	Multimodel evaluation of present-day and climate- driven changes in surface ozone over Africa and SouthAmerica
13:49	HelenWorden	Discussion
13:57	Owen/Martin	Wrap up and announcement of November TOAR-II workshop
14:00		End of session

Chemistry-Climate Model Initiative (CCMI) Session
September 16 2021, 1400-1600 UTC

Time UTC	Speaker	Title
1400 – 1405		**Introduction**
1405 – 1417	Joao Teixera	Coupling interactive fire with atmospheric composition and climate in the UK Earth System Model (UKESM)
1417 – 1429	Ren Fangxuan	Evaluation of CMIP6 model simulations of $PM_{2.5}$ components in China
1429 – 1441	Surendra Kunwar	Dynamical downscaling of a global chemistry-climate model to study the influence of climate change and variability on mid-21st century $PM_{2.5}$ in the continental US
1441 – 1453	William Collins	Climate-driven chemistry and aerosol feedbacks in Earth system models
1453 – 1505	Swaleha Inamdar	An overview of iodine chemistry over the Indian and Southern Ocean waters using ship-based observations and modelling
1505 – 1517	Domenico Taraborrelli	A large source of formic acid from cloud droplets
1520 – 1600	Three to four break-out groups	~60s summaries of CCMI posters followed by general discussions.

the Cryosphere and Atmospheric Chemistry (CATCH) Session September 17 2021, 1200-1400 UTC

Time UTC	Speaker	Title
1200-1205	Jakob Pernov*	**Introduction** Trend analysis of aerosol particle physical properties at Villum Research Station, Northern Greenland.
1210-1215	Jessica Mirrielees*	Sea Spray Aerosol Generation Experiments in the Summertime High Arctic Pack Ice.
1215-1220	Sérgio J. Gonçalves, Jr.*	Characterization and chemical imaging of aerosol in West Antarctica.
1220-1225	Alexander Kurganskiy*	The evolving sources of cloud condensation nuclei in the Arctic and North Atlantic: preliminary results from the SEANA project.
1225-1245	Jessica Burger*	**Discussion I** The importance of alkyl nitrates and sea ice emissions to atmospheric NOx sources and cycling in the summertime Southern Ocean marine boundary layer.
1250-1255	Anoop Mahajan	Observations of iodine monoxide over three summers at the Indian Antarctic bases, Bharati and Maitri.
1255-1300	Peter Neff	14CO in Glacial Ice from Law Dome, Antarctica as a Tracer of Changes in Atmospheric OH Abundance from 1870 AD to Present.
1300-1305	Shohei Hattori	Acidity-driven enhancement of sulfate formation after SO_2 emission control evidenced by 17O- excess of ice core sulfate.
1305-1325	Daun Jeong*	**Discussion II** Using gas phase, particle, and snow composition data to understand the spring shutdown of reactive bromine cycling in the Arctic boundary layer.
1330-1335	Amelia Bond*	Reactive nitrogen species in polar environments: a laboratory-based study of nitrous acid gas (HONO) production from snow.
1335-1340	Kathryn Kulju*	Urban inland wintertime N_2O^5 deposition and snowpack $ClNO_2$ production.
1340-1400		**Discussion III**

*Early career researcher

PACES
air Pollution in the Arctic:
Climate Environment and Societies

Air Pollution in the Arctic: Climate, Environment and Societies (PACES) Session
September 17 2021, 1400-1600 UTC

Time (UTC)	Speaker	Title
14.00	Steve Arnold, Kathy Law (co-chairs)	**Introduction**
		Session 1: Sources of aerosols and trace gases in the Arctic
14.10	Mark Parrington	Evaluating air quality and atmosphere composition impacts of Arctic wildfires in the summers of 2019 and 2020 (12 + 3 mins)
14.25	Tianlang Zhao*	Source and variability of formaldehyde (HCHO) vertical column density at northern high latitudes: an integrated satellite, ground/ aircraft, and model perspective (5 mins)
14.30	Tyler Wizenberg*	Observations of extreme wildfire enhancements of CH3OH, HCOOH, and PAN over the Canadian high Arctic (5 mins)
14.35	Yugo Kanaya	Ozone and carbon monoxide observations over open oceans on R/V Mirai from 67° S to 75° N during 2012 to 2017: Testing global chemical reanalysis TCR-2 in terms of Arctic processes and low ozone levels at low latitudes (5 mins)
14.40	Arnold Downey*	Size-resolved elemental analysis of high-latitude mineral dust aerosol in Kluane National Park, Yukon (5 mins)
14.45		Discussion including replies to questions posted on https:// board.net/ p/igac_ paces
15.00		Break: 5 mins
		Session 2: Arctic SLCFs and air pollution
15.05	Cyndi Whaley	Model simulations of short-lived climate forcers in the Arctic (12 + 3 mins)
15.20	Ulas Im	Future radiative forcing over the Arctic (5 mins)
15. 25	Eleftherios Ioannidis*	Wintertime anthropogenic Arctic air pollution over Alaska (5 mins)
15.30	Sarah Johnson*	Modelling atmospheric chemistry and vertical transport in Fairbanks, Alaska (5 mins)
15.35		Discussion including questions/answers
15.50		PACES upcoming meetings and activities
16.00		End of session

*Early career researcher

Poster	Title	Presenter	Cross Reference
ACAM-1A	Transport of black carbon from the planetary boundary layer to free troposphere during the summer monsoon over South Asia	Prashant Singh	CCMI, MANGO
ACAM-2B	The PM2.5 carbonaceous abundance and chemical constituents in ambient atmosphere of tropical urban city	Hanashriah Hassan	MANGO
ACAM-3C	Ozone and carbon monoxide over the northern Indian Ocean during winter and monsoon: influence of chemistry and dynamics	Imran Girach	TOAR, MANGO
ACAM-4A	Photochemistry over an urban environment in India: Integration of measurements with box model	Meghna Soni	MANGO
ACAM-5B	Organic, inorganic and total bromine in the extratropical tropopause and lowermost stratosphere in fall 2017: Origins, transport pathways and consequences for ozone	Meike Rotermund	AMIGO
ACAM-6C	Exploring potential impacts of Black Carbon on vertical mixing and overall air quality over Northern India	Prerita Agarwal	
ACAM-7A	Non-targeted screening of halogenated organosulfates in atmospheric particles	Ke Gao	China WG
ACAM-8B	Accuracy assessment of TRMM precipitation product across different Agro-Climatic Zones of Tamil Nadu, India	Venkadesh Samykannu	MANGO
ACAM-9C	Impacts of biomass burning over Southeast Asia on regional air quality, radiation, and meteorology	Jiawei Li	China WG
ACAM-10A	Comparisons between satellite and CTM model derived total columns of ammonia over South and East-Asia	Pooja Pawar	CCMI, MAP-AQ
ACAM-11B	The substantial modulation of vertical mixing on new particle formation in Yangtze River Delta	Shiyi Lai	China WG
ACAM-12C	Interannual variability of aerosol in the upper troposphere/lower stratosphere (UTLS): Connection to the climate variability, Asian summer monsoon strengths, and emissions	Mian Chin	
ACAM-13A	Storage stability of VOC in canisters under different conditions in HongKong	Yuchen Mai	China WG
ACAM-14B	Light Absorption Properties of Atmospheric Brown Carbon during Winter in Dhaka, Bangladesh.	Asfay Raihan	MANGO
ACAM-15C	Combining Multi-Wavelength AERONET SSA Retrievals with an MIE Model and UV AI from OMI to Quantify the Global AAOD of BC and OC	Xinying Wang	China WG
ACAM-16A	Linkage of water vapor distribution in the lower stratosphere to organized Asian summer monsoon convection	Bhupendra Bahadur Singh	
ACAM-17B	Light Absorption Properties of Brown Carbon from the Biomass Burning	Md. Islam	MANGO

Poster	Title	Presenter	Cross Reference
ACAM-18C	Transport of air in the region of the Asian monsoon anticyclone and its impact on the stratosphere	Bärbel Vogel	
ACAM-19A	Atmospheric outflow of anthropogenic iron and its deposition to China adjacent seas	Xiaohuan Liu	China WG
ACAM-20B	Intensified modulation of winter aerosol pollution in China by El Niño with short duration	Liangying Zeng	MAP-AQ, China WG
ACAM-21C	Simultaneous trace gas measurements of the HALO aircraft: Widespread detection of HONO in excess of model predictions during the EMeRGe-EU and -Asia campaigns and its possible formation mechanisms.	Benjamin Schreiner	AMIGO, MAP-AQ
ACAM-22A	Oxygenated volatile organic compounds measurement using proton transfer reaction time-of-flight mass spectrometry in Hong Kong: characteristics, chemical reactivities, and source apportionment	Lirong Hui	AMIGO, CATCH, CCMI, GEIA, MAP-AQ, PACES, TOAR, China WG
ACAM-23B	TCCON Nicosia: First ground-based FTIR greenhouse gas measurements in the Eastern Mediterranean and Middle East region	Constantina Rousogenous	
ACAM-24C	Carbon and health implications of trade restrictions	Lulu Chen	GEIA, MAP-AQ, China WG
ACAM-25A	Compositional Analysis of Cloud Droplet Residuals by High Resolution Time-of-Flight Aerosol Mass Spectrometry: A CAMP2Ex Case Study	Claire Robinson	
ACAM-26B	Observations of Regional Biomass Burning and Urban Trace Gas Enhancement Ratios in Southeast Asia and their Relationship with Aerosol Composition and Air Quality	Joshua DiGangi	MAP-AQ, MANGO
ACAM-27C	The Implication of Oil Production to Ozone Chemistry in the Oilfield Regions of Northern China	Tianshu Chen	CATCH, MAP-AQ, Americas WG, China WG
ACAM-28A	Airborne and Satellite Investigation of Asian Air Quality (ASIA-AQ): An Opportunity for International Collaboration	James Crawford	AMIGO, GEIA, MAP-AQ, MANGO
ACAM-29B	Aerosol structure, absorption and interactions with the PBL and impact on surface pollution	Zhanqing Li	
ACAM-30A	Decadal trend of black carbon aerosols over the Central Himalayas: 17 years of ground observations	Priyanka Srivastava	AMIGO, CATCH, CCMI, GEIA, MAP-AQ, PACES, TOAR, MANGO
ACAM-31A	Quantitative Assessment of Black Carbon over Southern China During Springtime: Regional and Sectoral Sources and the Impacts of East Asian Summer Monsoon Onset	Chenwei Fang	MAP-AQ, China WG, MANGO
ACAM-32B	Aromatics derived oxygenated organic molecules in Hong Kong: Source, formation and impacts	Penggang Zheng	AMIGO, CATCH, CCMI, GEIA, MAP-AQ, TOAR, China WG
ACAM-33C	Aqueous production of secondary organic aerosol from fossil-fuel emissions in winter Beijing haze	Junfeng Wang	China WG
ACAM-34A	Investigation of Dust Transportation Effects on Meteorological Parameters in Turkey: A Case Study in 2020	Umur Dinç	CCMI, MAP-AQ

Poster	Title	Presenter	Cross Reference
ACAM-35B	Chemical formation pathways of secondary organic aerosols in theBeijing-Tianjin-Hebei region in wintertime	Jie Li	China WG
AMERICAS-1A	Amazonian biogenic volatile organic compounds under global change	Ana Yañez-Serrano	AMIGO, GEIA
AMERICAS-2B	Air pollution measurements in Coyhaique, Patagonia	Zoe Fleming	
AMERICAS-3C	Assessing population exposure to air pollution in Metropolitan Lima and Callao, Peru: Creating a high-resolution spatial emissions inventory with limited data, supported by air quality monitoring	Ben Richmond	AMIGO, GEIA
AMERICAS-4A	Ammonia temporal variability from urban ground-based FTIR measurements	Beatriz Herrera	AMIGO
AMERICAS-5B	Air-borne measurements of CH2O, C2H2O2, and C3H4O2* and CO over the Amazon and their biomass burning emission ratios and emission factors in biomass burning plumes	Flora Kluge	AMIGO
AMERICAS-6C	Modeling and Assimilation of Atmospheric Aerosols over São Paulo-Brazil with the Regional Chemistry Transport EURAD-Inverse Model on High-Resolution	Ediclê Duarte	AMIGO, GEIA, MAP-AQ, Southern Hemisphere WG
AMERICAS-7A	An atmospheric perspective on Amazon fire emissions	Maarten Krol	AMIGO, MAP-AQ
AMERICAS-8B	Changes in Mortality in Response to Decreases in Ozone and PM2.5 Concentrations Across the United States from 1990 to 2019	Revathi Muralidharan	AMIGO, CCMI, GEIA, MAP-AQ, TOAR
AMERICAS-9C	Ozone trends at Tololo (30.17° S, 70.80° W, 2154 m a.s.l.) GAW monitoring station in Chile: an update and attribution study.	Laura Gallardo	TOAR, Southern Hemisphere WG
AMERICAS-10A	Assessment of TOAR Ozone Metrics Distributions over Latin American Cities	Angel Gálvez	TOAR
AMERICAS-11B	Assessing brown carbon light absorption from aerosol optical properties in Mexico City	Armando Retama	MAP-AQ
AMERICAS-12C	Hourly variation of polycyclic aromatic hydrocarbons in a receptor site in Mexico City during the cold dry season	Yadira Martínez-Domínguez	MAP-AQ
AMIGO-1A	Solar induced fluorescence and NO2 measurements from TROPOMI to constrain NO2 deposition fluxes to vegetation	Erin Delaria	MAP-AQ
AMIGO-2B	Ambient characterization of marine shipping emissions at the Port of Ningbo-Zhoushan on the coast of East China Sea	Dantong Liu	China WG
AMIGO-3C	Source Apportionment of Volatile Organic Compounds and Trace Metals in Houston	Morshad Ahmed	ACAM
AMIGO-4A	Trends and seasonal variability of ammonia across major biomes inferred from long-term series of ground-based and satellite measurements	Money Ossohou	CATCH, ANGA

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AMIGO-5B	Long-term air quality trends in fast-growing future megacities in the tropics	Karn Vohra	ACAM, MAP-AQ, ANGA, MANGO, SH WG
AMIGO-6C	Global-Scale In-Situ Measurements of Aerosol Optical Depth: An Overview from the Atmospheric Tomography (ATom) Project	Charles Brock	
AMIGO-7A	Satellite-Based Emission Estimates of Tropospheric Bromine During Arctic Spring in the GEOS-Chem Model	Pamela Wales	
AMIGO-8B	Evaluating the detectability of methane point sources from satellite observing systems using microscale modeling	Piyush Bhardwaj	GEIA, Americas WG
AMIGO-9C	How well can satellite derived XCO2 determine seasonal and interannual changes of CO2 over oceans? Evaluation by integrated ship and aircraft observations	Astrid Müller	GEIA, MAP-AQ, Japan NC, MANGO
AMIGO-10A	Anthropogenic point sources of ethylene revealed from space	Bruno Franco	MAP-AQ
AMIGO-11B	Meteorology-aerosol-chemistry multiphase data assimilation system improves estimation of wildfire carbonaceous emissions and transport	Benjamin Gaubert	Americas WG, ANGA
AMIGO-12C	Impact of the Raikoke volcanic eruption 2019 on the Northern Hemisphere UT/LS aerosol load and properties as seen from IAGOS-CARIBIC in-situ observations	Andreas Petzold	MAP-AQ
AMIGO-13A	Improving national emission inventories by advanced spatio-temporal inversion	Anne Caroline Lange	MAP-AQ
AMIGO-14B	Evaluation of new 4D-variational inverse modeling system, CIF-CHIMERE: Inversion of NOx emissions over China using NO2 OMI observations	Dilek Savas	GEIA
AMIGO-15C	Tropospheric NO2 observed from space with Copernicus Sentinel-5 Precursor TROPOMI: Validation with ground-based network data.	Tijl Verhoelst	MAP-AQ
AMIGO-16A	Agricultural emissions of ammonia estimated with satellite observations and GEOS-Chem	Eloise Marais	ANGA
AMIGO-17B	New insights on NOx sources and sinks from the divergence of the mean flux	Steffen Beirle	GEIA
AMIGO-18C	Using WRF-Chem Volcano to model the in-plume halogen chemistry of Etna’s 2018 eruption	Luke Surl	
AMIGO-19A	Contribution of fossil fuel sources to PM2.5 in Seoul constrained by carbon, nitrogen, and oxygen isotopic ratios	Meehye Lee	TOAR
AMIGO-20B	Expanded observations of oxygenated organic compounds in urban emissions via ammonium-adduct chemical ionization mass spectrometry	Drew Gentner	GEIA
AMIGO-21C	Assimilating CrIS Observations to Improve U.S. Ammonia Emissions within CMAQ	Shannon Capps	

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AMIGO-22A	A comprehensive analysis of shipping emissions over the Mediterranean and the Black Sea regions	Andreas Pseftogkas	
AMIGO-23B	4D-Var inversion of European NH3 emissions using CrIS NH3 measurements and GEOS-Chem adjoint with bi-directional and uni-directional flux schemes	Hansen Cao	
AMIGO-24C	Swiss Halocarbon Emissions Derived from Regional Atmospheric Measurements	Dominique Rust	GEIA
AMIGO-25A	Refining Ammonia Emissions Estimates with Satellite-based Observations Using a Novel Framework and an Air Quality Model	Congmeng Lyu	Americas WG
AMIGO-26B	Modeling methane from the North Sea region with ICON-ART	Christian Scharun	CCMI, GEIA
AMIGO-27C	TROPOMI based NOx emission estimate for Asia	Hao Kong	GEIA, China WG
AMIGO-28A	Investigation of the temporal and spatial variability of methane flux estimations from mass balance approach, using FLEXPART-WRF methane fields	Sarah-Lena Meyer	GEIA, MAP-AQ
AMIGO-29B	Sources of PM2.5 and BC in Beijing Based on Hourly Continuous Online Measurements from 2016 to 2019	Yue Liu	China WG
AMIGO-30C	Direct estimates of biomass burning NOx emissions and lifetime using daily observations from TROPOMI	Xiaomeng Jin	GEIA
AMIGO-31A	Brown Carbon in Harbin, China during the heating season of 2018	Jiumeng Liu	MAP-AQ, China WG
AMIGO-32B	A new divergence method to quantify methane emissions using observations of Sentinel-5P TROPOMI	Mengyao Liu	
AMIGO-33C	Globally Significant methane fluxes from African tropical wetlands	Jacob Shaw	
AMIGO-34A	Improving OMI-NO2 resolution based on deep learning over central and southern Chile	Santiago Parraguez	GEIA, Americas WG
AMIGO-35B	High-resolution tropospheric NO2 satellite retrieval in Asia based on OMI	Yuhang Zhang	MAP-AQ, China WG
AMIGO-36C	Estimation of Marine Isoprene Production and Emission based on Geostationary Satellite Remote Sensing Observations	Wentai Zhang	ACAM, GEIA, China WG
AMIGO-37A	Global-Scale Observation and Evaluation of Nitrous Oxide from IASI: Application to Source Estimates	Philippe Ricaud	
AMIGO-38B	Reconciling Assumptions in Bottom Up and Top Down Approaches for Estimating Aerosol Emissions from Wildland Fires in the Western US using Observations from FIREX-AQ	Elizabeth Wiggins	Americas WG

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AMIGO-39C	3 years of urban CO2 emissions in the San Francisco Bay Area inferred from a low-cost monitoring network	Alexander Turner	Americas WG
AMIGO-40A	Applications of satellite-derived NOx emissions	Ronald van der A	
AMIGO-41B	Temporal variations of atmospheric NH3 revealed from space: from intraday cycles to long-term global trends	Lieven Clarisse	ACAM, GEIA, MAP-AQ
AMIGO-42C	Optimizing carbon monoxide emission estimates from Californian wildfires through inverse modeling based on high-resolution satellite observations	Johann Nüß	GEIA
AMIGO-43A	Satellite-derived NOx emissions for 80 global megacities between 2005 and 2019	Daniel Goldberg	
AMIGO-44B	Estimation of NOx, SO2 and HCHO emissions from the Megacity of Lahore, Pakistan using car MAX-DOAS observations and comparison with regional atmospheric chemistry model and TROPOspheric Monitoring	Maria Razi	
AMIGO-45C	Airborne greenhouse gas (CO2 and CH4) measurements in Cyprus	Yunsong Liu	
AMIGO-46A	Insights of the Accuracy of Bottom-Up and Top-Down Local Emission Inventories through High-Resolution Atmospheric Modeling	Carlos Gonzalez	GEIA, Americas WG
AMIGO-47B	Identification of major air pollutant source location in India using satellite data and statistical-based analysis	Abhishek Chhari	ACAM, MAP-AQ, MANGO
AMIGO-48C	Propane emission estimates over Europe using observations and an inverse modelling approach	Francesco Graziosi	
AMIGO-49A	Methane and non-methane hydrocarbons concentrations and sources in an Eastern Mediterranean Island (Cyprus)	Emeric Germain-Piaulenne	ANGA
ANGA-1A	The local and remote climate and human health impacts of Africa’s 21st century aerosol emission trajectory	Chris Wells	CCMI, MAP-AQ
ANGA-2B	Dominant contribution of nitrogen compounds in precipitation chemistry in the Lake Victoria catchment (East Africa)	Adama Bakayoko	CATCH
ANGA-3C	Characterization of aerosol oxidative potential over African cities: a metric for relating air pollution and health effects	Cathy Leal-Liousse	GEIA
ANGA-4A	Assessment of Respirable Crystalline Silica Exposure among Miners of Konkola Underground Mine	Mwaba Sifanu	MAP-AQ
ANGA-5B	Review of Occupational Exposure to Respirable Crystalline Silica to Mineworkers at Mopani Mufulira Mine in Zambia	Lubinda Nabiwa	MAP-AQ, PACES
ANGA-6C	Evidence of Long-Term Trend of Visibility in the Sahel and Coevolution with Meteorological Conditions and Vegetation Cover during the Recent Period	N'Datchoh Toure	AMIGO, GEIA, MAP-AQ

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ANGA-7A	14C-based Source Apportionment of Black Carbon in PM2.5 aerosols in Urban Nairobi	Leonard Kirago	AMIGO, MAP-AQ
ANGA-8B	Learning the lessons of more than 150 years of air quality management: recommendations for future efforts to reduce air pollution	Aderiana Mbandi	
ANGA-9C	Optical Properties of Water-Soluble Carbonaceous Aerosols at the Rwanda Climate Observatory	Samuel Mwaniki Gaita	ACAM, MAP-AQ
ANGA-10A	Urban emissions inventories development for air quality modelling in Abidjan and Korhogo cities	Sekou Keita	AMIGO, GEIA,
ANGA-11B	HDM-4 Model Calibration and Estimation of Vehicular Emissions in Nairobi, Kenya	Ezekiel Nyaga	GEIA, MAP-AQ
ANGA-12C	How Has Sub-Saharan Africa's Air Quality and Climate Been Altered by Recent Land Use and Land Cover Change and Emissions Changes?	Timothy Glotfelty	Southern Hemisphere WG
ANGA-13A	Atmospheric Particulate Matter and gases at high altitude: a case study at 4760 m on Mt. Kenya	Anne Mutahi	MAP-AQ
ANGA-14B	Occupational exposure and spatial distribution of BTEX concentrations at Lanseria International Airport	Raeesa Moolla	
ANGA-15C	Air pollution in West African cities and some strategies for particulate pollutant emissions reduction.	Veronique Yoboue	
ANGA-16A	The Africa Integrated Assessment of Air Pollution, Climate Change & Sustainable Development in Africa	Youba Sokona	
BB-1A	Evolution of organic aerosol from wood smoke influenced by burning phase and solar radiation	Siyuan Li	ACAM, AMIGO, China WG
BB-2B	Uncertainty in fire emission factors and the impact on modeled atmospheric CO and O3	Rebecca Buchholz	AMIGO, GEIA, MAP-AQ, TOAR
BB-3C	Using observations of Western U.S. wildfire smoke to improve fire emissions in air quality forecasting models	Megan Bela	MAP-AQ, Americas WG
BB-4A	Employing the model to reproduce aerosol transport characteristics over Southeast Asia: comparison of different biomass burning emission inventories	Shuo Wang	ACAM, GEIA, MAP-AQ, Americas, China, MANGO
BB-5B	The impact of biomass burning emissions on Protected Natural Areas in central and southern Mexico	Fabiola Trujano	MAP-AQ, Americas WG
BB-6C	Effects of fire diurnal variation on U.S. air quality during FIREX-AQ based on the Multi-Scale Infrastructure for Chemistry and Aerosols (MUSICA-V0)	Wenfu Tang	CCMI, GEIA, MAP-AQ, Americas WG
BB-7A	Characterizing the Physical and Chemical Evolution of Organic Aerosol in Biomass Burning Smoke using Gas- and Particle-phase Molecular Tracers from Laboratory and FIREX-AQ Observations	Melinda Schueneman	

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BB-8B	Global Wildfire Plume-Rise Data Set and Parameterizations for Climate Model Applications	Ziming Ke	ACAM, CATCH, CCMI, GEIA, PACES, Americas WG
BB-9C	Persistent Influence of Biomass Burning Aerosols during Clean Air Conditions in the Western United States	Ryan Farley	
BB-10A	Submicron Particle Composition and Acidity in Fire Plumes during FIREX-AQ aircraft study	Hongyu Guo	ACAM,
BB-11B	Does Combustion Condition Impact Biomass Burning Aerosol Hygroscopicity?	Rudra Pokhrel	MAP-AQ, ANGA
BB-12C	Sources and characteristics of paddy-residue burning derived carbonaceous aerosols using dual carbon isotopes	M Devaprasad	ACAM, AMIGO, CATCH, CCMI, GEIA, MAP-AQ, PACES, TOAR, MANGO
BB-13A	A top-down method of estimating NO2 emissions over South, Southeast and East Asia based on OMI NO2 observations	Jian Liu	GEIA, China WG
BB-14B	Aerosol Emissions Factors for Agricultural Fires in the Southeast United States	Richard Moore	AMIGO, GEIA,
BB-15C	Photolysis of biomass burning organic aerosol, chemical transformations and photo-bleaching	Rachel O'Brien	
BB-16A	A Machine Learning Approach for Identifying Smoke Plumes Based on GOES Satellite Observations Over the United States Using the Trained on the Hazard Mapping System Fire and Smoke Product	Benjamin Brown-Steiner	
BB-17B	Aerosol properties and processing during wintertime under hazy condition	Susan Mathai	
BB-18C	Investigating the effect of wildfire on PM2.5 in southeastern U.S. in November 2016	Shuhui Guan	ACAM, China WG
BB-19A	Salting-out effects on evolvement of light-absorbing SOA in atmospheric aerosols	Jackson Tham	ACAM, MANGO
BB-20B	Mechanism development and model studies on the chemical multiphase processing of key biomass burning tracers with the new CAPRAM BBM1.0 module	Lin He	
CATCH-1A	Heterogeneous ice nucleation in the WRF-Chem model and its influence on the cloud response to volcanic aerosols	Louis Marelle	
CATCH-2B	Characterization and chemical imaging of aerosol in West Antarctica.	Sérgio Gonçalves Junior	
CATCH-3C	Impact of biomass burning aerosol from Amazon associated with changes of snow albedo over the Central Andes mountains using satellite remote sensing data	Tomás R. Bolaño-Ortiz	Americas WG
CATCH-4A	Role of oceanic ozone deposition in explaining short-term variability of surface ozone at high-Arctic sites	Johannes Barten	PACES, TOAR

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CATCH-5B	3-D modeling of bromine chemistry and boundary-layer mercury depletion across the springtime Arctic	Kenjiro Toyota	
CATCH-6C	Molecular simulations on potassium-rich feldspar surfaces interacting with ions and possibility of ice nucleation	Anand Kumar	ACAM, CCMI
CATCH-7A	Oxidation of methanesulfonate into sulfate at inland Antarctica evidenced by 17O-excess signature	Sakiko Ishino	Japan NC
CATCH-8B	Simulating brown carbon aerosol over High Mountain Asia: WRF-Chem model implementation and application	Cenlin He	
CATCH-9C	Investigating the relationship of meteorology and atmospheric composition to snow cover: A comparative study over High-Mountain Asia and Andes	Chayan Roychoudhury	ACAM, AMIGO, MANGO
CATCH-10A	The importance of alkyl nitrates and sea ice emissions to atmospheric NOx sources and cycling in the summertime Southern Ocean marine boundary layer.	Jessica Burger	Southern Hemisphere WG
CATCH-11B	A Southern Ocean-wide examination of Multi-year Trends in Sea Ice, Chlorophyll Concentration, and Marine Aerosol Optical Depth	Srishti Dasarathy	Southern Hemisphere WG
CATCH-12C	14CO in Glacial Ice from Law Dome, Antarctica as a Tracer of Changes in Atmospheric OH Abundance from 1870 AD to Present	Peter Neff	Southern Hemisphere WG
CATCH-13A	Urban inland wintertime N2O5 deposition and snowpack ClNO2 production	Kathryn Kulju	Americas WG
CATCH-14B	Using 1D-modelling to study Arctic chlorine activation, transport and VOC oxidation during Arctic springtime	Shaddy Ahmed	CATCH
CATCH-15C	Modeling large dust deposition events to alpine snow and their impacts: the role of model resolution	Foteini Baladima	CATCH
CATCH-16A	Atmospheric nitrogen deposition and watershed budget at the Lautaret Pass	Jim Grisillon	
CATCH-17B	What we learn from fundamental laboratory studies at the Swiss Light Source about atmospheric chemistry.	Thorsten Bartels-Rausch	
CATCH-18C	Reactive nitrogen species in polar environments: a laboratory-based study of nitrous acid gas (HONO) production from snow.	Amelia Bond	
CATCH-19A	Short-term variability in atmospheric carbon dioxide as observed from coastal Antarctica	Freya Squires	
CATCH-20B	Trend analysis of aerosol particle physical properties at Villum Research Station, Northern Greenland	Jakob Pernov	PACES
CATCH-21C	Acidity-driven enhancement of sulfate formation after SO2 emission control evidenced by 17O-excess of ice core sulfate.	Shohei Hattori	MAP-AQ, PACES, Japan NC

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CATCH-22A	Unprecedented snow darkening and melting in New Zealand due to 2019–2020 Australian wildfires	Wei Pu	China WG
CATCH-23B	An overview of the role of atmospheric composition within the CRiceS project	Jennie Thomas	
CATCH-24C	Increasing scientific impact through combined field and modelling studies – Example: sea salt aerosol from blowing snow above polar sea ice	Markus Frey	
CATCH-25A	The evolving sources of cloud condensation nuclei in the Arctic and North Atlantic: preliminary results from the SEANA project	Alexander Kurganskiy	
CATCH-26B	Modelling Study of the Arctic Clouds	Roya Ghahreman	CCMI
CATCH-27C	Sea Spray Aerosol Generation Experiments in the Summertime High Arctic Pack Ice	Jessica Mirrielees	PACES, Americas WG
CATCH-28A	Using both a blowing snow source and a snowpack source to model reactive bromine in GEOS-Chem	William Swanson	
CATCH-29B	Using gas phase, particle, and snow composition data to understand the spring shutdown of reactive bromine cycling in the Arctic boundary layer	Daun Jeong	Americas WG
CATCH-30C	Impacts of anthropogenic emissions on tropospheric reactive halogens and the oxidation capacity of the atmosphere	Shuting Zhai	
CATCH-31A	Observations of iodine monoxide over three summers at the Indian Antarctic bases, Bharati and Maitri	Anoop Mahajan	
CATCH-32B	Changes in the Structure of the Freeze-Concentrated Solution in the Veins of Ice due to Various Freezing Rates	Jan Zezula	MAP-AQ, TOAR
CATCH-33C	Halogen elements in two sub-Antarctic ice cores and their suitability as sea ice proxies	Delia Segato	
CATCH-34A	Perspectives of an early career researcher in the polar ocean-ice-atmosphere interactions community	Megan Willis	Southern Hemisphere WG
CCMI-1A	Understanding of the space-time variations of hydroxyl (OH) using methyl choloroform (CH3CCl3)	Prabir Patra	ACAM, TOAR
CCMI-2B	Coupling interactive fire with atmospheric composition and climate in the UK Earth System Model (UKESM)	Joao Teixeira	
CCMI-3C	Understanding the historical changes in tropospheric halogens and their impacts over the last century	Tomás Sherwen	
CCMI-4A	Irreversible changes in the future global methane cycle under the aggressive-mitigation SSP1-2.6 scenario, simulated with a fully coupled, dynamic methane cycle process model in UKESM1.0.	Gerd Folberth	

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CCMI-5B	Climate-driven chemistry and aerosol feedbacks in Earth system models	William Collins	
CCMI-6C	Turbulence-vegetation-chemistry interactions: Impacts on OH reactivity at a deciduous forest	Olivia Clifton	
CCMI-7A	Atmospheric Chemistry in the OpenIFS Model	Marcus Köhler	
CCMI-8B	Impact of heatwaves and drought stress on isoprene in a UK temperate forest: results from the 2018-2020 WIsDOM campaigns	Valerio Ferracci	
CCMI-9C	Characterisation and Molecularly Resolved Source Apportionment of Brown Carbon Absorption by UV-Vis Spectroscopy and Atmospheric Pressure Chemical Ionisation-Mass Spectrometry	Liudongqing Yang	
CCMI-10A	Ozone Production in U.S. Thunderstorm Convective Outflow Regions	Mary Barth	ACAM
CCMI-11B	Investigating aerosol radiative adjustment mechanisms and magnitudes with model nudging	Max Coleman	
CCMI-12C	Ozone changes from past to future: characterising regional ozone sensitivity across the globe	Zhenze Liu	
CCMI-13A	Insights from MOZAIC long-term routine in-situ measurements into vertical distribution, seasonal variability and tropospheric fingerprint of ice-supersaturated air masses in the northern mid-latitudes	Susanne Rohs	
CCMI-14B	How detailed should a vegetation canopy be represented for ozone deposition impact assessments?	Auke Visser	
CCMI-15C	New MESSy scavenging subroutine to treat aerosol particles gas-phase partitioning in convective clouds	Giorgio Taverna	
CCMI-16A	One value of cloud pH to rule them all: The impact of an interactive cloud pH scheme on aerosols in UKESM1	Steven Turnock	
CCMI-17B	Methane: At the Interface between Hydrology, Atmospheric Composition, Air Quality, and Climate	Fiona O'Connor	
CCMI-18C	Trends in global tropospheric hydroxyl radical and methane lifetime since 1850 from AerChemMIP	David Stevenson	
CCMI-19A	Graph Theory and Atmospheric Chemistry	Sam Silva	
CCMI-20B	Examining the Competition Between Oxidation and Deposition in the Fate of Reactive Organic Carbon	Gabriel Isaacman-VanWertz	
CCMI-21C	Reactive nitrogen in global upper troposphere from NASA DC8 and MOZAIC aircraft campaigns	Nana Wei	GEIA, MAP-AQ, TOAR

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CCMI-22A	A large source of formic acid from cloud droplets	Domenico Taraborrelli	
CCMI-23B	The NOAA Baseline Balloon Stratospheric Aerosol Profiles (B2SAP) Project	Elizabeth Asher	
CCMI-24C	Dynamical downscaling of a global chemistry-climate model to study the influence of climate change and variability on mid-21st century PM2.5 in the continental US	Surendra Kunwar	
CCMI-25A	Two proxies reflect OH variability on local scales in the remote atmosphere	Colleen Baublitz	
CCMI-26B	Viscosity of Secondary Organic Aerosol: Effects of Composition and Oxidation Method	Giuseppe Crescenzo	GEIA, MAP-AQ, Americas WG
CCMI-27C	Tropospheric Age-of-Air: Influence of SF6 Emissions in Recent Surface Trends and Model Biases	Clara Orbe	ACAM, CCMI
CCMI-28A	Observed and simulated effects of droughts and heatwaves on ozone concentration in Southern Europe	Antoine Guion	TOAR
CCMI-29B	Climatological pattern of hydrocarbon in the UTLS region associated with the Australian Bushfires	Donhee Lee	
CCMI-30C	Intercomparison of Ground- and Satellite-Based Total Ozone Column Data at Three stations, Antarctic Region	Songkang Kim	
CCMI-31A	Direct Comparison of the Submicron Aerosol Hygroscopicity of Water-Soluble Sugars	Kotiba Malek	
CCMI-32B	Hemispheric Lightning NOx Emissions and the Impact on Ground-Level Ozone	Mike Madden	GEIA, MAP-AQ
CCMI-33C	Observational Metrics that Relate to the Answers we seek from Chemistry-Climate Models	Michael Prather	MAP-AQ, TOAR
CCMI-34A	Impacts of future land use and land cover change on mid-21st-century dust air quality	Lang Wang	ACAM, GEIA, MAP-AQ, Americas, China, MANGO, SH
CCMI-35B	A Simplified Chemistry-Dynamical Model	Hao-Jhe Hong	Japan NC
CCMI-36C	Study of Different Carbon Bond 6 (CB6) Mechanisms by Using a Concentration Sensitivity Analysis	Le Cao	
CCMI-37A	Observationally constrained analysis of sulfur species in the marine atmosphere	Huisheng Bian	MAP-AQ
CCMI-38B	Revising the Ozone Depletion Potentials Metric for Short-Lived Chemicals Such as CF3I and CH3I	Jun Zhang	ACAM, AMIGO, MAP-AQ, PACES, Americas WG, China WG, MANGO

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CCMI-39C	Assessing dust impact on air quality using the global chemistry and transport model TM4-ECPL	Medea Zanoli	
CCMI-40A	Evaluation of CMIP6 model simulations of PM2.5 components in China	Fangxuan Ren	
CCMI-41B	Modeling atmospheric brown carbon in the GISS ModelE Earth system model	Maegan DeLessio	
CCMI-42C	Enhancing chemical schemes accounted in the FLEXPART v10.4 transport model using a kinetic preprocessor	Ruben Sousse	
CCMI-43A	In- and out-of-cloud measurements at SMEAR IV for pristine conditions and an aged forest fire plume event	Angela Buchholz	
CCMI-44B	Observations of Lightning NOx Production from TROPOMI Case Studies over the United States	Dale Allen	
CCMI-45C	The fingerprint of Biomass Burning on CO in the remote atmosphere	Nikos Daskalakis	GEIA, MAP-AQ
CCMI-46A	Assessing global chemistry-climate simulations on the long term in the UTLS with the IAGOS database	Yann Cohen	TOAR
CCMI-47B	Continuity of the Arosa ozone column series after Dobson automation and the displacement of the LKO instruments to Davos	René Stübi	ACAM, TOAR
CCMI-48C	An overview of iodine chemistry over the Indian and Southern Ocean waters using ship-based observations and modelling	Swaleha Inamdar	CATCH
CCMI-49A	Arctic warming and associated sea ice reduction in the early 20th century induced by natural forcings in MRI-ESM2.0 climate simulations and multimodel analyse	Takuro Aizawa	CATCH, Japan NC
CCMI-50B	A Core-Shell kinetic model for simulating Viscosity dependent secondary organic Aerosol (CSVA) and its applications	Long Jia	MAP-AQ, China WG
CCMI-51C	The impact of changes in anthropogenic emissions on future summer ozone concentrations over China based on CMIP6	Xinran Zeng	MAP-AQ, China WG
CCMI-52A	Dust minerals in the atmosphere as precursors of Ice Nuclei Particles	Marios Chatziparaschos	
CCMI-53B	Global PM2.5 prediction and estimated mortality to 2050 under different climate change scenarios	Wanying Chen	GEIA, MAP-AQ, China WG
CCMI-54C	Co-benefits of changing diet. A modelling assessment at the regional scale integrating social acceptability, environmental and health impacts	Michela Maione	
CCMI-55A	Size-resolved aerosol pH over Europe during summer	Stylianos Kakavas	

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CCMI-56B	Estimation of radiative forcing and heating rate based on vertical observation of black carbon in Nanjing, China	Shuangshuang Shi	PACES, China WG
CCMI-57C	On the formation of formic acid from formaldehyde processing in liquid clouds	Jean-Francois Muller	MANGO
CCMI-58A	Assessment of the impact of OH's temporal resolution on the global atmosphere	Sofía Gómez Maqueo Anaya	
CHINA-1A	Hygroscopicity of fresh and aged mineral dust aerosol	Mingjin Tang	
CHINA-2B	Health Effects of Global Air Pollution on Reproduction: from Fertility Rate Reduction in United States, to Pregnancy Loss in Africa, and Preterm Births in Beijing China	Tong Zhu	
CHINA-3C	Online Measurement of Fine Aerosol Nitrite via a Versatile Aerosol Concentration Enrichment System Coupled with Ion Chromatography	Xiaona Shang	AMIGO
CHINA-4A	Atmospheric Environmental Impacts of Freight Transportation	Huan Liu	ACAM, GEIA, PACES
CHINA-5B	Dibasic Esters Observed as Potential Emerging Indoor Air Pollutants in New Apartments in Beijing, China	Yingjun Liu	
CHINA-6C	Effects of Regional Transport on Haze in the North China Plain: Transport of Precursors or Secondary Inorganic Aerosols	Jie Li	TOAR
CHINA-7A	Overview of the aircraft measurements in the Northeastern and Northern China	Shan Ye	
CHINA-8B	The researches of unstable reactive oxidants in the atmosphere	Shengrui Tong	
CHINA-9C	The long-term trend of acidity and chemical compositions of precipitation in Shanghai	Shiyu Ye	
CHINA-10A	The impact of climate change and extreme weather events on ozone formation	Yang Gao	ACAM, CCMI
CHINA-11B	Estimation of heterogeneous ozone oxidation rates of oleic, elaidic, and linoleic acid in urban organic aerosols using their hourly measurement data.	Qiongqiong Wang	ACAM, CATCH, CCMI, MAP-AQ
CHINA-12C	Health Impact of Global Atmospheric Arsenic: 2005-2015	Lei Zhang	
CHINA-13A	Terpene-derived Nitrooxy Organosulfates	Jian Zhen Yu	MAP-AQ
CHINA-14B	Aerosol Acidity and Water Content as a Driver of Aerosol Formation, Intense Haze Events and Nutrient Deposition	Athanasios Nenes	AMIGO, MAP-AQ, PACES

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CHINA-15A	Study on the Ozone Photochemistry in China	Keding Lu	
CHINA-16B	First comprehensive measurements on atmospheric photochemistry over the Tibetan Plateau	Chunxiang Ye	
COVID-1A	First year of real-time VOC measurements at the SIRTA facility (Paris region, France): diurnal and seasonal variabilities, impact of COVID-19 lockdown on air quality	Leïla Simon	AMIGO
COVID-2B	Global tropospheric ozone responses to reduced NOx emissions linked to the COVID-19 world-wide lockdowns	Kazuyuki Miyazaki	AMIGO, GEIA, TOAR
COVID-3C	Impact of Singapore's COVID-19 lockdown on atmospheric CO2 fluxes at neighborhood scale	Erik Velasco	AMIGO, GEIA, MANGO
COVID-4A	Quantification of the Emission Changes in Europe During 2020 Due to the COVID-19 Mobility Restrictions	Marc Guevara	GEIA
COVID-5B	US COVID-19 shutdown demonstrates importance of background NO2 in inferring NOx emissions from satellite NO2 observations	Zhen Qu	AMIGO, Americas WG
COVID-6C	The impact of COVID-19 on projections, and the use of scenario analysis tools for modelling impacts of mitigation strategies on air pollutant emissions and concentrations.	Ben Pearson	AMIGO, GEIA
COVID-7A	Do satellite-based HCHO and NO2 observations help with the quantitative prediction of surface ozone during the pandemic?	Amir Souri	AMIGO, MAP-AQ
COVID-8B	Mapping Urban CO with BEACO2N and Bayesian Inversions	Naomi Asimow	AMIGO, MAP-AQ, Americas WG
COVID-9C	Impact of COVID-19 on NOx and VOC levels over China based on multi-species satellite data and modeling	Jenny Stavrakou	AMIGO
COVID-10A	The Impact of COVID-19 Lockdowns and Car Free- day Policy on Levels of Air Pollution in Kigali, Rwanda	Egide Kalisa	PACES, ANGA
COVID-11B	Fast Climate Responses to Aerosol Emission Reductions During the COVID-19 Pandemic	Yang Yang	ACAM, CCMI, PACES, TOAR, China WG
COVID-12C	The effects of the COVID-19 lockdowns on air-quality throughout the troposphere as seen by IAGOS in-situ data	Hannah Clark	AMIGO
COVID-13A	Impacts of COVID-19 on Black Carbon in Two Representative Regions in China Based on Online Measurement in Beijing and Tibet	Mei Zheng	China WG
COVID-14B	Analysis of the effect of the COVID-19 lockdown on Aerosol Optical Properties over Bangladesh	Khaled Joy	ACAM, MANGO
COVID-15C	From COVID-19 to Future Electrification: Assessing Traffic Impacts on Air Quality by a Machine Learning Model	Jiani Yang	ACAM, AMIGO, CATCH, CCMI, GEIA, MAP-AQ, PACES, TOAR, Americas

Poster	Title	Presenter	Cross Reference
COVID-16A	Knowns and unknowns on the impacts of COVID-19 lockdowns on urban air quality	Georgios Gkatzelis	AMIGO, GEIA, MAP-AQ
COVID-17B	Chemistry of Atmospheric Fine Particles during the COVID-19 Pandemic in a Megacity of Eastern China	Lei Liu	MAP-AQ, China WG
COVID-18C	Covid-19 induced lower-tropospheric ozone changes	Mariano Mertens	AMIGO, TOAR
COVID-19A	Quantifying and attributing carbon monoxide (CO) emission changes in New York City during the COVID-19 shutdown	Luke Schiferl	GEIA
COVID-20B	Errors and uncertainties associated with mobility and traffic activity data for estimating fossil fuel CO2 emissions during the COVID-19 pandemic	Tomohiro Oda	GEIA, Japan NC
COVID-21C	Impact of the COVID-19 lockdown period in surface Ozone, PM2.5, and SOA in the Mexico Megalopolis	Victor Almanza	AMIGO, MAP-AQ, Americas WG
COVID-22A	Lockdown influences on Ozone, NO2, and CO over Asia: Some contrary affects	Prajjwal Rawat	ACAM, AMIGO, MAP-AQ, TOAR, MANGO
COVID-23B	Changes in aerosol over the Indian subcontinent during the COVID19 Lockdown in 2020	Satyendra Pandey	ACAM, MAP-AQ
COVID-24C	Exploring Changes in Air Quality Across Africa from COVID-19 in 2020 and 2021: Observations from the AfriqAir Network	Michael Giordano	ANGA
COVID-25A	Investigating Air Quality and Emissions Changes from COVID-19 Lockdown Measures in Mexico City with Satellite Observations	Duncan Quevedo	AMIGO, GEIA, MAP-AQ, Americas WG
COVID-26B	Hourly Organic Tracer-based Source Apportionment of PM2.5 before and during the Covid-19 lockdown: A Case Study in Suburban Shanghai	Shan Wang	ACAM, MAP-AQ, ANGA, China WG
COVID-27C	COVID-19 Lockdown: Decadal Low of Indian Metro Air Quality	Ravi Yadav	AMIGO
COVID-28A	High-latitude urban air quality: 20 months of aerosol composition data from Fairbanks, Alaska	Ellis Robinson	PACES
SH-1A	Development of a regional airshed chemical transport model for priority airsheds in Western Australia	Sean Lam	ACAM, CCMI, GEIA, MAP-AQ, China WG, MANGO
SH-2B	Particulate matter mass concentration in different size fractions related to meteorological variables in the Metropolitan Area of São Paulo	Victória Peli	MAP-AQ, Americas WG
SH-3C	Temperature response measurements from eucalypts give insight into the impact of Australian isoprene emissions on air quality in 2050	Kathryn Emmerson	
SH-4A	Identifying the factors driving the Biogenic VOC uncertainty in CTM models in south-east Australia.	Jhonathan Ramirez	CCMI, MAP-AQ

Poster	Title	Presenter	Cross Reference
SH-5B	Dust emissions modelling over the semi-arid Argentinian territory	Ramiro Espada	MAP-AQ
SH-6C	Quantification and characterization of PM2.5 in Buenos Aires, Argentina.	Pablo Lichtig	AMIGO, CCMI, MAP-AQ, Americas WG
SH-7A	Black Carbon atmospheric emissions from biomass burning in the Amazon reaching the Chilean Central Andes: evidence from a multi-technical approach	Maria Ruggeri	CATCH, GEIA, Americas WG
SH-8B	An Overview of the COALA-2020 campaign at Cataract (Characterising Organics and Aerosol Loading in Australia)	Clare Murphy (Paton-Walsh)	GEIA
SH-9C	Mass spectrometry system (MALDI-TOF) validation in the identification of Aspergillus Nigri Section species of atmospheric air from São Paulo, Brazil.	Valter Duo Filho	MAP-AQ, Americas WG
SH-10A	Intercontinental Air Pollution Transport in the Southern Hemisphere	Lily Sheridan	
SH-11B	Radon Dosimetry in Nchanga Underground Mine on The Copperbelt Province	Rabbison Banda	ACAM, MAP-AQ, Americas, ANGA, China, Japan, MANGO
SH-12C	Can we see the impact of indigenous fire management on the interannual variability of carbon monoxide?	Shyno Susan John	ACAM, AMIGO, CCMI, GEIA, MAP-AQ
SH-13A	Prediction of Aerosol acidity in the remote marine boundary layer of the southern ocean during summer.	Sive Xokashe	CATCH
SH-14B	Southern Ocean latitudinal gradients of Cloud Condensation Nuclei	Ruhi Humphries	CATCH, PACES
SH-15C	Mapping the sources of organic PM1: A case study from the COALA campaign in Southeast Australia	Adhitya Sutresna	
SH-16A	Using Climate Mode Indices to Forecast Carbon Monoxide Variability in Fire-Prone Southern Hemisphere Regions	William Daniels	AMIGO, MAP-AQ, MANGO
SH-17B	Biomass burning smoke and coincident water vapor over the southeast Atlantic stratocumulus region: results from observations and models	Kristina Pistone	ANGA
SH-18C	AVOC and BVOC sensitivity study for ozone pollution in Santiago, Chile combining observations and a box model	Constanza Urbina	AMIGO, CCMI, TOAR
SH-19A	Update of Tropospheric Ozone trends at Ushuaia GAW Station	Pablo Medina	
SH-20B	The influence of ventilation coefficient on carbon monoxide concentration in São Paulo city: An observation from lidar data	Gregori Moreira	AMIGO, MAP-AQ, Americas WG
SH-21C	Anthropogenic air pollutant emission inventories for South America	Nicolas Huneeus	GEIA, MAP-AQ, Americas WG

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FF-1A	Identification of Different Generation Oxidation Products and Tracers: Secondary Organic Aerosol Formation from Aromatic Precursors	Deepchandra Srivastava	ACAM, MAP-AQ
FF-2B	Exploring modeled impacts and uncertainties of DMS oxidation mechanisms	Linia Tashmim	ACAM, Americas WG
FF-3C	First observations of gas-phase urea in the atmosphere	Emily Matthews	
FF-4A	Coexistence of three liquid phases in individual atmospheric aerosol particles	Fabian Mahrt	
FF-5B	Water as the pH probe for individual particles using micro-Raman spectroscopy	Xiaoyu Cui	ACAM, China WG
FF-6C	Using Measurements of Atmospheric 14CO in a Global Network to Improve Understanding of OH Spatial and Temporal Variability	Vasilii Petrenko	
FF-7A	Criegee intermediate yields from seven atmospherically important ozone-alkene systems	Beth Nelson	
FF-8B	Renoxification on Aerosol Particles over the Atlantic Ocean	Simone Andersen	
FF-9C	Organic nitrate deposition to trees: processes, rates and atmospheric implications	Bryan Place	
FF-10A	Elucidation of the Structure and Formation Mechanism of Dimer Esters in Monoterpene Secondary Organic Aerosol	Christopher Kenseth	
FF-11B	The Viscosity of Organic Films from Cooking Aerosol	Kristian Kiland	
FF-12C	Nitrate-mediated photooxidation of organic acids in the aqueous phase	Theodora Nah	ACAM, China WG
FF-13A	Unveiling Processes in Secondary Organic Aerosol Particles during Isothermal Evaporation	Zijun Li	
FF-14B	Formation of secondary aerosols, particulate nitrogen- and sulfur-containing organics through anthropogenic-biogenic interactions at night	Li Xu	ACAM, China WG
FF-15C	Highly oxygenated organic nitrates formed from NO3 radical initiated oxidation of β-pinene	Hongru Shen	MAP-AQ, China WG
FF-16A	An evaluation of the unexplored generation of hydrogen from the photolysis of aldehydes using two photochemistry models	Maria Pérez-Peña	Southern Hemisphere WG
FF-17B	Insights into tropical cloud chemistry at La Reunion Island reveals a high supersaturation of low-soluble VOCs in the aqueous phase	Pamela Dominutti	

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FF-18C	Spatial heterogeneity of LDSA using a pilot network of LDSA sensors	Jacinta Edebeli	AMIGO, MAP-AQ
FF-19A	Stereoscopic remote sensing of atmospheric trace gases	Cheng Liu	MAP-AQ, China WG
FF-20A	O2--induced SO2 oxidation in aerosol formation	Narcisse Tsona	ACAM, CATCH, China WG
FF-21C	Influence of atmospheric conditions on the role of trifluoroacetic acid in atmospheric sulfuric acid-dimethylamine nucleation	Ling Ling	ACAM, China WG
FF-22A	Comprehensive product characterization in the OH oxidation of dimethyl sulfide using an environmental chamber	Qing Ye	
FF-23B	Role of photo-generated hydroxyl radicals in the ozone depletion on the surface of and within the polar stratospheric clouds (PSCs)	Jun He	ACAM, AMIGO, CATCH, GEIA, MAP-AQ, PACES, TOAR, China WG,
FF-24C	Enabling exchange and adequate use of data for observation based atmospheric research	Jörg Klausen	CATCH, CCMI, MAP-AQ, PACES, TOAR
FF-25A	Constructing shapes and mixing structures of black carbon particles with applications to optical calculations	Yuanyuan Wang	ACAM, MAP-AQ, China WG
FF-26B	Application of the method to determine the atmospheric carbonyl compounds using liquid chromatography tandem mass spectrometry (LC-MS/MS) to ship measurement	Yang Xu	ACAM, AMIGO, CATCH, CCMI, GEIA, MAP-AQ, PACES, TOAR, China WG
FF-27C	Characterizing dynamic behaviors of phthalate monoesters and diesters in an office	Yatai Li	ACAM, AMIGO, MAP-AQ, China WG
FF-28A	Reaction Products and Pathways of Alkoxy Radicals in the Condensed Phase	Victoria Barber	
FF-29B	A new mobile UAV-based platform of ACTRIS for atmospheric profiling	Maria Kezoudi	ACAM
FF-30C	Submicron aerosol acidity variability at a Mediterranean Coastal site	Anna Maria Neroladaki	
FF-31A	Seasonal Variation in Phase State and Chemical Composition of Ambient Particles Collected at the Southern Great Plains Site at Different Altitude	Zezhen Cheng	ACAM, CATCH, MAP-AQ, PACES
FF-32B	Synergistic Multiphase Chemistry of Isoprene Hydroxy Hydroperoxides (ISOPOOH) with Sulfur Dioxide in Acidic Sulfate Aerosols Leading to Secondary Inorganic and Organic Aerosol Formation	Yue Zhang	ACAM, PACES, Americas WG, China WG
FF-33C	Identification and quantification of tracer products and influence factors of their yields in the OH-initiated oxidation of toluene and m-xylene	Shuyu He	ACAM, China WG
FF-34A	Supersaturated state accelerates the uncatalyzed autoxidation of SO2 within aerosol droplets	Pai Liu	ACAM, AMIGO, CCMI, China WG

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FF-35B	Atmospheric gas-phase alkylamines in the Mediterranean and their relation to new particle formation	Evangelia Tzitzikalaki	MAP-AQ
FF-36C	What has data science ever done for us? Successes, lessons learned and reflections from a data dilletante	Paul Young	
FF-37A	Theoretical Study on the Role of Environmental Factors in EPFRs Formation over CuO Surface	Danli Liang	ACAM, AMIGO, CATCH, CCMI, GEIA, MAP-AQ, PACES, TOAR, China WG
FF-38B	The role of Organophosphate Esters Flame Retardants and plasticizers (OPEs) in Phosphorus Cycle in the atmosphere of the Mediterranean Sea	Kalliopi Violaki	CATCH, MAP-AQ
FF-39C	Physicochemical properties and Ice Nucleation Potential of Long-range Transported Free tropospheric aerosols	Nurun Nahar Lata	ACAM, CATCH, Americas WG
FF-40A	Development of “Chemspot” instrument for the characterization of organic aerosol	Purushottam Kumar	ACAM, Americas WG
FF-41B	A Kinetic and Mechanistic Study on the Photochemistry of Polycylic Aromatic Hydrocarbons and its Effect on Atmospheric Iron Solubility	Desiree Sarmiento	
FF-42C	A new chemical pathway for stratospheric sulfate aerosol formation	Erik Larson	
GEIA-1A	Road Traffic Emission Inventory in an Urban Zone of West Africa: Case of Yopougon City (Abidjan, Côte d’Ivoire)	Doumbia Madina	ANGA
GEIA-2B	Estimation of Pollutant Emissions by Industrial Sources in Bogotá under Power Matrixes Scenarios Projected to the Year 2050 Implementing the LEAP Model	Karen Hernandez	Americas WG
GEIA-3C	The influence of change the fuel type used in power plants on reduction of carbon dioxide emission in the Energy Sector of Azerbaijan	Sadig Hasanov	Americas WG
GEIA-4A	Characterising oceanic emissions of alkenes and their impacts	Ryan Pound	
GEIA-5B	The CAMS Global and Regional Emissions for Global and Regional Forecasts and Reanalyses	Claire Granier	AMIGO, CCMI, MAP-AQ, TOAR
GEIA-6C	Incorporating interactive surface exchange of ammonia into chemistry-climate models	Jize Jiang	
GEIA-7A	Secondary Organic Aerosol Formation from Emissions of Coastal Sage Shrubs	Archit Mehra	
GEIA-8B	Connecting seasonal variability in monoterpene concentrations to features in the biosphere of a southeastern U.S. forest.	Deborah McGlynn	
GEIA-9C	Evaluation of black carbon emissions in East Asia: Comparisons of six inventories and constraints from surface observations and model simulations	Kohei Ikeda	Japan NC

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GEIA-10A	Investigation of major emission sources and photochemical processes of Volatile Organic Compounds (VOCs) at a suburban site of New Delhi, India in the winter	Nidhi Tripathi	
GEIA-11B	Forecasting policy, innovation and new technologies for reducing transport emissions in Chile 2020-2050	Mauricio Osses	Americas WG, Southern Hemisphere WG
GEIA-12C	Aerosols in Western Mediterranean Basin: three complementary approaches for source emission identification	Abdelfettah Benchrif	
GEIA-13A	Road Traffic Emission Inventory in an Urban Zone of West Africa: Case of Yopougon City (Abidjan, Côte d'Ivoire)	Madina Doumbia	ANGA
GEIA-14B	A comprehensive and spatially resolved Mercury Emission Inventory for Indian Subcontinent	Madhusmita Mishra	ACAM, AMIGO, CATCH, MAP-AQ, PACES
GEIA-15C	Quantification of methane emissions from offshore oil & gas platforms in the Norwegian Sea.	Amy Foulds	AMIGO
GEIA-16A	Experimental determination of isoprene and other BVOCs emissions from Platanus x hispanica under urban conditions	Carmen Kalalian	AMIGO, MAP-AQ
GEIA-17B	Emission sources and health risk of volatile organic compounds during heating season in rural northern China	Hui Chen	AMIGO, China WG
GEIA-18C	The CAMS Global Anthropogenic Emissions	Antonin Soulié	AMIGO, CCMI
GEIA-19A	Estimation of Methane emissions from Akouédo landfill through a modelling approach	Séka Yapo	MAP-AQ
GEIA-20B	Global Emission trends to 2020 from the Community Emissions Data System (CEDS)	Steven Smith	AMIGO, CATCH, CCMI, MAP-AQ, PACES, TOAR, Americas WG, ANGA,
GEIA-21C	Annual changes of ship emissions around China under gradually promoted control policies from 2016 to 2019	Xiaotong Wang	China WG
GEIA-22A	Third Revision of the Bottom-up Global Surface Seawater Dimethyl Sulphide Climatology (DMS-Rev3)	Shrivardhan Hulswar	
GEIA-23B	A Technological Inventory of Particulate Matter Emission for Indian Megacity Kolkata	Poonam Mangaraj	
GEIA-24C	Unfolding Inventory of Indoor Air Pollutant Emission in Indian Household: An Invisible Potential Threat	Saroj Sahu	MANGO
GEIA-25A	Emissions from Stationary Sources and Their Impact on Air Quality in Cuba	Cuesta Osvaldo	Americas WG
GEIA-26B	The CAMS-REG v5 high-resolution European emission inventory for air pollutants and greenhouse gases (2000-2018) to support air quality and climate change modelling	Stijn Dellaert	

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GEIA-27C	Understanding the Effect of Drought on Biogenic Isoprene and the Biosphere-Atmosphere-Chemistry Relationship with NASA GISS ModelE+MEGAN Simulations	Elizabeth Klovenski	
GEIA-28A	The Effects of Light on the Emission of Biogenic Isoprene and Monoterpenes: A Review	Xinyu Wang	
GEIA-29B	Downscaling method: Increasing the resolution of EDGAR emission inventory data for complex terrains like Switzerland	Curdin Spirig	CCMI, MAP-AQ
GEIA-30C	Sensitivity of different BVOC emission schemes in WRF-Chem(v3.6) to vegetation distributions and its impacts over East China	Mingshuai Zhang	ACAM, CCMI, China WG
GEIA-31A	BVOCs emission factors of urban green trees	Yuran Tan	
GEIA-32B	A case study to clarify emissions of biogenic volatile organic compounds (BVOCs) based on measurements of total ozone reactivity in the ambient air of a suburban forest in Japan	Jun Matsumoto	Japan NC
GEIA-33C	RTEII: A new high-resolution (0.1° × 0.1°) road transport emission inventory over India of 74 VOCs, CO, NOx, NH3, SO2, CH4, CO2 , PM2.5 constrained by measured emission factors and regional vehicular activity data	Haseeb Hakkim	ACAM, AMIGO, MAP-AQ, MANGO
GEIA-34A	A new “hybrid” gridded 1 km × 1 km emission inventory for paddy stubble burning reveals that stubble burning is a massive source of VOCs unaccounted for by existing emission inventories and overwhelms other	Ashish Kumar	ACAM, AMIGO, MANGO
GEIA-35B	Volatile chemical product emissions and criteria pollutant enhancements in the United States	Karl Seltzer	MAP-AQ
GEIA-36C	Global NH3 emissions from livestock management : implementation of a dynamical module within a land surface model and impact on atmospheric chemistry	Maureen Beaudor	CCMI, Americas WG, China WG, Southern Hemisphere WG
GEIA-37A	Airborne measurements of formaldehyde from biomass burning plumes and urban and wetland emissions using Laser-Induced Fluorescence Spectroscopy	Samuel Seldon	
GEIA-38B	Modeling and Mapping Biomass Burning for High Northern Latitudes with the Wildland Fire Emissions Inventory System (WFEIS)	Nancy French	
GEIA-39C	Improving the bottom-up estimates of natural geologic emissions via microseepage	Marika Stock	
GEIA-40A	Assessing vehicle fuel efficiency using a dense network of CO2 observations	Helen Fitzmaurice	Americas WG
GEIA-41B	Comparison of bottom-up and top-down road transport emission inventories	Erika Trejos	Americas WG
GEIA-42C	COvid-19 adjustmeNt Factors fOR eMissions (CONFORM): A dataset for atmospheric models	Thierno Doumbia	AMIGO, MAP-AQ
GEIA-43A	Global high-resolution emissions of soil NOx, sea salt aerosols, and biogenic VOCs	Hongjian Weng	

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GEIA-44B	The impact of land cover change and biogenic emissions from urban green space on summer ozone formation over North China Plain	Mingchen Ma	ACAM, CCMI, China WG
GEIA-45C	Municipal solid waste burning is a neglected source of highly reactive VOCs that fuel ozone formation over rural India	Pooja Chaudhary	ACAM, AMIGO, MAP-AQ, MANGO
GEIA-46A	Residential heating emissions cause more aerosol pollution than paddy-residue burning and in rural northwest India	Harshita Pawar	ACAM, AMIGO, MAP-AQ, MANGO
GEIA-47B	Agricultural particulate matter emissions in the Colombian Orinoco region	Andres Ardila Ardila	MAP-AQ, Americas WG
GEIA-48C	Particulate matter emission factors for light and heavy-duty vehicles in a South American megacity (São Paulo, Brazil)	Guilherme Pereira	MAP-AQ, Americas WG
GEIA-49A	Reactive Nitrogen Emissions from Turfgrass Systems: Emission, Emission Factor, and Modeling	Viney Aneja	ACAM
GEIA-50B	Concentrations of Atmospheric VOCs Emitted from Fireworks in Southwest Mexico City Measured by a Real-time Vocus PTR-TOF-MS	Maribel Hernández-Camarillo	MAP-AQ, Americas WG
GEIA-51C	Geostatistical analysis and inventory of emissions from sugarcane pre-harvest burning in Southwest Colombia	Andrea Cardozo	MAP-AQ, Americas WG
GEIA-52A	Updating the 2013 National Emissions Inventory for air quality modeling in Central Mexico	Jose Rodriguez	AMIGO, MAP-AQ, Americas WG
GEIA-53B	Estimating Road Transportation Emissions using CNNs and Satellite Imagery	Ryan Mukherjee	
JNC-1A	Light absorption properties of brown carbon aerosols in the Asian outflow: Implications from a combination of filter and ground remote sensing observations at Fukue Island, Japan	Chunmao Zhu	PACES
JNC-2B	Evaluation of a Low-Cost Mobile PM2.5 Sensor and Application to the Measurements along the Japan National Route 1	Kenta Kanegae	
JNC-3C	Effects of marine nitrogen fixation on the formation of atmospheric water-soluble organic nitrogen revealed by a laboratory incubation experiment	Yuzo Miyazaki	
JNC-5A	A chemistry-transport modeling to support satellite observations of NO2 and CO2 emitted from megacities	Yousuke Yamashita	
JNC-6C	Temperature and acidity dependence of secondary organic aerosol formation from α-pinene oxidation: implication for SOA models	Yange Deng	
JNC-7A	Modelling the sources of air pollution over the East China Sea	Adedayo Adedeji	ACAM, MAP-AQ
JNC-8B	First Concurrent Observations of NO2 and CO2 from Power Plant Plumes by Airborne Remote Sensing	Tamaki Fujinawa	MANGO

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JNC-9C	A comparison of the impact of TROPOMI and OMI tropospheric NO2 on global chemical data assimilation and emission inversion	Takashi Sekiya	AMIGO, GEIA
JNC-10A	Aerosol soluble iron production under clean, haze and fog conditions at a coastal site of China	Daizhou Zhang	MAP-AQ, China WG
JNC-11B	Significant Anthropogenic Contribution to Particulate Chloride in Marine Aerosol in the Northern China	Junyi Liu	ACAM, China WG
JNC-12C	Investigation of the wet removal rate of black carbon in East Asia: validation of a below- and in-cloud wet removal scheme in FLEXible PARTicle (FLEXPART) model v10.4	Yongjoo Choi	PACES
JNC-13A	Changes in tropospheric nitrogen dioxide vertical column densities over Japan and Korea during the COVID-19 using Pandora and MAX-DOAS	Yongjoo Choi	MAP-AQ
JNC-14B	Observing anthropogenic emissions of greenhouse gases and air pollutants with the GOSAT-GW satellite: Scientific targets and policy contributions	Hiroshi Tanimoto	ACAM, AMIGO, GEIA, MANGO
JNC-15C	Model analysis of the atmospheric aerosol concentrations and depositions by ship-onboard observations over the Eastern Indian Ocean	Kazuyo Yamaji	ACAM, AMIGO, GEIA, MAP-AQ
JNC-16A	Investigation of adhesivity of marine organic aerosols by atomic force microscopy	Kohei Ono	CATCH
JNC-17B	Chemical characteristics of humic-like substance (HULIS) organic aerosol in a cool-temperate forest area of Japan	Sonia Afsana	
MANGO-1A	Indoor Air Quality Indicators and Toxicity Potential at the Hospitals' Environment in Dhaka, Bangladesh	Shahid Zaman	ACAM, AMIGO
MANGO-2B	Indoor Exposure of Particulate Matter and Association of PM2.5 with Lung Function and Oxygen Saturation Level of the Residents in Dhaka, Bangladesh	Samiha Nahian	ACAM, AMIGO, GEIA, MAP-AQ
MANGO-3C	Fine particulate matter concentrations during 2020-2021 Lunar New Year holidays and the COVID-19 pandemic in Ho Chi Minh City, Vietnam	Cong-Thanh Tran	ACAM, MAP-AQ
MANGO-4A	Evolution of urban aerosols in warm and humid environment: Number concentrations & specific density	Yang Lan	ACAM, AMIGO, China WG
MANGO-5B	Particulate Matter Pollution over North Western India using integrated modeling approach: Case Study of Pre-monsoon Event	Manish Soni	ACAM, MAP-AQ
MANGO-6C	Investigating the performance of WRF-Chem in simulating the Indian Summer Monsoon and associated chemistry-feedback processes	Sreyashi Debnath	ACAM, CCMI, MAP-AQ
MANGO-7A	A model- and observation-based approach to quantify trends and uncertainty of premature mortality due to PM2.5 in China	Paolo Giani	MAP-AQ
MANGO-8B	Assessment of statistical models to improve performance of low-cost optical aerosol sensors in a warm and humid urban environment	Pongpichit Chuanraksasat	

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MANGO-9C	Effect of relative humidity on SOA formation from aromatic hydrocarbons: Implications from the evolution of gas- and particle-phase species	Tianzeng Chen	China WG
MANGO-10A	Fungal spores as emission sources of 137Cs to ambient aerosols after a nuclear accident in Fukushima 2011	Kimitaka Kawamura	
MANGO-11B	Personal PM2.5 exposures of solid fuel users in rural China: in vitro toxicity and chemical composition	Alexandra Lai	China WG
MANGO-12C	Multi-drugs Resistant Bacteria Associated Particulate Matter in the Ambient Air over Dhaka, Bangladesh	Razia Ankhy	ACAM, AMIGO, CATCH, CCMI, GEIA, MAP-AQ, PACES, TOAR, Americas
MANGO-13A	A ship-borne field campaign on ozone and precursors in Hong Kong waters	Xin Feng	ACAM, AMIGO, CATCH, CCMI, GEIA, MAP-AQ, PACES, TOAR, China WG
MANGO-14B	Measurements of hydrogen peroxide and formaldehyde concentrations over Toyama Prefecture in central Japan	Koichi Watanabe	ACAM, CATCH, TOAR, Japan NC
MANGO-15C	Formation and impacts of gaseous nitrated phenols at Hok Tsui during autumn and winter of 2018	Yi Chen	ACAM, AMIGO, TOAR, China WG
MANGO-16A	Measurement of Black Carbon Mass Concentration by using Aethalometer in Megacity Lahore, Pakistan	Noor Ahmad	
MANGO-17B	Geographic distribution of fluorescent bioaerosols and roles of marine biological particles in the cloud processes over the Arctic Ocean	Kaori Kawana	PACES, Japan NC
MAPAQ-1A	Linking land surface conditions with biogenic emissions, dry deposition and ozone in several latitude regions	Min Huang	GEIA, TOAR
MAPAQ-2B	Chemical characterization and source apportionment of PM2.5 in two West African cities (Korhogo and Abidjan in Cote d'Ivoire)	Sylvain Gnamien	GEIA, ANGA
MAPAQ-3C	PM2.5-bound silicon-containing secondary organic aerosols (Si-SOA) in Beijing ambient air	Jingsha Xu	ACAM, AMIGO, CATCH, CCMI, GEIA, PACES, TOAR
MAPAQ-4A	Direct and indirect effects of aerosols on meteorology and air pollutant concentrations during dry and wet periods on Southeast Brazil	Sergio Espinosa	AMIGO, CCMI, GEIA, Americas WG, Southern Hemisphere WG
MAPAQ-5B	The impact of large-scale circulation on daily PM2.5 in major populated regions of China during winter	Zixuan Jia	ACAM, CCMI, MANGO
MAPAQ-6C	Impact of aerosol chemical parameterization in a regional chemical transport model on PM distribution over Thailand.	Sherin Bran	ACAM, CCMI, MANGO
MAPAQ-7A	Model evaluation of Zeppelin and surface observations of reactive compounds in the evolving Atmospheric Boundary Layer: Entrainment versus other ABL sources and sinks.	Laurens Ganzeveld	
MAPAQ-8B	The impact of climate change on winter haze over the North China Plain	Shipra Jain	

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MAPAQ-9C	Association between pollution sources of ambient fine particulate and the changes in biomarkers of oxidative stress and inflammation: A case study in urban Beijing in 2016	Yidan Zhang	AMIGO, China WG
MAPAQ-10A	Mountain-valley circulation in Santiago, Chile: consequences on Black Carbon deposition over glaciers and Ozone injection into the free troposphere	Rémy Lapere	
MAPAQ-11B	Trace Metals Associated with Atmospheric Fine Particulate Matters in the Two most Populous Cities in Vietnam	Chi Nguyen	ACAM, MANGO
MAPAQ-12C	Towards high resolution air quality modeling using large eddy simulation: a case study for Eindhoven, the Netherlands	Ruud Janssen	
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MAPAQ-15C	Statistical and Machine Learning Methods for Evaluating Emissions Reduction Policies under Changing Meteorological Conditions	Minghao Qiu	GEIA, Americas WG, China WG
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MAPAQ-18C	Black carbon dispersion in central and southern Chile in winter and summer 2016	Kevin Basoa	ACAM, AMIGO, GEIA, Americas WG, Southern Hemisphere WG
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MAPAQ-27C	Diagnosis and prognosis of air quality in South Korea using the UKESM1 modeling	Taegyung Lee	
MAPAQ-28A	Polycyclic Aromatic Hydrocarbons (PAHs) in the Atmospheric Suspended Particulate Matter from Fertilizer Industries in Bangladesh	Snigdha Aziz	ACAM, AMIGO, CATCH, CCMI, GEIA, PACES, TOAR, Americas WG, ANGA,
MAPAQ-29B	Effect of Global Atmospheric Datasets in Modeling Meteorology and Air Quality in the Andean Region of Ecuador	René Parra	Americas WG, Southern Hemisphere WG
MAPAQ-30C	Efficient vertical transport of black carbon in the planetary boundary layer	Kang Hu	AMIGO, China WG
MAPAQ-31A	Quality Assurance in the WMO-Global Atmosphere Watch (GAW) Program: A New Expert Team on Measurement Quality for More Standardization and Evaluation	Herman Smit	
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ACAM-1A

Transport of black carbon from the planetary boundary layer to free troposphere during the summer monsoon over South Asia

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

This study uses Weather Research and Forecasting model, coupled with Chemistry (WRF-Chem), to understand black carbon (BC) vertical transport over South Asia during the active convection period. We analyze the climatology (1995–2014) of convective weather using TRMM lightning data. The results show both temporal and spatial variability within South Asia. The WRF-Chem model simulation for BC transport was conducted for an ENSO (El-Nino Southern Oscillation) moderate year - 2013. The model simulates the observed concentrations trend for most of the region except the central Himalayan cities. Our analysis indicates the dominant role of synoptic atmospheric dynamics and upper boundary conditions for the inverted seasonal trend of BC during the pre-monsoon season over these cities. The study presents time series and seasonal scale analysis of BC concentration over South Asia at various altitude levels. Our model simulations suggest that free troposphere (FT) BC concentration is higher in the monsoon season compared to the winter season at the same elevation. In addition, our results show the presence of a persistent BC plume from 500 hPa and above over central India with implications for the summer monsoon. The presence of an anti-cyclonic region during the monsoon season at the higher troposphere (500–300 hPa) contributes to this stable BC layer. Although individual high convection days (high helicity/CAPE) can easily transport a significant amount of BC from the surface to the FT, simulations do not show significant BC transported to the upper troposphere-lower stratosphere during these days. While satellite derived products provide some insights into model predictions, there is a need for in-situ measurements of BC concentration aloft over South Asia to further constrain model performance and improve understanding of BC transport to FT.

Early Career Scientist

YES, I am an early career scientist.

ACAM-2B

The $PM_{2.5}$ carbonaceous abundance and chemical constituents in ambient atmosphere of tropical urban city

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Noteworthy portion of carbonaceous matter (CM) in $PM_{2.5}$ has been addressed in many studies thus far. The inclusion of chemical species information has nearly completed the evaluation on ambient $PM_{2.5}$ compositions. This study designed to identify the fraction of $PM_{2.5}$ CM and chemical species in ambient environment of tropical urban city, Petaling Jaya (PJ), Malaysia for one complete seasonal cycle (January 2017 to February 2018). Gravimetric $PM_{2.5}$ daily concentration obtained from High Volume Sampler (HVS) mounted on the rooftop of MetMalaysia office in PJ. The elemental carbon (EC) and organic carbon (OC) concentration obtained via Sunset ECOC Analyzer while water soluble inorganic ions (WSI) and trace metal (TM) detected via ion chromatography (IC) and inductively coupled plasma mass spectrometry (ICPMS), respectively. The total average of $PM_{2.5}$ concentration was 27.76±9.69 μgm^{-3}.The main fraction of $PM_{2.5}$ components were identified as OC (24.4%), EC (2.5%) and inorganic matter (IM) (23.7%). The monthly variations of EC OC ratio showed high ratio value (5 to 22) indicate both EC and OC derived from different sources. High secondary organic carbon (SOC) concentration were found during cold season compared to dry period. The IM (WSI and TM) showed the leading percentage in descending order as SO_4^{2+}>NO_3^- >NH_4^+>Ca^{2+}>K^+ >Na^+>Fe> Al>Mg^{2+} (>0.1 % of total IM mass). The major WSI (NH_4^+, NO_3^- and SO_4^{2+}) showed lower concentration during dry season. Highest correlation of V and Ni (r = 0.862, p<0.01) explained the high usage of petroleum sources that reasonably connected with vehicles oil combustion. The chemical mass closure (CMC) analysis reconstructed $PM_{2.5}$ components to CM (36-43%) followed by dust (12-27%), secondary inorganic aerosol (SIA, 16-17%), sea salt (0.7-2.6%), K^+ (0.8-1.8%) and trace elements (0.6-1.2%). This study conclude that the pollutant constituents subjugated by the carbonaceous matter and WSI contributed bigger fraction than TM in tropical urban city ambient environment.

Early Career Scientist

YES, I am an early career scientist.

ACAM-3C

Ozone and carbon monoxide over the northern Indian Ocean during winter and monsoon: influence of chemistry and dynamics

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Continental south Asian airmass outflows over the Arabian Sea and equatorial Indian Ocean (IO) during winter and over the Bay of Bengal (BoB) during Monsoon. We have investigated the distribution of ozone (O_3) and carbon monoxide (CO) over the northern IO combining ship-based in-situ measurements carried out during the Integrated Campaign for Aerosols, gases, and Radiation Budget (ICARB) campaign (January–February 2018) and the International Indian Ocean Expedition (IIOE-2; July-August 2018), retrievals from Measurements of Pollution in the Troposphere (MOPITT), and Copernicus Atmosphere Monitoring Service (CAMS) model. Higher level of O_3 upto 80 ppbv and CO up to 350 ppbv were observed close to the coastal region during winter, being lower during monsoon (O_3 :45 ppbv; CO: 160 ppbv). Influence of shipping emission (around 6°N) gets infused in the south Asian outflow causing higher level of CO (~120 ppbv) and O_3 production (1.1–1.3 ppbv h^{-1}) with a diurnal amplitude of 4–8 ppbv over the southern BoB. Satellite and model results show increasing trend in surface O_3 (0.8–1.4 ppbv $decade^{-1}$) with decline in CO (3–5 ppbv $decade^{-1}$) as also inferred from in situ observations during present and previous measurements. Similar to the lower troposphere, decreasing trend is observed in the upper tropospheric CO (100–200 hPa) over the equatorial IO during winter. Interestingly, unusual enhancement in the upper-tropospheric CO over the equatorial IO was observed up to 30% during February-2018 as compared to the decadal mean, coinciding with anomalous westerlies over the region. The combined effect of the disturbed "Indonesia-IO" Walker circulation cell and the deeper penetration (up to the equator) of sub-tropical jet brought the influence of forest fire burning over the African region. Changes in large scale dynamics influence the composition of upper troposphere.

Early Career Scientist

YES, I am an early career scientist.

ACAM-4A

Photochemistry over an urban environment in India: Integration of measurements with box model

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The photochemical processes over the Indian region profoundly influence
the atmospheric composition and climate from regional to global scales. In a
global warming scenario, enhancements in biogenic and anthropogenic emissions are anticipated to further intensify the photochemistry and deteriorate the air quality in this part of the world. Here, we combine in situ and satellite-based measurements in a box model (NCAR Master Mechanism v2.5) to simulate the photochemistry over the urban environment of Ahmedabad (23° N, 72.6° E) in western India. Model has been initialized with the in situ measurements of nitrogen oxides, carbon monoxide, and several volatile organic compounds of natural and anthropogenic origin in prescribed environmental conditions. Model simulates large ozone build up (upto 115 ppbv) during the first three days, followed by a gradual decrease. Such high levels of ozone, in the absence of additional emissions, suggest that urban outflows can have strong impacts on the health and agriculture of the downwind regions. The photochemistry is also estimated to produce significant amounts of secondary inorganics such as nitric acid (17 ppbv), hydrogen peroxide (9 ppbv) and organics including ketones (11 ppbv). Noontime levels of hydroxyl and hydroperoxyl radicals are estimated as 0.3 and 44 pptv, respectively. Model also captures episodic large ozone changes in response to the variations in aerosol optical depth. Unprecedented reductions in anthropogenic emissions during the COVID-19 lockdown while reduced precursors dramatically, the ozone build up was found to be enhanced by ∼41%. Model simulations suggest that this was due to non-linear chemistry with NOx (by ∼25%) as well as change in meteorological conditions (by ∼16%).
The findings would be valuable to design strategies to curb ozone pollution and
highlight the need to conduct more measurements of detailed air composition
in the urban environments of Indian regions.

Early Career Scientist

YES, I am an early career scientist.

ACAM-5B

Organic, inorganic and total bromine in the extratropical tropopause and lowermost stratosphere in fall 2017: Origins, transport pathways and consequences for ozone

Meike K. Rotermund[1], Vera Bense[2], Martyn P. Chipperfield[3,4], Andreas Engel[5], Jens-Uwe Grooß[6], Peter Hoor[2], Tilman Hüneke[1,7], Timo Keber[5], Flora Kluge[1], Ben Schreiner[1], Tanja Schuck[5], Bärbel Vogel[6], Andreas Zahn[8], Klaus Pfeilsticker[1]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations

Abstract

Inferred total bromine (Br^{tot}) was measured in the upper troposphere and lower stratosphere from a research aircraft over the North Atlantic and north western Europe in fall 2017 during the WISE (Wave-driven ISentropic Exchange) campaign. The lower stratosphere weighted-mean Br^{tot} is 19.2 ± 1.2 ppt. A closer look into organic and inorganic bromine, as well as simultaneously measured transport (CO and N_2O) and air mass lag-time (SF_6) tracers, suggests that bromine-rich air masses persistently protruded into the lower stratosphere in fall creating a high bromine region (HBrR). A subsection, HBrR*, has a Br^{tot} weighted average of 20.9 ± 0.8 ppt. The most probable source region is former tropical upper tropospheric air with a Br^{tot} weighted mean of 21.6 ± 0.7 ppt. A secondary smaller source is transport across the extratropical tropopause. Lagrangian transport modelling quantifies these multi-pathway contributions to the lower stratosphere and HBrR. Further, the influences of the Asian monsoon and its tropical adjacent regions as well as tropical cyclones from Central America on bromine are discussed. And lastly, the consequences of ~1-2 ppt additional bromine in the tropical upper troposphere are simulated by a global chemistry transport model resulting in 3.1 ± 0.7% ozone decrease within the 20 K potential temperature layer directly above the tropopause.

Early Career Scientist

YES, I am an early career scientist.

ACAM-6C

Exploring potential impacts of Black Carbon on vertical mixing and overall air quality over Northern India

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

Black Carbon (BC) particles are released into the atmosphere from incomplete combustion. They can perturb the Earth's energy balance by absorbing solar radiation and modifying cloud microphysics. They can also impact vertical stability at high concentrations, potentially affecting the near-surface concentrations of other ambient species. BC emissions from India are one of the highest globally and significantly impact the Indian summer monsoon, regional climate, and human health. We use the WRF-Chem v.4.2 chemistry transport model with the MOSAIC sectional aerosol scheme to study the diurnal evolution of the vertical profiles of BC and $PM_{2.5}$ concentrations at a high temporal and horizontal resolution of 12km × 12km. An evident heterogeneity in the spatial distribution of modelled $PM_{2.5}$ and BC concentrations is observed, which changes from the Summer (September) towards the autumn (October, November) season. The model is able to capture elevated $PM_{2.5}$ concentrations (~300 μgm^{-3}) over the IGP region and localised hotspots over some major megacities. More recently, significant aerosol-planetary boundary layer (PBL) feedbacks have been reported to impact the vertical temperatures and the PBL stability over China during extreme haze events combined with high BC concentrations. We aim to build on these findings and examine similar events in India. To isolate contributions of emissions from anthropogenic and biomass burning sources to the overall air quality, we perform a base simulation and two sensitivity experiments. The diurnal PBL dynamics appear to strongly influence the temporal and spatial variations in aerosol distributions. We follow this by analysing the factors that control these distributions and compare our results with available observations to evaluate the model. We will also investigate the role of BC in influencing the PBL dynamics during high pollution events and, hence, overall air quality by perturbing the vertical radiation, temperature, and stability profiles.

Early Career Scientist

YES, I am an early career scientist.

ACAM-7A

Non-targeted screening of halogenated organosulfates in atmospheric particles

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BIC-ESAT and SKL-ESPC, College of Environmental Sciences and Engineering, Peking University, Beijing, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Organosulfates (OSs) are important secondary organic aerosols (SOA) components discovered in recent years. Although several types of OSs have been well studied, there are still plenty of unknown OSs generated from various precursors that have not yet been discovered, especially in China, where the characteristics of atmospheric environment and the source of VOCs are quite different from those in other countries. Halogenated volatile organic compounds (HVOCs) exist widely in the environment, these HVOCs might react with atmospheric oxidants and SO_2 or H_2SO_4 to form halogenated OSs (HOSs). HOSs might have both biological toxicity of HVOCs and the strong oxidizing and hygroscopic properties of OSs, posing risks to the atmospheric environment and human health. However, until now, no report focused on HOSs is found in literature. Using liquid chromatography coupled with negative electrospray ionization (ESI) quadrupole time-of-flight (QTOF) mass spectrometry, we established a systematic procedure for screening unknown HOSs in fine particulate matter ($PM_{2.5}$) collected in Beijing, based primarily on the characteristic fragment ions of sulfite radical ($\cdot SO_3^-$, m/z 79.9574), sulfate radical ($\cdot SO_4^-$, m/z 95.9523), and bisulfate anion ($\cdot HSO_4^-$, m/z 96.9601). The data was generated with untargeted data-dependent acquisition mode, and the identification procedures were implemented with a fully automated data extraction algorithm, taking into account accurate mass spectra, fragment masses, and retention times. Structure confirmation and quantification/semiquantification of HOSs were carried out based on authentic standards with accurate or similar structures of observed HOSs. These HOSs could be divided into aliphatic, aromatic, allylic, and nitro OSs, which might originate from alkenes and polycyclic aromatic hydrocarbons. Different ratios among abundances of halogenated analogues were observed and proposed as a marker to distinguish sources of HOSs from natural or anthropogenic sources.

Acknowledgement. This study was supported by National Natural Science Foundation of China Grant 91844000.

Early Career Scientist

YES, I am an early career scientist.

ACAM-8B

Accuracy assessment of TRMM precipitation product across different Agro-Climatic Zones of Tamil Nadu, India

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Tamil Nadu is located in the southernmost part of the Indian peninsular and the climate is categorized as a tropical monsoon with diverse agro-climatic condition allows growing a multi-various crop that lies between 08° 05′ to 13° 35′ Northern Latitudes and 76° 15′ to 80° 20′ Eastern Longitudes. In this study, the accumulated precipitation of the Tropical Rainfall Measuring Mission (TRMM) data over different Agro-Climatic Zones of Tamil Nadu was analyzed using statistical analysis, which showed an accountable variation during the study period from 2015 to 2017. Minimum precipitation of 144.31, 34.40, and 75.01 mm was recorded with TRMM during north-east monsoon (NEM) of 2015, 2016, and 2017, respectively. The corresponding maximum values were 1400, 251, and 687 mm whereas the automatic weather station (AWS) recorded a minimum of 151.65, 31.82, and 73.29 mm during the NEM of 2015, 2016, and 2017, respectively. Maximum values of 1755.31, 450.39, and 939.58 mm were recorded for the corresponding years. TRMM data was found to have higher R^2 values of more than 0.8 in all the NEM season of 2015, 2016, and 2017 irrespective of the Agro-climatic zones assessed. During NEM 2016, TRMM estimated maximum rainfall in High Altitude and Hilly Zone (HAHZ) and low rainfall in North Western Zone (NEZ), which revealed that the TRMM product performance was high and dependable for use. Even though RMSE values were found to be high in HAHZ and NEZ and the other Zones recorded less value, the agreement of the data with (AWS) values was found to be more than 80 percent which indicated the high correlation of the data with ground truth. It concludes TRMM product provides a lot of scope in climate research studies.

Early Career Scientist

YES, I am an early career scientist.

ACAM-9C

Impacts of biomass burning over Southeast Asia on regional air quality, radiation, and meteorology

Dr. Jiawei Li[1], Professor Zhiwei Han[1], Dr. Vanisa Surapipith[2,3], Dr. Narisara Thongboonchoo[4], Ms. Lin Liang[1], Ms. Jie Li[1], Dr. Ronald Macatangay[3], Mr. Sherin Hassan Bran[2,3]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

An online-coupled regional atmospheric chemistry/aerosol-climate model RIEMS-Chem was utilized to study the impacts of severe wildfire emissions (biomass burning emissions) during March to May 2019 over Southeast Asia on regional air quality, radiation, and climate. The model results were validated with a series of observations. Comparisons with meteorological parameters suggested that RIEMS-Chem was able to reflect the meteorological conditions (temperature, precipitation, etc.) during the pre-monsoon period (March to May) of 2019 over Southeast Asia and south China. Comparisons with organic carbon (OC), black carbon (BC), $PM_{2.5}$ (particulate matter with aerodynamic diameter ≤ 2.5 μm), and aerosol optical depth (AOD) demonstrated a good skill of the model in simulating pollutants and aerosol optical properties. During March to May 2019, the differences between model results with and without biomass burning (BB) emissions showed that BB aerosols contributed 85%, 91%, and 76~90% of OC, BC, and $PM_{2.5}$ concentrations, respectively, over north Thailand, while the contributions were 83% for BC and 67% for $PM_{2.5}$ over southwest China. BB aerosols accounted for 67~82% of AOD at AERONET sites in north Thailand and even 67% at a remote island site in the South China Sea. Model results indicated that the BB aerosols induced a positive radiative forcing of 2~20 W/m^2 at the top of the atmosphere (TOA) and a negative forcing of -50~-20 W/m^2 at the surface over north Thailand, Laos, Vietnam, and south China. As a result, the near surface temperature decreased by approximately 0.4~1.8°C along with a decrease in wind speed of 0.1~0.8 m/s, leading to a reduction of 60~270 m in planetary boundary layer height in these regions. Domain average precipitation was slightly depressed over Southeast Asia.

Early Career Scientist

NO, I am not an early career scientist.

ACAM-10A

Comparisons between satellite and CTM model derived total columns of ammonia over South and East-Asia

Miss Pooja V Pawar[1,2], Dr. Sachin D Ghude[1], Dr. Chinmay Jena[3], Dr. Andrea Moring[4], Dr. Mark A sutton[5], Dr. Santosh Kulkarni[6], Dr. Deen Mani Lal[1], Dr. Divya E Surendran[7], Dr. Martin Van Damme[8], Dr. Lieven Clarisse[8], Dr. Pierre-Francois Coheur[8], Dr. Xuejun Liu[9], Dr. Gaurav Govardhan[1], Dr. Wen Xu[9], Jize Jiang[4], Dr. Tapan Kumar Adhya[2]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Limited availability of atmospheric ammonia (NH_3) observations, limits our understanding of controls on its spatial and temporal variability and its interactions with the ecosystems. Here we used the Model for Ozone and Related chemical Tracers (MOZART-4) global chemistry transport model and the Hemispheric Transport of Air Pollution version-2 (HTAP-v2) emission inventory to simulate global NH_3 distribution for the year 2010. We presented a first comparison of the model with monthly averaged satellite distributions and limited ground-based observations available across South Asia. The MOZART-4 simulations over South Asia and East Asia were evaluated with the NH_3 retrievals obtained from the Infrared Atmospheric Sounding Interferometer (IASI) satellite and 69 ground based monitoring stations for air quality across South Asia, and 32 ground based monitoring stations from the Nationwide Nitrogen Deposition Monitoring Network (NNDMN) of China. We identified the northern region of India (Indo-Gangetic Plain, IGP) as a hotspot for NH_3 in Asia, both using the model and satellite observations. In general, a close agreement was found between yearly-averaged NH_3 total columns simulated by the model and IASI satellite measurements over the IGP, South Asia (r=0.81) and North China Plain (NCP), of East Asia (r=0.90). However, the MOZART-4 simulated NH_3 column was substantially higher over South Asia than East Asia, as compared with the IASI retrievals, which show smaller differences. Model simulated surface NH_3 concentrations indicated smaller concentrations in all seasons than surface NH_3 measured by the ground based observations over South and East Asia, although uncertainties remain in the available surface NH_3 measurements. Overall, the comparison of East Asia and South Asia using both MOZART-4 model and satellite observations showed smaller NH_3 columns in East Asia compared with South Asia for comparable emissions, indicating rapid dissipation of NH_3 due to secondary aerosol formation, which can be explained by larger emissions of acidic precursor gases in East Asia.

Early Career Scientist

YES, I am an early career scientist.

ACAM-11B

The substantial modulation of vertical mixing on new particle formation in Yangtze River Delta

Shiyi Lai[1,2], Shangfei Hai[1], Yang Gao[3], Yuhang Wang[4], Lifang Sheng[1], Aura Lupascu[5], Aijun Ding[2], Wei Nie[2], Ximeng Qi[2], Chun Zhao[6,7], Bin Zhao[8], Manish Shrivastava[8], Jerome D. Fast[8], Xiaohong Yao[3], Huiwang Gao[3]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Spring marks the season with highest frequency of NPF events in the Yangtze River Delta. In this study, based on measurements at the SORPES station in Nanjing, the period of 15 April to 20 April 2018 was selected considering the daily occurrence of NPF event. The six-day NPF events can be nicely classified into two categories based on the intensitify of vertical mixing within PBL. During the first three-day, the weaker sub-3 nm and nucleation mode particle number concentration showed relatively earlier peaks compared with the other three days, implying a early start time of NPF. To shed light on the linkage between the PBL mixing and NPF, several numerical experiments are conducted with the NPF-explicit WRF-Chem model, implying that new particles formed at the PBL top could be transported downward by vertical mixing as the development of PBL. The sensitivity numerical modeling by elimination of aerosol vertical mixing suppressed downward transport of particles formed at a higher altitude and the dilution of particles near surface. Both the lack of downward transport and high Fuchs surface area at the surface yielded a sharp weakening of NPF strength and a delayed start of NPF. The vertical mixing of aerosols increased surface $CN_{10\text{-}40}$ by about 122% and decreased PBL top $CN_{10\text{-}40}$ by 64%. NPF at the PBL top also resulted in the presence of high CCN layer in the vicinity. It is noteworthy that upward transport of condensable gases is the critical factor of continuous growth of nucleated ultrafine particles, with mean enhancement close to half of the particle number concentration in Aitken mode and CCN at supersaturation rate of 0.75%. The findings in this study may bridge the gap of understanding the complex interaction between PBL dynamics and NPF events, potentially reducing the uncertainty in assessing the climate impact of aerosol.

Early Career Scientist

YES, I am an early career scientist.

ACAM-12C

Interannual variability of aerosol in the upper troposphere/lower stratosphere (UTLS): Connection to the climate variability, Asian summer monsoon strengths, and emissions

Mian Chin[1], Huisheng Bian[2], Qian Tan[3], Michelle Santee[4], Ghassan Taha[5]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

We present our study of decadal variations of UTLS aerosol composition in terms of their sources and convective transport mechanisms associated with the Asian summer monsoon. We use the NASA global model GEOS that incorporates emissions from anthropogenic, biomass burning, volcanic, and other natural sources to simulate the aerosols and related gases, and satellite observations of aerosols and CO in the UTLS from 2010-2020 to investigate (1) the interannual variability of aerosol composition in the UTLS, (2) such variability in relationship to the ENSO and Asian summer monsoon strengths, and (3) the connections of UTLS aerosol with the anthropogenic and natural emissions.

Early Career Scientist

NO, I am not an early career scientist.

ACAM-13A

Storage stability of VOC in canisters under different conditions in HongKong

YUCHEN MAI
Hong Kong University of Science and Technology, Hong Kong, Hong Kong

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

As essential pollutants, volatile organic compounds (VOCs) in the atmosphere rank high in atmospheric environmental science. The traditional method of measuring VOC has been used for many years, and most of its sampling methods use canister and bags. When sampling VOC, the stability and recovery rate of the sample have a great influence on the analysis process. Therefore, a better understanding on storage stability of VOC could be of great assistance to our analysis and experiment, improving the quality of experiment and minimizing possible deviation. In this study, we aims to generate a systematic understanding on the stability performance of VOCs which are stored in canisters under different conditions. Stainless-steel canisters with a maximum air volume capacity of 2L and VOC standard gas will be used. In the initial stage, two temperatures (25℃, 40℃) and two humidity levels (RH 60%, 90%) are set to obtain the preliminary result with time interval as Day 0, Day 7, and Day 28. Although many related studies have been published all around the world, yet no research specifically concerning Hong Kongmeteorology conditions is conducted so far. Hence, this study is mainly focusing on Hong Kong's unique characteristic atmospheric condition (temperature and humidity). Further studies based on different storage media like air bags will have significant implications by making a comparison with the result of this study, giving a greater complete picture to the VOC storage theme.

Early Career Scientist

YES, I am an early career scientist.

ACAM-14B

Light Absorption Properties of Atmospheric Brown Carbon during Winter in Dhaka, Bangladesh.

Mr. ASFAY RAIHAN, Dr. Md. Safiqul islam, Mrs Farah Jeba, Dr. Abdus Salam
University of Dhaka., Dhaka, Bangladesh

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Brown carbon (BrC) in the atmospheric aerosols plays a vital role in climate due to its absorption properties. It has profound effects on atmospheric photochemistry and Earth's radiation budget. BrC light absorption properties have been measured in the ambient atmosphere of Dhaka Bangladesh. Suspended particulate matter (SPM) samples were collected on quartz filter paper in both day and night during highly polluted winter season from November to December 2019 with a low volume sampler. BrC absorption properties were measured with UV-Vis spectroscopic techniques by extracted in two different solvents (deionized water and methanol) and with Aethalometer. The mass concentration was calculated from Aethalometer attenuation. The average mass concentration was found to be $7.1\times10^4 \pm 1.7\times10^4$ μgm^{-3} during night, which was significantly higher than the daytime of $4.4\times10^4 \pm 1.2\times10^4$ μgm^{-3}. The absorbance of MeS-BrC is greater than that of WS-BrC during both day and night period. The absorbance is found to be higher in the UV-Vis region and decreases with increasing wavelength. The average b_{abs} value of MeS-BrC during day and night was 61.39 Mm^{-1} and 135.91 Mm^{-1}, respectively. A lower b_{abs} in WS-BrC was observed as 51.49 and 89.78 Mm^{-1}, respectively during day and night. The average MAE value varied from day to night, ranging from 1.47×10^{-3} to 2.21×10^{-3} m^2g^{-1} for MeS-BrC and 1.25×10^{-3} to 1.40×10^{-3} m^2g^{-1} for WS-BrC. For both solvents, the MAE value observed at night was greater than that observed during the day. As a result, it is reasonable to believe that nighttime particles have a high scattering potential and have led to increase the light absorption.

Keywords: Brown carbon, Absorption coefficient (b_{abs}), Mass absorption efficiency (MAE), Mass concentration.

Early Career Scientist

YES, I am an early career scientist.

ACAM-15C

Combining Multi-Wavelength AERONET SSA Retrievals with an MIE Model and UV AI from OMI to Quantify the Global AAOD of BC and OC

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

We employ a MIE model to simulate the absorption of core-shell coated mixtures of AA (specifically a mixture of BC core with sulfate shell (MBS) and OC core with sulfate shell (MOS) across multiple individual wavelengths. These values are then merged with individual inversions of SSA from AERONET at each individual wavelength across the spectrum from the UV through the NIR. Fitting is done based on the temporally varying magnitude band of the measured AOD and the inverted SSA incorporating all individual data points where both calculations exist at each station, from 2010 to 2016. The relationship between core and shell sizes that is consistent with AERONET is then fitted to OMI measurements that overlap AERONET in space and time. A sensitivity matrix of optical uncertainties is made to compute the robustness of the constrained aerosol size, chemical composition and refractive indices.

Initial results show that retrieved aerosol properties of MBS and MOS are consistent with known properties over urban areas, biomass burning areas, and those regions frequently impacted by long-range transport events, as observed over Asia. A few interesting scientific findings include mixing between these different sources and detection of otherwise missing sources. It is hoped that ongoing calculations allowing our approximation to be extended spatially away from sites where AERONET measurements exist will also be ready to present.

Early Career Scientist

YES, I am an early career scientist.

ACAM-16A

Linkage of water vapor distribution in the lower stratosphere to organized Asian summer monsoon convection

Bhupendra Bahadur Singh[1,2], Krishnan Raghavan[1], Ayantika D. C.[1], Ramesh K Vellore[1], Sabin T.P.[1], Ravi Kumar Kunchala[3], Simone Brunamonti[4], Sreeharsha Hanumanthu[5], Teresa Jorge[4], Peter Oelsner[6], Sunil Sonbawne[1], Manish Naja[7], Suvarna Fadnavis[1], Thomas Peter[4], Manoj Kumar Srivastava[2]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

Accumulation of water vapor (WV) in the upper troposphere/lower stratosphere (UT/LS) over the Asian continent is a recognized feature during boreal summer. While there has been a debate on the role of monsoon convective intensities on the UT/LS WV accumulations, there are ambiguities with regard to the effects of organized monsoon convection on the spatial distribution of WV. We provide insights into this aspect using balloon-borne measurements of WV from a high-elevation site Nainital (29.4° N, 79.5° E), India, and satellite retrievals from the Microwave Limb Sounder (MLS). We also use precipitation estimates from the Tropical Rainfall Measuring Mission (TRMM) satellite (estimates of rain rate and rain type viz convective/stratiform), reanalysis circulation data, as well as numerical model simulations. It is seen that the LS WV distribution is closely linked to the organization of the South Asian monsoon convection and its influence on the UT/LS circulation. It is evidenced that periods of organized summer monsoon convective activity over the Indian subcontinent and Bay of Bengal promote divergence of WV flux in the UT/LS; additionally the Tibetan anticyclonic circulation causes widespread distribution of the UT/LS WV. Results indicate that widespread spatial distribution and accumulation of WV in the LS tend to co-occur with organized monsoon convection, intensified divergence of WV flux in the UT/LS, and intensified Tibetan anticyclone. On the other hand, the circulation response and LS WV distribution to pre-monsoon localized deep convection tends to have a limited spatial scale confined to Southeast Asia. Model experiments suggest that the UT/LS circulation response to organized monsoon convection has a resemblance to stationary Rossby waves forced by latent heating, with the westward extending response larger by about 15° longitudes as compared to that of the pre-monsoon localized deep convection.

Early Career Scientist

YES, I am an early career scientist.

ACAM-17B

Light Absorption Properties of Brown Carbon from the Biomass Burning

Md. Safiqul Islam, Farzana Runa, Farah Jeba, Abdus Salam
University of Dhaka, Dhaka, Bangladesh

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Brown carbon (BrC), a light-absorbing portion of organic carbon released from incomplete combustion of biomass, is an important component of the atmospheric carbonaceous aerosol. The light absorption properties of BrC from biomass burning were studied in a laboratory-scale experiment as part of this research. Fourteen different biomasses were used for the combustion to collect particulate matter (PM) on a quartz fiber filter. A UV-Vis spectrometer was used to determine the absorption properties of methanol-soluble BrC (MeS-BrC) and water-soluble BrC (WS-BrC). The absorption properties of water-extractable BrC were determined, including the mass absorption efficiency (MAE), the absorption coefficient (b_{abs}), the Absorption Angström Exponent (AAE), and the absorbing factor of refractive index (k_{abs}). Significant variations of the light absorption properties among different biomasses were observed. The influence of pH on the optical absorption of WS-BrC was discovered to be that with increasing pH, the absorbance increased. BrC's absorption properties are influenced by the solvent used to extract it. Methanol extracted BrC showed higher absorbance than water-soluble BrC for all these fourteen biomass samples.

Early Career Scientist

YES, I am an early career scientist.

ACAM-18C

Transport of air in the region of the Asian monsoon anticyclone and its impact on the stratosphere

Bärbel Vogel
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

The Asian summer monsoon is associated with deep convection over the Indian subcontinent and with an anticyclonic flow that extends from the upper troposphere into the lower stratosphere (UTLS). The strong anticyclonic circulation in the UTLS acts as an effective transport barrier, causing a confinement of tropospheric trace gases in the anticyclone. The transport of tropospheric trace gases by the Asian monsoon anticyclone (AMA) into the lower stratosphere changes its chemical composition and can impact the radiative balance. The transport of air masses out of the AMA is determined by different processes and time scales. Here, the basic transport mechanisms are introduced and are demonstrated based on simulations with the chemical Lagrangian transport model (CLaMS) combined with airborne and balloon measurements in Asia and over the northern Atlantic.

It is believed that the transport of air masses from boundary layer sources in the region of the Asian monsoon into the tropical pipe occurs in three distinct steps (convection, diabatic heating superimposed on the anticyclonic motion, transport within the tropical pipe). It is known that the export of monsoon air quasi-isentropically out of the AMA both to the east and to the west has a larger impact on the composition of the northern extratropical UTLS (ExUTLS) than the vertical upward transport via the tropical pipe on the tropical lower stratosphere. Air transported to the east can move along the subtropical jet after it has separated from the AMA and cross-tropopause transport can occur most likely driven by large-scale Rossby wave breaking. Subsequently, streamers of subtropical air reach far into high latitudes and transport polluted air from the AMA into the northern ExUTLS. Examples to illustrate these transport pathways will be shown both from CLaMS simulations and from aircraft measurements (i.a. STRATOCLIM in Nepal 2017 and WISE in Ireland 2017).

Early Career Scientist

NO, I am not an early career scientist.

ACAM-19A

Atmospheric outflow of anthropogenic iron and its deposition to China adjacent seas

Xiaohuan Liu, chunqiang Chen
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Atmospheric deposition of iron (Fe) can increase marine primary productivity, consequently affect ocean biogeochemical cycles and climate change. In this study, we develop an adaptor to generate anthropogenic Fe emission inventories for China in 2012 and 2016 via anthropogenic $PM_{2.5}$ emissions from Multi-resolution Emission Inventory for China (MEIC) using local source-specific mass fractions of Fe in $PM_{2.5}$. Using the generated emission inventories, we simulated Fe concentrations as well as dry deposition fluxes to China marginal adjacent seas using a WRF-CMAQ model during four campaign periods. The simulated Fe concentrations are in good agreement with observations except for those in presence of severe dust-intrusion events (NMB -13% ~ -13%), indicating a reasonably good performance of the generated Fe emissions. The total anthropogenic emissions of Fe over China in 2012 and 2016 are estimated as 5.5×10^2 Gg and 3.3×10^2 Gg, respectively. Simulated Fe concentrations over China marginal seas are in the range of 62 - 6.5×10^2 ng m^{-3}, providing 2.0 - 12.5 μg m^{-2} d^{-1} to the seas during the study periods. Due to lower Fe solubility in nature mineral aerosols than in anthropogenic aerosols, dry deposition fluxes of bioavailable Fe on haze days almost double that in dust days and 4.7 times in less polluted days. We also estimated the primary productivity derived by dry atmospheric deposition of assumed bioavailable Fe over China marginal seas as 3.3, 15.4 and 8.7 mg C m^{-2} d^{-1} in less polluted days, haze and dust event, respectively.

Early Career Scientist

NO, I am not an early career scientist.

ACAM-20B

Intensified modulation of winter aerosol pollution in China by El Niño with short duration

Liangying Zeng[1], Yang Yang[1], Hailong Wang[2], Jing Wang[3], Jing Li[4], Lili Ren[1], Huimin Li[1], Yang Zhou[1], Pinya Wang[1], Hong Liao[1]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

El Niño-Southern Oscillation (ENSO), a phenomenon of periodic changes in sea surface temperature in the equatorial central eastern Pacific Ocean, is the strongest signal of interannual variability in the climate system with a quasi-period of 2-7 years. El Niño events have been shown to have important influences on meteorological conditions in China. In this study, the impacts of El Niño with different durations on aerosol concentrations and haze days during December-January-February (DJF) in China are quantitatively examined using the state-of-the-science Energy Exascale Earth System Model version 1 (E3SMv1). We find that $PM_{2.5}$ concentrations are increased by 1-2 μg m^{-3} in the northeastern and southern China and decreased by up to 2.4 μg m^{-3} in central-eastern China during El Niño events relative to the climatological means. Compared to long duration (LD) El Niño events, El Niño with short duration (SD) but strong intensity causes northerly wind anomalies over central-eastern China, which is favorable for aerosol dispersion over this region. Moreover, the anomalous southeasterly winds weaken the wintertime prevailing northwesterly in northeastern China and facilitate aerosol transport from South and Southeast Asia, enhancing aerosol increase in northeastern China during SD El Niño events relative to LD El Niño events. In addition, the modulation on haze days by SD El Niño events is 2-3 times more than that by LD El Niño events in China. The aerosol variations during El Niño events are mainly controlled by anomalous aerosol accumulation/dispersion and transport due to changes in atmospheric circulation, while El Niño-induced precipitation change has little effect. The occurrence frequency of SD El Niño events has been increasing significantly in recent decades, especially after 1940s, suggesting that El Niño with short duration has exerted increasingly intense modulation on aerosol pollution in China over the past few decades.

Early Career Scientist

YES, I am an early career scientist.

ACAM-21C

Simultaneous trace gas measurements of the HALO aircraft: Widespread detection of HONO in excess of model predictions during the EMeRGe-EU and -Asia campaigns and its possible formation mechanisms.

Benjamin Schreiner[1], Meike Rotermund[1], Flora Kluge[1], Prof. Dr. Klaus Pfeilsticker[1], Dr. Helmut Ziereis[2], Dr. Mariano Mertens[2], Eric Förster[3], Dr. Maria Dolores Andres Hernandez[4], Dr. Birger Bohn[5], Dr. Andreas Giez[6], Katharina Kaiser[7,8], Dr. Johannes Schneider[8], Dr. Mira Pöhlker[9], Bruna Holanda[9]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Abstract

As part of the EMeRGe-EU and EMeRGe-Asia (Effect of Megacities on the transport and transformation of pollutants on the Regional to Global scales) campaigns over continental Europe and Southeast Asia in July 2017 and March 2018, respectively, atmospheric trace gases were measured in the free troposphere from the HALO (High Altitude LOng range) aircraft. The remote sensing of NO_2 and HONO was performed with the miniDOAS instrument and analyzed using DOAS (Differential Optical Absorption Spectroscopy) in conjunction with the novel scaling method. Several other species and quantities such as NO, NO_Y, RO_2^* (HO_2 + SRO_2), relative humidity, aerosol chemical composition and size distribution, black carbon mass concentration, and the photolysis frequencies of NO_2 and HONO were measured in situ. Comparison with MECO(n) (MESSy-fied ECHAM and COSMO/MESSy nested n times) simulations reveals HONO measured in excess of gas phase formation predictions by up to an order of magnitude. Likely heterogeneous HONO formation mechanisms suggested by recent laboratory and field studies are investigated via correlation against the excess HONO and its formation rate (assuming steady state with loss via photolysis).

Early Career Scientist

YES, I am an early career scientist.

ACAM-22A

Oxygenated volatile organic compounds measurement using proton transfer reaction time-of-flight mass spectrometry in Hong Kong: characteristics, chemical reactivities, and source apportionment

phd student Lirong HUI, Professor Zhe WANG
HKUST, Hong Kong, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CATCH: the Cryosphere and Atmospheric Chemistry, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

China Working Group

Abstract

As the most populated and economically vibrant region in China, Hong Kong frequently suffered from extremely high O3 exposure over the past years, which has become one of the most severely polluted areas of O3 in China. As the important precursors of O3, volatile organic compounds (VOCs) can rapidly produce O3 through photochemical oxidation in the presence of NOx. In this study, VOCs were continuously measured by proton transfer reaction time-of-flight mass spectrometry (PTR-ToF-MS) on November 2020 in HKUST in Hong Kong. This study will present the concentrations, chemical reactivities, and source apportionment of oxygenated volatile organic compounds (OVOCs). During the sampling period, 83 ions including CxHy-related ions, OVOC-related ions, and N-containing ions were detected in PTR-ToF-MS mass spectra. The total VOC concentration was about 47 ppb, while 53 OVOC-related ions contributed about 83% on the total VOC concentrations, with the concentration of about 39 ppb. Among which, methanol, acetaldehyde, acetic acid and acetone were the most abundant OVOCs. OVOCs contributed significantly to OH reactivity, accounting for about 48% of the total OH reactivity, especially acetaldehyde, formaldehyde, and acetic acid. In addition, OVOCs contributed more to OH reactivity on O3 episode days than non-episode days. Receptor model PMF was used to make the identification and quantification of OVOC sources in this study.

Early Career Scientist

YES, I am an early career scientist.

ACAM-23B

TCCON Nicosia: First ground-based FTIR greenhouse gas measurements in the Eastern Mediterranean and Middle East region

PhD Student Constantina Rousogenous[1], Christof Petri[2], Thorsten Warneke[2], Pierre-Yves Quéhé[1], Thomas Laemmel[3,4], Michel Ramonet[4], Justus Notholt[2], Mihalis Vrekoussis[2,1], Jean Sciare[1]
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IGAC Activities

Abstract

The Eastern Mediterranean and Middle East (EMME) region, with its population of more than 400 million people, is identified as one of the primary climate change "hot spots" worldwide, experiencing adverse impacts ranging from extreme weather events to poor air quality. Projections show that these phenomena are expected to further exacerbate in the coming decades. At the crossroads of Europe, Africa, and Asia, the island of Cyprus, in the middle of the EMME, receives long-range pollution from various anthropogenic and natural sources. To assess the variability and amounts of greenhouse gases (GHG) contributing to radiative forcing in the area, we have set up, in 2019, a new Total Carbon Column Observing Network (TCCON) site, the TCCON Nicosia, at The Cyprus Institute. Herewith, we present the first results; columnar amounts of the main GHGs in the region, namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and carbon monoxide (CO). The TCCON Nicosia site was validated against the World Meteorological Organization (WMO) reference scale in June 2020 with the first AirCore campaign in Cyprus. The WMO scale ensures common accuracy among observations from different platforms, i.e. in-situ, ground- and space-based remote sensing. The existing data set of 1.5 years of GHG data, together with the results of the AirCore comparison, are presented. Interestingly, two of the AirCore flights revealed elevated GHG levels in the upper troposphere, transferred by the Asian Summer Monsoon Anticyclone (ASMA). The latter provides evidence that long-range transported pollution originating in southeast Asia can reach the Eastern Mediterranean.

Early Career Scientist

YES, I am an early career scientist.

ACAM-24C

Carbon and health implications of trade restrictions

Dr. Jintai Lin[1], Dr. Mingxi Du[1], Miss Lulu Chen[1], Dr. Kuishuang Feng[2], Dr. Yu Liu[3], Dr. Randall Martin[4], Dr. Jingxu Wang[1], Dr. Ruijing Ni[1], Dr. Yu Zhao[5], Mr. Hao Kong[1], Mr. Hongjian Weng[6], Dr. Mengyao Liu[1], Dr. Aaron von Donkelaar[7], Mr. Qiuyu Liu[8], Dr. Klaus Hubacek[2]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

In a globalized economy, production of goods can be disrupted by trade disputes. Yet the resulting impacts on carbon dioxide emissions and ambient particulate matter ($PM_{2.5}$) related premature mortality are unclear. Here we show that in contrast to a free trade world, with the emission intensity in each sector unchanged, an extremely anti-trade scenario with current tariffs plus an additional 25% tariff on each traded product would reduce the global export volume by 32.5%, gross domestic product by 9.0%, carbon dioxide by 6.3%, and $PM_{2.5}$-related mortality by 4.1%. The respective impacts would be substantial for the United States, Western Europe and China. A freer trade scenario would increase global carbon dioxide emission and air pollution due to higher levels of production, especially in developing regions with relatively high emission intensities. Global collaborative actions to reduce emission intensities in developing regions could help achieve an economic-environmental win-win state through globalization.

Early Career Scientist

YES, I am an early career scientist.

ACAM-25A

Compositional Analysis of Cloud Droplet Residuals by High Resolution Time-of-Flight Aerosol Mass Spectrometry: A CAMP^{2}Ex Case Study

Claire E Robinson[1,2,3], Rachel E O'Brien[2], Matthew D Brown[1,3], Ewan C Crosbie[1,3], Francesca Gallo[3,4], Carolyn Jordan[3,5], Richard H Moore[3], Kevin J Sanchez[3,4], Taylor J Shingler[3], Michael A Shook[3], Kenneth L Thornhill[1,3], Elizabeth B Wiggins[3,4], Edward L Winstead[1,3], Bruce E Anderson[3], Luke D Ziemba[3]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

The complexity of cloud-aerosol interactions remains a significant research front in the field of atmospheric chemistry. Variations in the chemical composition of cloud condensation nuclei (CCN) play a role in cloud formation and reactions that occur in the cloud droplets. Determining the chemical composition and carbon oxidation state of sub-cloud aerosols and their corresponding cloud droplet residuals helps us further understand the overall formation of clouds and the effect on the radiative budget of the atmosphere. The Cloud, Aerosol and Monsoon Processes-Philippines Experiment (CAMP^{2}Ex) is a collaborative field campaign between NASA and the Philippines research community that flew during the 2019 southwest monsoon season. One of its primary focuses was to characterize aerosol and cloud microphysics in the study region utilizing a complex suite of instrumentation on the NASA P-3B aircraft.

Here, we present a case study examining on-line High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS) data from CAMP^{2}Ex. This specific flight in question was conducted on 16 September 2019 over the Sulu Sea targeting biomass burning aerosol originating from the Borneo region. The HR-ToF-AMS sampled from a forward-facing isokinetic inlet for the majority of the flight, but was switched to sample from a Counter-Flow Virtual Impactor (CVI) inlet when passing through clouds in order to characterize cloud droplet residual composition. Clouds sampled during the flight were a mixture of shallow marine cumulus (i.e., with cloud tops reaching approximately 1 km) and a more-developed convective cell reaching 4-5 km altitude. Organic aerosol elemental ratios and mass spectra for this flight give insight into the chemical composition of the sampled aerosol and cloud droplet residuals. This unique set-up allows us to observe the effects of cloud processing on the chemical composition of the sampled biomass burning aerosol and determine relevant scales of altitude or spatial variability during the flight.

Early Career Scientist

YES, I am an early career scientist.

ACAM-26B

Observations of Regional Biomass Burning and Urban Trace Gas Enhancement Ratios in Southeast Asia and their Relationship with Aerosol Composition and Air Quality

Joshua P DiGangi[1], Glenn S Diskin[1], Subin Yoon[2], Sergio L Alvarez[2], James H Flynn[2], Claire E Robinson[1,3], Michael A Shook[1], Kenneth L Thornhill[1,3], Edward L Winstead[1,3], Luke D Ziemba[1], Maria O Cambaliza[4], James B Simpas[4], Miguel Ricardo A Hilario[5], Armin Sorooshian[5]
[1]NASA Langley Research Center, Hampton, VA, USA. [2]University of Houston, Houston, TX, USA. [3]Science Systems and Applications, Inc., Hampton, VA, USA. [4]Manila Observatory, Quezon City, Philippines. [5]University of Arizona, Tucson, AZ, USA

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Biomass burning in Southeast Asia is a major pollutant source contributing to poor air quality throughout the region. Thus, understanding these emissions is critical for predicting and mitigating their health impacts. While there have been many studies reporting ground-based and satellite measurements, airborne regional scale measurements to tie the two together have not been common. The 2019 Cloud, Aerosol and Monsoon Processes Philippines Experiment (CAMP^{2}Ex) field campaign examined Southeast Asian regional sources and their effects on aerosol/cloud interactions using a combination of airborne, shipboard, and ground-based measurements. Flights sampled a variety of airmasses in the Philippine, South China, and Sulu seas during both the southwest monsoon and monsoon transition periods. Thus, CAMP2Ex provides a unique opportunity to study how transported and local emissions affect air quality trends and airmass chemical composition. In this analysis, correlated airborne in situ enhancement ratios of CH_4 to CO are used to identify source regimes of high urban or biomass burning influence as well as urban regimes with different emission factors. Combined with HYSPLIT backtrajectories, these source regimes are examined for their effects on ozone, NO_y, and aerosol chemical composition. For example, while observed O_3/CO enhancement ratios remain constant for differing urban source regimes, NO_y/CO ratios are observed to vary across these regimes. For biomass burning sources, O_3/CO enhancement ratios are observed to be lower than previously reported by measurements in the region.

Early Career Scientist

NO, I am not an early career scientist.

ACAM-27C

The Implication of Oil Production to Ozone Chemistry in the Oilfield Regions of Northern China

Tianshu Chen[1], Penggang Zheng[1], Can Dong[1], Rui Gao[2], Guangxuan Han[3], Xin Zhang[1,2], Hong Li[2], Wenxing Wang[1], Likun Xue[1]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

China Working Group, Americas Working Group

Abstract

Despite the development of new energy, the O&NG production is increasing globally with the increased importance of petrochemicals in driving oil demand growth. Volatile organic compounds (VOCs) emissions associated with the O&NG production have the potential to form tropospheric ozone (O_3) and organic aerosol. Studies in the United States have confirmed the high concentration of VOCs and O_3 in oil basins with the help of adverse weather conditions in winter. However, significant gaps remain in our knowledge concerning situations in other continents.

To evaluate the impact of O&NG production on VOCs and O_3 pollution in China, two intensive measurements were conducted in two areas: the Yellow River Delta which surrounded by the fifth-largest oilfield of China, Shengli Oilfield (during February-April and June-July 2017), and Yulin city which adjoined the largest oilfield of China, Changqing Oilfield (during February-March 2021). Many parameters have been in-situ measured, including O_3, nitrogen oxides, VOC, carbonyls, HONO, aerosol properties, and meteorological parameters. In addition, the source profile of O&NG production was obtained from samples collected in O&NG wells in the Shengli Oilfield. Both areas showed higher alkanes than other areas, with richer long alkanes in the Shengli Oilfield than Changqing Oilfield. The radical chemistry and ozone formation mechanism were systematically analyzed by chemical explicit modeling. The research results indicated O&NG and its associated petrochemical industries have a significant impact on the rapid production of ozone in a broad region.

Early Career Scientist

YES, I am an early career scientist.

ACAM-28A

Airborne and Satellite Investigation of Asian Air Quality (ASIA-AQ): An Opportunity for International Collaboration

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The recent launch of the Geostationary Environment Monitoring Spectrometer (GEMS) provides an important catalyst for increased dialogue and cooperation among Asian countries to address air quality. Other emerging efforts to support GEMS validation and international cooperation include the Pandora Asia Network (PAN) and the Pan Asia Partnership for Geospatial Air Pollution Information (PAPGAPI). These efforts represent long-term commitments to bridging satellite observations with ground-based monitoring to inform air quality. Aircraft observations can provide invaluable context to the satellite and ground-based perspectives that are used more routinely to inform air quality models used for both forecasting and attribution. Important information from aircraft includes measuring detailed composition for source fingerprinting, vertical profiling of composition for satellite validation and model assessment, observing chemical and dynamical processes affecting secondary pollution (i.e., fine particles and ozone), relating specific VOC mixtures to satellite HCHO, providing fine scale pollution mapping with remote sensors, etc. Such information is critical for understanding the local factors influencing air quality for a specific location, quantifying emission sources, and assessing potential mitigation strategies for decision makers. ASIA-AQ proposes to provide airborne observations over three to five Asian megacities with repetitive observations that will observe the diurnal and vertical distribution of primary emissions and secondary pollutants with at least four flights over each location. In combination with satellite and ground observations, data would support analyses for assessment of emissions, model evaluation, process-level understanding of secondary pollutants (i.e., fine particles and ozone), and satellite validation and interpretation. Current status of the ASIA-AQ white paper, nominal plans, and opportunities for involvement will be presented.

Early Career Scientist

NO, I am not an early career scientist.

ACAM-29B

Aerosol structure, absorption and interactions with the PBL and impact on surface pollution

Professor Zhanqing Li
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

Aerosol-planetary boundary layer (PBL) interaction was proposed as an important mechanism to stabilize the atmosphere and exacerbate surface air pollution. Despite the tremendous progress made in understanding this process, its magnitude and significance still have large uncertainties and vary largely with aerosol distribution and meteorological conditions. In this study, we focus on the role of the vertical distribution on thermodynamic stability and PBL development by jointly using micropulse lidar, sunphotometer, and radiosonde measurements. Despite the complexity of aerosol vertical distributions, cloud-free aerosol structures can be largely classified into three types: well-mixed, decreasing with height, and inverse structures. The aerosol-PBL relationship and diurnal cycles of the PBL height and $PM_{2.5}$ associated with thesedifferent aerosol vertical structures show distinct characteristics. The vertical distribution of aerosol radiative forcing differs drastically among the three types with strong heating in the lower, middle, and upper PBL, respectively. Such a discrepancy in heating rate affects the atmospheric buoyancy and stability differently in the three distinct aerosol structures. Absorbing aerosols have the weak effect of stabilizing the lower atmosphere under the decreasing structure than under the inverse structure. As a result, the aerosol-PBL interaction can be strengthened by the inverse aerosol structure, and can be potentially neutralized by the decreasing structure. The entrainment process at the top of PBL is suppressed under the inverse aerosol structure, and further serves as a favorable condition for high aerosol loading in upper PBL. This study attempts to improve our understanding of the aerosol-PBL interaction, showing the importance of the observational constraint of aerosol vertical distribution for simulating this interaction and consequent feedbacks.

Early Career Scientist

NO, I am not an early career scientist.

ACAM-30A

Decadal trend of black carbon aerosols over the Central Himalayas: 17 years of ground observations

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CATCH: the Cryosphere and Atmospheric Chemistry, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Long-term trends in the aerosols are analysed by combining 17 years of ground observations of black carbon (BC) at a high altitude site in the Central Himalayas (29.5N, 79.4E, 1958m a.m.s.l.) with co-located data from satellites and MERRA2.

This analysis reveals a statistically significant yet weak decreasing trend (Mann Kendall test) in BC over the Central Himalayas at an average rate of ~18ng m−3 year-1 during the period 2004–2020. This result is in contrast with the trends obtained from both surface and columnar BC concentration in MERRA2 which show a slight increasing tendency. Further, BC was segregated into fossil fuel and biomass burning components and it is found that the fossil fuel fraction dominates the total BC content throughout the period. It is also evidenced that the fossil fuel BC fraction declines faster than the biomass burning one. The biomass burning BC fraction rises with the increase in the frequency of fire events over the Northern Indian region particularly during spring. The trend in both fire events and their association with the declining trend in the observed BC is also presented. The temporal variation of BC concentrations is also analysed with the meteorological parameters and changes in boundary layer dynamics. Concentration weighted trajectory analysis used for assessing long range transport revealed that emissions from Indo-Gangetic plains are important contributors to pollutants even at this high altitude. In contrast to the declining trend observed in BC, aerosol optical depth observations over the region show a somewhat increasing trend which compares well with that from MODIS. Long term observations from CALIPSO reveal an elevated aerosol layer at around 2-4 km a.m.s.l. around the region.

These observations thus provide a unique long term characterization of aerosols in an otherwise sparsely studied complex terrain of Central Himalayas and will be very important to assess the regional radiation budget.

Early Career Scientist

YES, I am an early career scientist.

ACAM-31A

Quantitative Assessment of Black Carbon over Southern China During Springtime: Regional and Sectoral Sources and the Impacts of East Asian Summer Monsoon Onset

Dr. Chenwei Fang
Nanjing University of Information Science and Technology, Nanjing, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group, China Working Group

Abstract

Previous studies emphasized that abundant black carbon (BC) originating from strong biomass burning (BB) in peninsula Southeast Asia (PSEA) can transport to Southern China (SC) during springtime, while its long-term contributions to BC over SC remain unquantified. East Asian Summer Monsoon (EASM) is also established in spring with the wind reversal and affects the regional transport of BC over SC, while the impacts of EASM onset time on BC distribution and sources are unclear. In this study, A BC-tagging-technique that can track the regional and sectoral sources of BC simultaneously is added into the Community Earth System Model. We quantify the BC sources at different altitudes over SC in spring during 2000-2014 driven by offline meteorological field MERRA. Results show that about 64% of BC column burden (BCC) and 27% of BC surface concentration (BCS) over SC can be attributed to non-local sources, and their largest remote regional sources are PSEA (20%) and Northern China (NC; 18%), respectively. The contribution of BB sector to BC over SC increases from the surface (3%) to the upper air (13%), which can be attributed to that BC from PSEA mainly transport above 850 hPa. BB emission from PSEA accounts for about 80% of BCC in the BB sector over SC. BC from NC is largely composed of residential and industrial sectors (80~90%) and its main transport layer is below 850 hPa. An emission-fixed simulation shows that the interannual variation in BC concentrations over SC is significantly related with the varying EASM onset times, which is mainly resulted from the BC outflow/inflow transported from NC. When EASM onset time is early (late), a southerly (northerly) wind anomaly blocks (promotes) the southward transport of BC from NC to SC, thus leading to a BC decrease (increase) in SC.

Early Career Scientist

YES, I am an early career scientist.

ACAM-32B

Aromatics derived oxygenated organic molecules in Hong Kong: Source, formation and impacts

PhD student Penggang ZHENG[1], Assistant Professor Zhe WANG[1], Post-doc Yi CHEN[1], Professor Tao WANG[2], Associate Professor Wei NIE[3], Post-doc Chao Yan[4], Dandan HUANG[5]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CATCH: the Cryosphere and Atmospheric Chemistry, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

China Working Group

Abstract

Aromatics are considered as a significant source to the secondary organic aerosol (SOA) formation in urban area. But the specific pathway from aromatics to aerosol, including their atmospheric oxidation, gas-particle phase transition processes remain unclear. With the development of the detection technology, a kind of oxygenated organic molecules (OOMs) were recently found in the atmosphere. They are most likely the products of aromatics inferred from their carbon number. Here, we investigate the processes from aromatics to aromatics derived OOMs (Aro-OOMs), and from Aro-OOMs to aerosol in Hong Kong by integrating insights from field campaign, chemical mechanism speculation and aerosol growth model. Besides the traditional knowledge on oxidation process of aromatics and OH, we found a new breakage of benzene ring, followed with carbonyl group loss and termination reaction with NO_x and HO_2 radical should be responsible for most Aro-OOMs formation. With the help of the aerosol growth model, the condensation of Aro-OOMs also shows considerable contribution to SOA and NPF. These findings establish the bridge from the aromatics to the aerosol in the urban region and also demonstrate the significance of the Aro-OOMs.

Early Career Scientist

YES, I am an early career scientist.

ACAM-33C

Aqueous production of secondary organic aerosol from fossil-fuel emissions in winter Beijing haze

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Secondary organic aerosol (SOA) produced by atmospheric oxidation of primary emitted precursors is a major contributor to fine particulate matter ($PM_{2.5}$) air pollution worldwide. Observations during winter haze pollution episodes in urban China show that most of this SOA originates from fossil-fuel combustion but the chemical mechanisms involved are unclear. Here we report field observations in a Beijing winter haze event that reveal fast aqueous-phase conversion of fossil-fuel primary organic aerosol (POA) to SOA at high relative humidity. Analyses of aerosol mass spectra and elemental ratios indicate that ring-breaking oxidation of POA aromatic species, leading to functionalization as carbonyls and carboxylic acids, may serve as the dominant mechanism for this SOA formation. A POA origin for SOA could explain why SOA has been decreasing over the 2013–2018 period in response to POA emission controls even as emissions of volatile organic compounds (VOCs) have remained flat.

Early Career Scientist

YES, I am an early career scientist.

ACAM-34A

Investigation of Dust Transportation Effects on Meteorological Parameters in Turkey: A Case Study in 2020

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CCMi: Chemistry Climate Model Initiative

Abstract

Air pollution and meteorology are considered as two main mechanisms that affect each other interactively. It has been proven in many studies that the air pollution of a region is affected by meteorological variables. Similarly, it is one of the major research topics that air pollution of a region affects the meteorological characteristics and even accelerate the climate change effect in the region. One of the factors that cause degradation in air quality is air pollution episodes. Air pollution episodes are events that threaten human and environmental health as a result of a combination of air pollution and meteorological factors. Turkey encounters dust episodes that affect the general air quality of the country, especially in the spring, due to its geographical proximity to Africa and Arabia. These episodes are generally visible and sometimes combined with precipitation causing rain dust. In this study, the effect of dust transport on meteorological parameters is investigated in the 2020's spring season in Turkey. The dust transport event which has affected Turkey for about 10 days between May 10 and May 24, 2020, was selected for this matter. Modelling with WRF-Chem model and WRF model was made as 7 runs separately. Simulation with WRF is based on no chemical effect run and other simulations with the WRF-Chem model cover the control run and ensemble runs. The particulate matter as fine and coarse particles and meteorological parameters as long-wave radiation, short-wave radiation, net solar radiation, surface temperature and precipitable water were analysed together. The evaluation of the impact of dust episode on meteorological parameters was made with metric analyses and visual correlation comparison.

Early Career Scientist

YES, I am an early career scientist.

ACAM-35B

Chemical formation pathways of secondary organic aerosols in theBeijing-Tianjin-Hebei region in wintertime

Jie Li
IAP,CAS, Beijing, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

A regional air quality model system (RAQMS) was developed by incorporating an aqueous reaction mechanism for secondary organic aerosol (SOA) formation and primary semi-volatile (SVOC) and intermediate volatile organic compounds (IVOC) precursors to investigate various chemical pathways for SOA formation in the Beijing-Tianjin-Hebei (BTH) region in wintertime. Model comparison against observations demonstrates that the model is able to well reproduce meteorological variables and major aerosol chemical components, and the model improves SOA simulation significantly by including primary S/IVOCs (SVOC + IVOC) and aqueous reactions into the model. SVOC and IVOC emissions were relatively higher over the regions from southern Hebei province to Beijing and Tianjin, with the emission rates up to 0.15 mg m-2 hr-1 and 0.3 mg m-2 hr-1, respectively. The glyoxal (GLY) and methylglyoxal (MGLY) emissions were similar in distribution to those of S/IVOC emissions, with the maximum of 0.08 mg m-2 hr-1. The simulated SOA concentrations exhibited a southwest-northeast belt extending from southern Hebei to Beijing, with the maximum of 35 μg m-3 in southern Hebei province. The average contributions from various precursors or chemical pathways to SOA formation during the study period were estimated, in which AVOCs (anthropogenic VOCs), SVOCs, IVOCs, BVOCs (biogenic VOCs), GLY and MGLY contributed 38.4%, 24.9%, 28.4%, 0.2% and 8.1% of SOA mass concentration, respectively, in the BTH region. From the clean to haze periods, concentrations of all SOA components apparently increased along with increasing atmospheric stability and weakening dispersion, but the increasing rates of SOA concentration produced by AVOCs and aqueous reactions were larger than those by primary S/IVOCs due to different chemical processes, and the AVOC-produced SOA dominated over the other SOA components during the haze periods.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-1A

Solar induced fluorescence and NO2 measurements from TROPOMI to constrain NO2 deposition fluxes to vegetation

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

The bi-directional exchange of gases between vegetation and the atmosphere is controlled by a variety of environmental factors and feedbacks that are entangled and difficult to quantify. As a result of this complexity, parameterizations of canopy conductance Gc in atmospheric models introduce large uncertainties and likely biases into representations of atmosphere-biosphere gas exchange. We present a novel representation of canopy conductance derived from measurements of solar-induced fluorescence (SIF) from the TROPOspheric Monitoring Instrument (TROPOMI). We show a strong linear correlation between GPP and Gc across a variety of ecosystem types in the AmeriFlux network. We couple this Gc-GPP correlation to previous research showing a strong linear correlation between SIF and GPP and estimate Gc at a 500 m spatial resolution across the continental United States. We also combine our model with surface estimates of NO2 and PAN from WRF-Chem and TROPOMI NO2 columns to estimate stomatal deposition fluxes of these gases. Our results suggest that satellite measurements of solar-induced fluorescence can provide important constraints on model representations of stomatal activity and canopy gas exchange on regional and global scales.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-2B

Ambient characterization of marine shipping emissions at the Port of Ningbo-Zhoushan on the coast of East China Sea

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

China Working Group

Abstract

Marine shipping emissions exert important air quality and climatic impacts. This study chose the busiest Ningbo-Zhoushan port (NZ-port) in the mid-latitude East China Sea, which has the world's largest annual cargo throughput, and characterized the ambient pollutants in this region. The experimental period dominated by clean marine air mas allowed a direct characterization on the predominant local shipping emissions without continental influence. The detailed mass spectra of organic aerosol (OA) was online monitored, and attributed to different source profiles by factorization analysis, based on which the other measurements of black carbon (BC) and gas pollutants were linked to these factors. Two discernible primary vessel emission factors are identified, highly linked with nitrogen oxides (NO_x)/BC or CO, respectively. The former (latter) factor, diurnally peaking at morning rush-hour (midday), corresponded with a more localized (wider) vessel frequencies identified by the automated identification system (AIS). This can be explained as vessels with lower speed (mostly at departure near port) emitted higher NO_x (52 ± 14%) and BC (65 ± 24%); while vessels in cruise with higher speed emitted higher CO (42 ± 24%). OA showed more oxygenated state at full speed. Further analysis showed that the emission structure was only broadly related to the vessel type in terms of engine size, emphasizes that the operation mode more importantly determines the ambient emission structures of marine shipping in this region.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-3C

Source Apportionment of Volatile Organic Compounds and Trace Metals in Houston

Morshad Ahmed, Dr Bernhard Rappenglueck
University of Houston, Houston, Texas, USA

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

During the Study of Houston Atmospheric Radical Precursors (SHARP) field campaign in April-May 2009, volatile organic compounds (VOCs), temporally highly resolved trace metals, CO, and SO_2 were collected at the urban Clinton Drive (CD) site in Houston, Texas. Factor analysis was done for the first time in a combination of VOCs and trace metals using the positive matrix factorization (PMF) model to explore potential co-emissions. In addition, bivariate polar plots were used to find the major source location in the Houston area. Nine factors have been identified by the PMF which are natural gas/crude oil (21.3±5.5%) isoprene emission (17.0±7.1%), Si-rich (14.6±1.3%), liquefied petroleum gas (LPG) (11.2±4.0%), traffic (10.6±0.4%), Fluidized-bed Catalytic Cracking (FCC)/high temperature operations (7.2±4.3%), oil refinery (6.8±0.9%), soil and road dust (6.2±0.6%), and petrochemical industries (5.0±5.0%). Separate daytime and nighttime PMF analyses were carried out to see potential differences among and within emission sources and also to distinguish photochemical influences. Nocturnal isoprene emission was identified from traffic exhaust and industrial source. Corrosion is responsible for emitting metals (i.e., Cr, Mo, Ni) into the atmosphere from oil refinery facilities during nighttime. Metal ratios typically found in crude oil and natural gas (i.e., Ni/V, Ni/Pb, V/Pb) reveal greater contribution from crude oil in the merged natural gas/crude oil emission factor, which would not be resolved using VOC data only. The presence of Pb in the soil and road dust factor is due to traffic emissions occurring decades ago. Bivariate polar plots suggest that the Houston Ship Channel area is the primary source of emission for LPG, natural gas/crude oil, FCC/high temperature operations, and petrochemical industries.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-4A

Trends and seasonal variability of ammonia across major biomes inferred from long-term series of ground-based and satellite measurements

Dr Money Ossohou[1,2], Dr Corinne Galy-Lacaux[3,4], Dr Jonathan E. Hickman[5], Dr Marcellin Adon[6], Pr Véronique Yoboué[1], Eric Gardrat[3,4]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

We present the long-term ammonia (NH3) assessment in the Western and Central Africa region within the framework of the International Network to study Deposition and Atmospheric chemistry in Africa (INDAAF) program, part of the ACTRIS-FR European Research Infrastructure. This paper analyses seasonal variations and trends of ground-based NH3 concentrations (1998/2005-2018) and NH3 total columns (2008-2018) along a rural African transect from dry savannas in Banizoumbou, Niger and Katibougou, Mali - wet savannas in Djougou, Benin and Lamto, Côte d'Ivoire, and forests in Bomassa, Republic of Congo and Zoétélé, Cameroon. We determined ground-based concentrations and total column densities using passive samplers and the version 3 of the Infrared Atmospheric Sounding Interferometer (IASI) at 1°x1° grid cell centered on each INDAAF site on a monthly basis, respectively. Annual mean ground-based NH3 concentrations were around 5.9 ppb in dry savannas, 3.6-4.7 ppb in wet savannas and 3.5-5.9 in forests suggesting that NH3 emissions from precipitation-induced pulses and volatilization from animal excreta (in dry savanna) are more important than biomass burning and agriculture (in wet savanna and forest). Annual IASI NH3 total columns were 10.1-11.0 x 1015 molec cm-2 in dry savanna, 16.5-21.4 x 1015 molec cm-2 in wet savanna and 14.3-15.1 x 1015 molec cm-2 in forest biomes. Statistical Mann-Kendall trend test applied to annual data showed that ground-based NH3 concentrations decreased at Katibougou (-2.06 % yr-1) and Zoétélé (-2.48 % yr-1), but increased at Bomassa (+3.72 % yr-1) over the 21-year period. IASI NH3 showed yearly increasing trends at Katibougou (+3.98 % yr-1) and Djougou (+2.24 % yr-1), but no annual trend for other sites over this 11-year period.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-5B

Long-term air quality trends in fast-growing future megacities in the tropics

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group, ANGA: African Group on Atmospheric Sciences, Southern Hemisphere Working Group

Abstract

Cities in the tropics are experiencing unprecedented population growth in the absence of environmental regulation that will inevitably lead to enhanced exposure to air pollution detrimental to health. Routine monitoring of air quality in these cities is severely limited. Satellites provide daily coverage of a dynamic range of pollutants spanning more than a decade. Here we focus on 46 of these tropical cities in Africa and Asia that are forecast to be amongst the largest cities in the world by 2100. We determine recent (2000s-2010s) long-term trends in a range of satellite observations that provide proxies for air pollution sources (NO_x, NH_3, CO, NMVOCs) and air pollutants hazardous to health and the environment ($PM_{2.5}$, NO_2, ozone production from $HCHO/NO_2$). The record of satellite observations indicates that most cities in Africa and South Asia are experiencing a significant increase in sources of NO_x and NH_3. Increases in NO_x, reactive NMVOCs and $PM_{2.5}$ in the Indian subcontinent coincide with decline in NH_3, reflecting the influence of acidic aerosols on abundance of NH_3. At present, ozone production in almost all (44) cities is sensitive to NO_x, but steeper and more significant increases in NO_x than NMVOCs and CO suggest that these cities are on a trajectory to transition to NO_x-saturated ozone production synonymous with megacities in Europe, the US, and China. We find that anthropogenic emission inventory trends are generally within 50 % of the satellite observation trends, but underestimate NH_3 trends by a factor of 2-5. We further determine that trends in the combined effect of increasing population and pollutants hazardous to health ($PM_{2.5}$, NO_2) are staggering, notably in West and East Africa for NO_2 (2.0-23.6 % a^{-1}) and the Indian subcontinent for $PM_{2.5}$ (3.1-18.3 % a^{-1}). If these trends continue, a health crisis in these cities is inevitable.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-6C

Global-Scale In-Situ Measurements of Aerosol Optical Depth: An Overview from the Atmospheric Tomography (ATom) Project

Charles A. Brock[1], Agnieszka Kupc[2], Christina J. Williamson[1,3], Karl D. Froyd[1,3], Gregory P. Schill[1,3], Daniel M. Murphy[1], Jose L. Jimenez[3], Pedro Campuzano-Jost[3], Bernadett Weinzierl[2], Maximilian Dollner[2], Joshua P. Schwarz[4], Joseph M. Katich[1,3], Siyuan Wang[1,3], Shobha Kondragunta[5], Glenn S. Diskin[6], ThaoPaul Bui[7]
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Abstract

From August 2016 to May 2018, an instrumented DC-8 aircraft operated by NASA performed global-scale in situ measurements of aerosol composition and size distribution. Nearly continuous en-route slantwise vertical profiles were made between ~0.16 and ~12 km altitude as the aircraft flew over the central Pacific and Atlantic oceans from ~84 °N to ~86 °S latitude in each of four seasons. Dry size distributions and single particle and bulk composition measurements were used to calculate aerosol hygroscopicity and reconstruct ambient size distributions based on measured temperature and water vapor. Coarse-mode size distribution measurements made with an underwing aerosol/cloud probe were added to these data to produce an ambient size distribution from 3 nm to 50 µm in diameter approximately every one minute of flight.

From these hydrated size distributions we calculated ambient optical properties, including single scatter albedo, extinction and absorption coefficients, mass extinction efficiency, Ångstrom exponent, and asymmetry parameter. By vertically integrating optical properties during each profile, aerosol optical depth (AOD) and absorption AOD were determined. The contribution to AOD from sea-salt, dust, sulfate-organic mixtures, black carbon, and particulate water were determined for each profile location (roughly every 5 degrees of latitude). These AOD estimates are compared with the closest available measurements from the Aerosol Robotic Network (AERONET) and with data from NOAA's VIIRS satellite instrument. This unique ATom dataset of ambient aerosol properties determined from in situ measurements provides powerful constraints for satellite and surface-based remote sensing measurements and global chemistry-climate models. An overview of the contributions of sea-salt, dust, biomass burning and sulfate/organic particles to AOD in different airmass types will be presented.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-7A

Satellite-Based Emission Estimates of Tropospheric Bromine During Arctic Spring in the GEOS-Chem Model

Pamela Wales[1,2], Christoph Keller[1,2], Emma Knowland[1,2], Steven Pawson[1], Sungyeon Choi[3,4]
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IGAC Activities

Abstract

The satellite-based Ozone Monitoring Instrument (OMI) provides total column measurements of bromine monoxide (BrO) with daily global coverage. Reactive bromine compounds (Br and BrO) catalytically destroy ozone in both the stratosphere and troposphere. Periods of elevated tropospheric BrO during polar spring are observable by OMI, and past studies have connected these so-called “bromine explosion” events to near complete removal of surface ozone.

In this study, we use OMI retrievals of BrO in combination with the GEOS-Chem model to develop a method for estimating tropospheric bromine emissions during Arctic spring. Total column BrO is modeled in GEOS-Chem using a combined stratospheric and tropospheric chemical mechanism. We find that globally total column BrO in GEOS-Chem is low with respect to the OMI retrievals. We specify a statistical bias threshold to define elevated tropospheric BrO events and estimate lower limits for the missing tropospheric BrO during Arctic spring. By simulating an Arctic source of bromine in GEOS-Chem, we explore the impact of bromine explosion events on Arctic air quality. We will assess the ability to apply our emission scheme in the GEOS-CF (Composition Forecast) model, which is under development at the NASA Global Modeling and Assimilation Office and provides daily five-day forecasts of atmospheric composition.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-8B

Evaluating the detectability of methane point sources from satellite observing systems using microscale modeling

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IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group

Abstract

This study evaluates the efficacy of current satellite observing systems to detect methane point sources from oil and gas production facilities using a simulated methane data set. The methane emissions from 22 sources located on seven well pads were provided by an oil field emission simulator (OFES). The methane emissions were input into a large eddy simulation (LES) version of the Weather Research and Forecasting (WRF) model with a 6.9 km x 8.3 km domain at 10 m spatial resolution. The two-hour simulations at one-second temporal resolution provided 7200 independent realizations of methane plumes. These plumes were used to estimate methane column enhancements for pseudo satellite footprints (pixels) of 3 km, 1 km, and 50 m. The detectability of methane plumes increased with an increase in pixel resolution and maximum column enhancements were observed during liquid unloading events. The column enhancements at 50 m pixels were used to estimate emission source rates following the integrated mass enhancement (IME) technique. The IME-derived source rates only underestimated the input OFES emissions by ~1% and the methodology was found to be very effective in determining the aggregated plumes with large, unexpected constant emissions (super emitters). However, the methodology is ill-suited to resolve short-term emission fluctuations (< 20 mins) in typical well site emissions and is often limited by the detection limit and precision of the instrument.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-9C

How well can satellite derived XCO_2 determine seasonal and interannual changes of CO_2 over oceans? Evaluation by integrated ship and aircraft observations

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group, Japan National Committee

Abstract

Satellite observations provide global datasets of column-averaged mixing ratios of CO_2 (XCO_2) over the Earth's surface. The accuracy of these datasets is validated against reliable standards in some areas, but other areas remain inaccessible. To date, limited reference data over oceans hinders successful uncertainty quantification or bias correction efforts and precludes reliable conclusions about changes in the carbon cycle in some regions. In a new approach, we analyze and evaluate the seasonal, interannual and latitudinal variations of CO_2 by integrating cargo-ship (SOOP, Ship Of Opportunity) and commercial aircraft (CONTRAIL, Comprehensive Observation Network for Trace gases by Airliner) observations with the aid of state-of-the art atmospheric chemistry-transport model calculations. The consistency of the "observation-based column-averaged CO_2 dataset (obs. XCO_2) with satellite estimates was analyzed over the Western Pacific between 2014 and 2017. The new dataset accurately captures seasonal and interannual variations of CO_2. Retrievals of XCO_2 from GOSAT (Greenhouse gases observing satellite: NIES v02.75, National Institute for Environmental Studies; ACOS v7.3, Atmospheric CO_2 Observation from Space) and OCO-2 (Orbiting Carbon Observatory, v9r) show a negative bias of about 1 parts per million (ppm) in northern midlatitudes. This bias was substantially reduced for the newer products ACOS v9 and OCO-2 v10. While ACOS and OCO-2 show rather a systematic offset, the NIES retrieval seems to be noisier and with many fewer valid data and high scatter at low latitudes. At different times, the seasonal cycles of all retrievals show positive phase shifts of one month relative to obs. XCO_2. This was attributed to remaining uncertainties introduced by limitations in the retrieval algorithms and have not been previously identified due to the lack of validation data over open oceans. In future, this ship-aircraft based approach will be applied to CH_4 and CO to better understand sources and sinks of atmospherically important trace gases.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-10A

Anthropogenic point sources of ethylene revealed from space

Bruno Franco[1], Lieven Clarisse[1], Martin Van Damme[1], Juliette Hadji-Lazaro[2], Cathy Clerbaux[2,1], Pierre-François Coheur[1]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations

Abstract

Ethylene (C_2H_4) is a major unsaturated hydrocarbon in the Earth's atmosphere. While biomass burning represents a significant source, it is also emitted by various human-related activities, such as incomplete fuel combustion and leakage from industrial processes. Ethylene is the most abundant organic compound that is produced industrially as it serves as the raw material for polyethylene plastics and other derivatives, and its production is projected to increase further with the rising global demand. Ethylene is rapidly degraded in the vicinity of its sources and affects air quality, especially in urban and industrial environments, as a high-yield precursor of tropospheric ozone and formaldehyde.

The spatially dense measurements from the Infrared Atmospheric Sounding Interferometer (IASI), embarked on the Metop satellite platforms, allow the monitoring of ethylene despite its weak signature in the thermal infrared. To achieve this, we use a sensitive hyperspectral range index (HRI) to detect and quantify its signal strength in the IASI spectra. An ethylene HRI value is calculated for each individual observation from the decadal IASI time series. A superresolution technique is then applied to the HRI dataset, which allows increasing the spatial resolution of averaged satellite data beyond what the native resolution of the satellite measurements can initially offer. The high-resolution map obtained from the 10-year dataset reveals for the first time a series of ethylene hotspots. We have identified so far over 150 point sources throughout the globe, which we have inventorized and categorized. They are mainly associated with megacities, chemical clusters that include ethylene production and transformation plants, iron and steel plants, and coal-related activities such as coke plants and coal-fired power stations. For the world's main point sources, we derive the ethylene mean abundance and estimate the annual emissions

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-11B

Meteorology-aerosol-chemistry multiphase data assimilation system improves estimation of wildfire carbonaceous emissions and transport

Benjamin Gaubert[1], David P. Edwards[1], Kevin Raeder[1], Claire Granier[2,3], Ivan Ortega[1], Dr. Edward J. Hyer[4], Jérôme Barré[5], Christine Wiedinmyer[6], Louisa K. Emmons[1], Simone Tilmes[1], Rebecca R. Buchholz[1], Helen M. Worden[1], James Hannigan[1], Jeffrey L. Anderson[1], Merritt N. Deeter[1], Wenfu Tang[1]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Americas Working Group

Abstract

Predicting the air quality and climate impacts of reactive gases and aerosols requires an accurate quantification of anthropogenic and biomass burning emissions. Transport errors and inaccurate model representation of physical and chemical processes generate additional uncertainties. Here we present a prototype of a global meteorology-aerosol-chemistry assimilation system that simultaneously assimilates aerosol optical depth (AOD) from MODIS Collection 6.1 Terra and Aqua combined, Carbon Monoxide (CO) from Terra/MOPITT (V9J) along with weather observations. The analysis is performed with an Ensemble Adjustment Kalman Filter (EAKF) within the Data Assimilation Research Testbed (DART). We use a meteorological ensemble with perturbations of emissions, combined with an adaptive inflation scheme to represent model error in the online Community Atmosphere Model with Chemistry (CAM-Chem). The model prior emissions include the CAMSv5.1 inventory and FINNv2.2 daily fire emissions. We perform deterministic runs to evaluate transport uncertainties using nudging to MERRA-2, GEOS-FP and the CAM6/DART reanalyses and a simulation with a prescribed OH field from TransCom to assess chemistry errors.

We leverage strong correlations between primary emissions of carbon aerosol and carbon monoxide (CO) to inform organic and black carbon emissions sources. We compare wildfire and anthropogenic emissions that are optimized following (1) AOD, (2) CO and (3) the joint CO and AOD assimilation. We also investigate how the vertical sensitivity of the CO profiles can be used to improve the vertical distribution of aerosols. We focus on the summer 2015 wildfire season over the United States and evaluate the results with independent measurements such as Particulate Matter (PM2.5) at the surface and CO from a ground-based solar absorption Fourier Transform Spectrometer in Boulder, Colorado.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-12C

Impact of the Raikoke volcanic eruption 2019 on the Northern Hemisphere UT/LS aerosol load and properties as seen from IAGOS-CARIBIC in-situ observations

Andreas Petzold[1], Ulrich Bundke[1], Marcel Berg[1], Rita Gomes[1], Jim Haywood[2,3], Martin Osborne[2,3], Johannes Schneider[4], Christiane Schulz[5,4], Markus Hermann[5], Florian Obersteiner[6], Torsten Gehrlein[6], Harald Bönisch[6], Andreas Zahn[6]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

IAGOS (In-Service Aircraft for a Global Observing System; www.iagos.org) is a European Research Infrastructure which uses passenger aircraft equipped with autonomous instrumentation for the continuous and global-scale observation of atmospheric composition in the upper troposphere and lowermost stratosphere (UT/LS). Among others, IAGOS provides detailed information on atmospheric trace species by the flying laboratory IAGOS-CARIBIC. From July 2018 to March 2020 number concentration and fraction of non-volatile particles for d_p > 15 nm as well as size distributions for d_p > 250 nm were measured. Since lately, aerosol chemical composition is provided as well. IAGOS-CARIBIC flight routes covered regular flights from Munich, Germany, to North America, East Asia and South Africa.

On 22 June 2019, the Raikoke Volcano erupted and transported vast amounts of gaseous and particulate matter into the UT/LS. Two months after the eruption CALIPSO observed enhanced aerosol optical depth and aerosol scattering across the entire lower stratosphere. IAGOS-CARIBIC conducted several flight series in the Northern Hemisphere before and after the eruption phase such that the pre- and post-eruption data provide profound information on the impact of the Raikoke eruption on the Northern Hemisphere UT/LS aerosol and the evolution of the plume during 9 months of regular observation.

Data indicate an increase in the number concentration of particles with d_p > 250 nm by a factor of 10 across the entire sampled altitude range, while the increase of the total aerosol number concentration (d_p > 15 nm) is less pronounced but also significant. We present a detailed analysis of the changes in UT/LS aerosol load and properties caused by the Raikoke eruption, including the temporal evolution of the aerosol plume during 9 months past the eruption. In-situ observations are backed-up by analyses of CALIPSO products and results from associated volcanic plume modelling studies deploying the UK Earth System Model UKESM1.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-13A

Improving national emission inventories by advanced spatio-temporal inversion

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

One reason of large uncertainty in air quality forecasting is given by poorly known emissions. Inventories of anthropogenic emissions used in atmospheric chemistry transport models are based on estimations by national authorities complying with international commitments (e. g. Gothenburg protocol). Yet emissions can hardly be measured directly. Applying advanced spatio-temporal inverse modelling techniques allows for an improvement of the emission inventories by combining atmospheric chemistry transport modelling with measurements of air quality monitoring networks and environmental satellite retrievals.

This study investigates the inventories of anthropogenic emissions regarding nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM), sulphur oxides (SO_x), ammonia (NH_3), and non-methane volatile organic compounds (NMVOCs) on a European scale. The year 2016 has been selected as a reference year to perform a detailed analysis. In this regard, 2016 is characterized by meteorological and air quality conditions, which are deemed to be representative for current climate conditions, and does not include any special emission episodes or extreme events. The 4-dimensional variational data assimilation method embedded in EURAD-IM (European Air pollution Dispersion – Inverse Model) is applied using ground-based measurements as well as satellite products. Further to the general emission optimisation, it is investigated to what extend specific regions, particular pollutants or scenarios favour certain emission correction factors. Systematic over- and under-estimations of the emission data are evaluated and the limits of our approach, due to missing observations is analysed.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-14B

Evaluation of new 4D-variational inverse modeling system, CIF-CHIMERE: Inversion of NOx emissions over China using NO2 OMI observations

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative

Abstract

The potential of the new 4D-Var inverse modeling system CIF based on CHIMERE chemical transport model is evaluated in this work with the case study on NOx emissions using NO2 OMI satellite observations over China. Nitrogen oxides (NOx = NO2 + NO) are primary pollutants that are mainly produced by anthropogenic activities. They play a key role in oxidation processes in the troposphere. They control the photochemical production of Ozone (O_3) and affect the concentration of the hydroxyl radical (OH), thus causing air quality degradation. Industrialized countries with high air quality degradation such as China, are implementing mitigation strategies with the aim of improving air quality. However, these decisions are made by using air quality prediction models based on bottom-up emission inventories which remain uncertain and not up-to-date, especially when sudden changes in the emissions occur. In the framework of this study, we propose a complementary approach to the current NOx Emission Inventory for China (MEIC) and evaluate the impact of the changing NOx emissions on air quality levels in China. For this latter purpose, the NOx emissions in 2015 are inversed using OMI observations, and the system is evaluated against surface measurements and the recent MEIC inventory. These results are compared with the inversed emissions of late winter 2020 in which sudden emission changes occurred due to the coronavirus pandemic shutdown in industrial activities and upon travel restrictions. In addition to these, its potential and the use of high-resolution TROPOMI observations in the CIF-CHIMERE inversion system are investigated and compared to OMI observations.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-15C

Tropospheric NO_2 observed from space with Copernicus Sentinel-5 Precursor TROPOMI: Validation with ground-based network data.

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations

Abstract

As a proxy for NOx and other pollutants related to fossil fuel combustion and nitrogen fertilizers, and also as a precursor to several essential climate variables, tropospheric NO_2 has been monitored globally from space by several UV-visible nadir sounders since the pioneering ages of GOME in the 1990s. Nowadays international space agencies are building a constellation of air quality satellites. Part of it, and launched in October 2017, Sentinel-5 Precursor (S5P) TROPOMI is the flagship atmospheric composition mission for the European Copernicus programme. With unprecedented horizontal resolution, it has been used extensively to monitor air quality effects of regulatory measures, e.g. in the context of the COVID-19 global crisis.

We report here on the consolidated quality assessment of the first three years of S5P NO_2 column data (tropospheric, stratospheric, and total) produced operationally, using ground-based correlative measurements from the NDACC ZSL-DOAS, MAX-DOAS, and Pandonia global networks. The performance and fitness-for-purpose of the TROPOMI data is assessed in terms of biases, random errors, dependence on influence quantities (e.g., cloud cover, surface albedo…), and stability.

TROPOMI NO_2 is found to satisfy pre-launch mission requirements for stratospheric columns, and also for tropospheric columns in clean to lightly-polluted conditions. Over high pollution, although still within requirements, TROPOMI shows a significant negative bias with respect to network data. Part of this can be attributed to differences in spatial representativeness and vertical sensitivity, but the largest error source is likely the too coarse resolution of the modelled NO_2 vertical profile used as a priori in the TROPOMI retrieval and, to a lesser extent, limitations in the treatment of clouds. The latter is improved upon with the processor update of December 2020. It is concluded that S5P NO_2 data products can be used for a variety of applications, provided that users follow the recommendations associated with the data.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-16A

Agricultural emissions of ammonia estimated with satellite observations and GEOS-Chem

Eloise A Marais[1], Alok K Pandey[2], Martin Van Damme[3], Lieven Clarisse[3], Pierre-François Coheur[3], Mark W Shephard[4], Karen E Cady-Pereira[5], Tom Misselbrook[6], Lei Zhu[7], Gan Luo[8], Fangqun Yu[8]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Agricultural emissions of ammonia (NH_3) impact air quality, human health, and the vitality of aquatic and terrestrial ecosystems. In many countries, there are few or no direct policies regulating anthropogenic NH_3 emissions and development of sustainable mitigation measures necessitates reliable emissions estimates. Here we use observations of column densities of NH_3 from two space-based sensors (IASI and CrIS) with the GEOS-Chem model to derive top-down NH_3 emissions for the UK at fine spatial scales (~10 km, monthly). We focus on March-September when there is adequate spectral signal to reliably retrieve NH_3. We estimate total emissions of 272 Gg from IASI and 390 Gg from CrIS. Bottom-up emissions are 27% less than IASI and 49% less than CrIS. There are also differences in seasonality. Top-down and bottom-up emissions agree on a spring April peak due to fertilizer and manure application, but there is also a comparable summer July peak in the top-down emissions that is not in bottom-up inventories and appears to be associated with dairy cattle farming. We estimate relative errors in the top-down emissions of 11-36% for IASI and 9-27% for CrIS, dominated by column density retrieval errors. The bottom-up versus top-down emissions discrepancies estimated in this work impact model predictions of the environmental damage caused by NH_3 emissions and warrant further investigation.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-17B

New insights on NO_x sources and sinks from the divergence of the mean flux

Steffen Beirle, Christian Borger, Steffen Dörner, Thomas Wagner
Max-Planck-Institut für Chemie, Mainz, Germany

IGAC Activities

GEIA: Global Emissions Initiative

Abstract

Applications of satellite measurements of NO_2 usually make use of temporal means of tropospheric column densities. Fluctuations of wind speed and direction, however, smear out the spatial patterns and limit the spatial resolution. Averaging the NO_2 fluxes instead avoids this loss of resolution and directly accounts for horizontal transport effects.

According to the continuity equation, the divergence (spatial derivative) of the mean flux directly provides information on sources and sinks of NO_x. This allows for deriving high resolution maps of NO_x emissions, with high sensitivity to point sources like power plants where spatial gradients in the NO_2 flux (and thus the divergence) are particularly high (Beirle et al., 2019, DOI: 10.1126/sciadv.aax9800).
Negative values of the divergence, on the other hand, allow to infer the NOx loss processes, which reflect the in-plume OH concentration.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-19A

Contribution of fossil fuel sources to PM2.5 in Seoul constrained by carbon, nitrogen, and oxygen isotopic ratios

Doctor Saehee Lim[1], Professor Meehye Lee[1], Director Joel Savarino[2], Professor Claudia Czimczik[3]
[1]Korea University, Seoul, Korea, Republic of. [2]Institut des Géosciences de l'Environnement / CNRS, Grenoble, France. [3]University of California,Irvine, California, USA

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Stable isotopes are powerful tools to identify sources and formation processes of aerosols. From 2018 to 2019 in Seoul, the isotopic composition of $PM_{2.5}$ was determined, including $d^{13}C$ and $\Delta^{14}C$ of total carbon, $d^{15}N$ of nitrate, ammonium and total nitrogen, and $\Delta^{17}O$ of nitrate. All chemical composition was seasonally distinguished by higher mass concentrations and nitrate contribution in colder months (November ~ March) than in warmer months. On average, contemporary sources accounts for 67 % of total carbon. The $d^{13}C$ values tends to approach the coal in the cold season and the liquid fossils in the warm season. The $d^{15}N$ of nitrate indicates that mobile sources were predominant, but the contribution of coal and biomass combustion was increased in the cold season. The Isotopic Mixing Model yielded a much higher contribution of fossil fuel related sources to ammonia than estimated in emission inventories, especially in warmer months. In addition, stable oxygen isotopes of nitrate suggest nitric acid formed mainly through dark pathways when the daily average $PM_{2.5}$ concentration was raised above 75 mg m^{-3} during winter. The combined multiple isotopic signature indicates the co-emission of NOx and NH_3.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-20B

Expanded observations of oxygenated organic compounds in urban emissions via ammonium-adduct chemical ionization mass spectrometry

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative

Abstract

Emissions from volatile chemical products and other non-traditional sources have become increasingly important for urban air quality and bottom-up estimates of emissions for a variety of understudied functionalized compounds remain uncertain in emissions inventories. We employ a Vocus high-resolution time-of-flight mass spectrometer with ammonium (NH_4^+) as the reagent ion to minimize analyte fragmentation and extend the range of observable oxygenates without the relative humidity-dependence of other NH_4^+ implementations. Using this instrument, we present new online measurements of a wide range of oxygenated compounds at an elevated site in New York City. Observations include volatile, intermediate-volatility, and semivolatile oxygenates and other organic compounds, which were collected at the rooftop observatory of the Advanced Science Research Center (City University of New York) in upper Manhattan, over a 10-day period during Winter 2020 (pre-COVID) when biogenic sources and photochemistry were less active. These observations are supplemented by offline gas chromatography with high-resolution mass spectrometry and online measurements of carbon monoxide (CO).

Among a diverse range of ions observed by Vocus NH_4^+-CIMS, atmospheric abundances of over 100 chemical formulas are closely examined with likely assignments that span a wide range of functionalized compound classes including glycols, glycol ethers, alcohols, acetates, ethanolamines, fatty acid methyl esters, and others that originate from various consumer, commercial, and industrial products, including personal care products and widely-used solvents. Their concentrations were dynamic and varied with wind direction, including enhancements over the highly-populated areas of Manhattan and the surrounding region that reached parts per billion (ppb) levels for some compounds. These top-down measurements are used to generate emissions ratios against common anthropogenic tracers (e.g., CO, benzene) and are compared to emissions inventories specifically for New York City generated using the new VCP_y framework that will be used in constructing the next U.S. National Emissions Inventory (NEI).

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-21C

Assimilating CrIS Observations to Improve U.S. Ammonia Emissions within CMAQ

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Abstract

The Community Multiscale Air Quality (CMAQ) model calculates the impact of emission on atmospheric composition, including inorganic aerosols. Through chemical and physical transformations, the uncertainty in input emissions is propagated into output concentrations. Ascertaining the quality of emissions by comparing modeled concentrations with observations is possible when the science processes are well understood, which is the case for inorganic species such as ammonia (NH3). A four-dimensional variational data assimilation framework propagates differences in simulated and actual observations to revise estimates of emissions with temporal and spatial specificity.

In this study, we evaluate the capacity of a CMAQ-based data assimilation system to improve NH3 emissions, which are relatively uncertain especially given the diversity of emissions processes in the agricultural sector. To do so, a Python-based four-dimensional variational framework (py4dvar) is integrated with an ammonia-active version of CMAQ and its adjoint. The accuracy of the adjoint-based sensitivities of concentrations with respect to emissions is evaluated by comparing them to sensitivities calculated with the forward model using the finite difference method. Additionally, the py4dvar implementation is tested. Specifically, pseudo-observation tests are conducted with the CrIS observation operator to evaluate the extent to which emissions are expected to be recovered with the assimilation.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-22A

A comprehensive analysis of shipping emissions over the Mediterranean and the Black Sea regions

Mr Andreas Pseftogkas[1], Ms. Maria-Elissavet Koukouli[2], Ms Ioanna Skoulidou[2], Mr Dimitris Balis[2], Ms Charikleia Meleti[2], Ms Trissevgeni Stavrakou[3]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

The aim of this work is to assess the current state-of-the-art nitrogen oxides (NO_X) and sulphur dioxide (SO_2) emission inventories for the shipping sector over the Mediterranean and the Black Sea. Firstly, three inventories are analyzed and intercompared over these two regions: the Copernicus Atmospheric Monitoring Service European Anthropogenic emissions – Air pollutants version 4.2 of 2018 (CAMS-REG-AP v4.2), the European Monitoring and Evaluation Program of 2018 (EMEP) and the Emissions Database for Global Atmospheric Research version 5.0 of 2020 (EDGAR).The different shipping lanes, also with respect to their known traffic loads, are defined via the European Marine and Observation Data network (EMODnet) developed in 2016. By applying a lane separation method to the emissions inventories based on the European Marine Observation and Data Network (EMODnet) we find that cargo and tanker vessels account for approximately 80% of the total emissions, followed by fishing, passenger, and miscellaneous vessel emissions with contributions of 8%, 7% and 5%, respectively. The same methodology is applied to the tropospheric NO_2 vertical column densities of the TROPOspheric Monitoring Instrument (TROPOMI) onboard the Sentinel 5 Precursor (S5P) satellite in order to quantify the effects of shipping activity on the observed NO_2 levels. Tropospheric NO_2 mean column densities attributed to cargo, fishing and tanker vessels appear to be significantly higher compared to the passenger vessels by approximately 71%, 58% and 44%, respectively. These findings will permit us to proceed with creating a top-down emissions inventory for NO_x and SO_2 shipping emissions using S5P/TROPOMI satellite observations and the LOTOS-EUROS chemical transport model.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-23B

4D-Var inversion of European NH3 emissions using CrIS NH3 measurements and GEOS-Chem adjoint with bi-directional and uni-directional flux schemes

Dr. Hansen Cao[1], Daven Henze[1], Liye Zhu[2], Mark Shephard[3], Enrico Dammers[4], Michael Sitewell[3], Karen Cady-Pereira[5], Matthew Alvarado[5], Chantelle Lonsdale[5], Jesse Bash[6], Kazuyuki Miyazaki[7], Christophe Flechard[8], Yannick Fauvel[8], Roy Wichink Kruit[9], Stefan Feigenspan[10], Christian Brummer[11], Frederik Schrader[11], Marsailidh Twigg[12], Yuk Tang[12], Amy Stephens[12], Keith Vincent[12], Mario Meier[13], Eva Seitler[13], Camilla Geels[14], Thomas Ellermann[14], Shannon Capps[15]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

Ammonia (NH_3) is an important precursor of fine particulate matter ($PM_{2.5}$) via formation of ammonium sulfate and ammonium nitrate. Excess deposition of ammonia and ammonium can cause water eutrophication and reduce ecosystem biodiversity. Europe is of special interest because of the proximity of population centers to agricultural sources and adoption of NH_3 abatement policies. Despite the Gothenburg Protocol, NH_3emission estimates and surface measurements have shown slightly increasing trends since 2010, potentially due to decreasing trends of SO_x and NO_x emissions and increasing NH_3 emissions. Here we make the first application of a bi-directional NH_3flux scheme to 4D-Var inversion of NH_3 emissions using CrIS NH_3observations over Europe in 2016. We find that the top-down (posterior) NH_3 emissions have a stronger springtime peak than prior emissions at the domain-wide to national scales, and annually they are generally lower than the prior emissions over central Europe but higher over most of the rest of Europe. The annual total posterior anthropogenic NH_3 emissions for 25 European Union members (EU25) are 25% higher than the prior estimate, and very close (< 2%) to estimates in other bottom-up inventories such as HTAP v2 and CEIP. Our posterior annual anthropogenic emissions estimates for EU25, UK, the Netherlands, and Switzerland are generally 10-20% lower than when treating NH_3 fluxes as uni-directional emissions. Compared to in-situ observations, our posterior NH_3 emissions generally improve the magnitude and seasonality of simulated surface NH_3 and bulk NH_x wet deposition across most of Europe. Overall, our top-down ammonia emissions can help to examine the effectiveness of air pollution control policies to facilitate future air pollution management, as well as helping us understand the uncertainty in top-down NH_3 emission estimates associated with the treatment of NH_3 surface exchange.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-24C

Swiss Halocarbon Emissions Derived from Regional Atmospheric Measurements

Dominique Rust[1], Ioannis Katharopoulos[1], Dr. Martin K. Vollmer[1], Dr. Stephan Henne[1], Matthias Hill[1], Dr. Lukas Emmenegger[1], Prof. Dr. Renato Zenobi[2], Dr. Stefan Reimann[1]
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IGAC Activities

GEIA: Global Emissions Initiative

Abstract

Anthropogenic halocarbons contribute approximately 11% to the current radiative forcing by long-lived greenhouse gases. Moreover, chlorinated or brominated halocarbons cause stratospheric ozone depletion. Therefore, the production and consumption of halocarbons is regulated by international treaties. To derive real-world estimates of halocarbon emissions on a global to transnational scale, so called "top-down" inverse modeling approaches have been developed. These models rely on atmospheric observations, for example from the long-term halocarbon measurement networks Advanced Global Atmospheric Gases Experiment (AGAGE) and the National Oceanic and Atmospheric Administration (NOAA), which monitor the worldwide atmospheric abundance of halocarbons. However, to estimate halocarbon emissions on a country to local level and to validate national emission inventories by top-down methods, additional regional-scale measurements are required.
We present 12 months of continuous halocarbon measurements from the Beromünster tall tower, a site that is sensitive to the most densely populated and industrialized area of Switzerland. High-precision, high-frequency atmospheric measurements were performed with the analytical setup of the global AGAGE network. The samples were pre-concentrated at low temperatures (down to -180 °C), before the analytes were separated and detected by gas chromatography and quadrupole mass spectrometry (GC-MS). Based on the observations, we robustly estimated Swiss emissions for 28 halocarbons, covering the halocarbons of the Montreal and Kyoto Protocols. The emissions were quantified using two independent top-down methods: a tracer ratio method and a Bayesian inversion based on regional atmospheric transport modelling. We found good agreement between the top-down and the national inventory estimates for the major hydrofluorocarbons (HFCs), whereas for HFC-134a, the inventory shows considerably higher emissions. For the banned chlorofluorocarbons (CFCs) and the regulated hydrochlorofluorocarbons (HCFCs), outgassing from existing banks is on-going. In addition, we present the first Swiss emission estimates for three recently phased-in, unregulated hydrofluoroolefins (HFOs).

Early Career Scientist

YES, I am an early career scientist.

AMIGO-25A

Refining Ammonia Emissions Estimates with Satellite-based Observations Using a Novel Framework and an Air Quality Model

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group

Abstract

The Community Multiscale Air Quality (CMAQ) model calculates the impact of emissions on atmospheric composition, including inorganic aerosols, while considering the transport and reactions of chemical constituents. Adjusting emissions by comparing modeled concentrations with observations is justified when the science processes are well understood as is the case for inorganic species such as ammonia (NH_3). The Finite Difference Mass Balance (FDMB) method and four-dimensional variational (4D-Var) data assimilation leverage differences in simulated and actual observations to revise estimates of emissions with spatial specificity. In this study, we evaluate the capability of a CMAQ-based data assimilation system to improve NH_3 emissions, which are relatively uncertain given the diversity of emissions processes in the agricultural sector. To do so, the iterative FDMB and a Python-based four-dimensional variational framework (py4dvar) are integrated with CMAQ and its adjoint to constrain NH_3 emissions with observations from the satellite-based Cross-track Infrared Sounder (CrIS). Observing System Simulation Experiments (OSSEs) are conducted with the CrIS observation operator to evaluate the extent to which emissions are expected to be recovered with the hybrid assimilation framework. The OSSE conducted with the 2007 modeling platform and 2016 CrIS data on a regional domain in Georgia results in promising recovery of the true emissions. The framework is then ported to a 2017 modeling platform for assimilation of 2017 CrIS NH_3 observations to mitigate the mismatch between modeling platform and satellite observation years. Three suitable periods are selected from April through October 2017 for assimilation. Independent surface measurements are used to evaluate posterior modeled concentrations.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-26B

Modeling methane from the North Sea region with ICON-ART

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IGAC Activities

GEIA: Global Emissions Initiative, CCMi: Chemistry Climate Model Initiative

Abstract

Methane (CH_4) is the second most important greenhouse gas after CO_2 affecting global warming. Various sources (e.g. fossil fuel production, agriculture and waste, biomass burning and natural wetlands) and sinks (the reaction with the OH-radical as the main sink contributes to tropospheric ozone production) determine the methane budget. Due to its long lifetime in the atmosphere methane can be transported over long distances.

Disused and active offshore platforms can emit methane, the amount being difficult to quantify. In addition, explorations of the sea floor in the North Sea showed a release of methane near the boreholes of both, oil and gas producing platforms. The basis of this study is the established emission data base EDGAR (Emission Database for Global Atmospheric Research), an inventory that includes methane emission fluxes in the North Sea region. While methane emission fluxes in the EDGAR inventory and platform locations are matching for most of the oil platforms almost all of the gas platform sources are missing in the database.

We develop a method for estimating the missing emission sources based on satellite measurements and the known locations of platforms implemented as additional point source emissions into the global atmospheric model ICON-ART (ICOsahedral Nonhydrostatic model - Aerosols and Reactive Trace gases). ART is an online-coupled model extension for ICON that includes chemical gases and aerosols. One aim of the model is the simulation of interactions between the trace substances and the state of the atmosphere by coupling the spatiotemporal evolution of tracers with atmospheric processes. ICON-ART sensitivity simulations are performed with inserted and adjusted sources to access their influence on the methane and OH-radical distribution on regional (North Sea) and global scales.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-27C

TROPOMI based NOx emission estimate for Asia

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IGAC Activities

GEIA: Global Emissions Initiative, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

China Working Group

Abstract

A computationally efficient method to estimate NOx emissions at high resolution (≤5km) is developed, which is able to account for the nonlinear relationship between NOx emissions, concentration, chemical loss, deposition, & transport.

Our inversion offer high-resolution information

•to monitor the fine-scale emission sources,

•to improve the bottom-up inventory,

•to model the urban pollution chemistry and the effect of urbanization,

•to conduct spatially targeted emission control.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-28A

Investigation of the temporal and spatial variability of methane flux estimations from mass balance approach, using FLEXPART-WRF methane fields

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Aircraft trace gas measurements can provide novel information on the quantification of the strength of emission sources. One way to estimate emission fluxes is to use measured concentrations of the trace gas of interest in the so-called mass balance approach. However, such a task is not trivial. It entails uncertainties since the resulting flux is highly variable and influenced by various parameters such as the boundary layer height and background concentration. Moreover, the results depend on the location and number of the chosen vertical cross-sections.

This study investigates the above-stated variability by modeling the dispersion characteristics of a methane plume emitted by a coal mine-shaft at the Upper Silesian Coal Basin in Poland. The simulations were performed for five days in May 2018 with the Lagrangian particle dispersion model FLEXPART-WRF. To estimate the influences various 'simulated measurements' where added to this setting, mirroring possible measurements with different vertical resolution (200m and 400m) and ten distances from the source (1, 2, 5, 10, 15, 20, 25, 30, 40 and 50km). The simulated methane concentrations where combined with wind fields from the underlying WRF data in the mass balance approach to calculate emission fluxes.

The results show that the agreement between the computed methane fluxes and the, by the mass provided to the model, expected ones depends on local time (and thereby boundary-layer height) and the degree of the merging of plumes of different age and origin. The agreement was stronger for points closer to the mine-shaft, and weakens with increasing distance. Simulating the measurement of vertical columns instead of local measurements in different altitudes leads to a better agreement of the estimated emission flux, which probably stems from the missing necessity of vertical interpolation of methane concentration. Comparing the results of two vertical resolutions of the simulated measurements shows non-systematic differences.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-29B

Sources of PM2.5 and BC in Beijing Based on Hourly Continuous Online Measurements from 2016 to 2019

Yue Liu[1], Junyi Liu[1], Yali Jin[1], Baoxian Liu[2,3], Qiang Zhang[3], Shuxiao Wang[3], Tong Zhu[1], Mei Zheng[1]
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IGAC Regional Working Groups

China Working Group

Abstract

Air quality in Beijing has been improved significantly in recent years due to the implementation of multiple stringent control policies. Although researchers have been trying to evaluate the impacts using emission inventory and air quality model, it is the first time to investigate the influence of control policy as well as the long-term variation of $PM_{2.5}$ and BC sources based on observation and receptor model perspective.

In our study, high-time resolution measurements of major species of $PM_{2.5}$ including multiple ions and metals, and BC were conducted continuously from 2016 to 2019 in an urban site of Beijing. Receptor model (PMF) was applied to study the sources of $PM_{2.5}$ and BC. Our results showed that $PM_{2.5}$ and BC concentration both decreased in four years while the BC/$PM_{2.5}$ ratio has decreased, indicating that the reduction of BC was more significant than $PM_{2.5}$. Under the influence of policy control in Beijing, the contribution of coal combustion source to both $PM_{2.5}$ and BC significantly decreased in four years, with its concentration decreased the most from 2016 to 2017 (by about 80%). However, the decrease of traffic source to $PM_{2.5}$ and BC were only 56% and 24%, respectively, and its relative contribution increased from 2016 to 2017, suggesting that strict control of vehicle emission is still important in the future. Besides, the source apportionment of PMF was compared with emission inventory (MEIC, Multi-resolution Emission Inventory for China). The PMF results and MEIC showed good correlation in the temporal variation trends for both $PM_{2.5}$ and BC as well as their source apportionment results, providing direct and supportive evidence for the effectiveness of control policies. In summary, the policy for coal combustion including the residential sector is a success, while in the future, traffic will remain a major focus for reducing $PM_{2.5}$ and BC concentrations in Beijing.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-30C

Direct estimates of biomass burning NOx emissions and lifetime using daily observations from TROPOMI

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University of California Berkeley, Berkeley, CA, USA

IGAC Activities

GEIA: Global Emissions Initiative

Abstract

Biomass burning emits an estimated 20% of global annual nitrogen oxides (NO_x), an important constituent that participates in the oxidative chemistry of the atmosphere. Estimates of NO_x emission factors, representing the amount of NO_x per mass burned, are primarily based on field or laboratory case studies, but the sporadic and transient nature of wildfires makes it challenging to verify whether these case studies represent the behaviour of the global fires occur on earth. Satellite remote sensing provides a unique view of the earth, allowing the study of emission and downwind evolution of NO_x from a large number of fires. We describe direct estimates of NO_x emissions and lifetime for fires using an exponentially modified Gaussian analysis of daily TROPOspheric Monitoring Instrument (TROPOMI) retrievals of NO_2 tropospheric columns. We correct the low bias of satellite retrieved NO_2 columns over fire plumes by replacing the *a priori* profile of NO_2 with a fine-resolution (0.25˚) global model simulation from NASA's GEOS Composition Forecasting System (GEOS-CF). We derive representative NO_x emission factors for six fuel types globally by linking TROPOMI derived NO_x emissions with observations of fire radiative power from Moderate Resolution Imaging Spectroradiometer (MODIS). Satellite-derived NO_x emission factors are largely consistent with those derived from in-situ measurements. We observe decreasing NO_x lifetime with fire intensity, which we infer is due to the increase in both NO_x abundance and hydroxyl radical production. Our findings suggest promise for applying space-based observations to track the emissions and chemical evolution of reactive nitrogen from wildfires.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-31A

Brown Carbon in Harbin, China during the heating season of 2018

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

The light-absorbing organic aerosol (OA), commonly referred to as “brown carbon (BrC)”, has attracted considerable attention in recent years and has motivated numerous laboratory and field studies around the world. However, the characteristics of BrC in Northeastern China have not been carefully examined yet. Here, we investigated the properties of BrC and its relationship with relevant components in urban Harbin during the heating period of 2018. High BrC light absorption was observed during the months of Dec. to early March, which agrees with the open window period of straw-burning prohibition in surrounding area. The strong correlation between levoglucosan and BrC also suggests that emissions from biomass burning are a significant source of BrC. The contribution from biomass burning emissions was further resolved into agricultural fires and residential burning, and agricultural fires were identified as the major driver responsible for elevated BrC levels. The inherent changes in chemical compositions and BrC light absorption, as well as associated climate impacts, will be discussed in detail.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-32B

A new divergence method to quantify methane emissions using observations of Sentinel-5P TROPOMI

Dr. Mengyao Liu[1], Professor Ronald van der A[1,2], Dr Michiel van Weele[1], Dr Henk Eskes[1], Professor Xiao Lu[3], Dr Pepijn Veefkind[1,4], Dr Jos de Laat[1], Mr. Hao Kong[5], Dr. Jingxu Wang[6], Dr Jiyunting Sun[1], Dr. Jieying Ding[1], Professor Yuanhong Zhao[6], Mr. Hongjian Weng[5]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

We present a new divergence method to estimated methane (CH_4) emissions from satellite observed mean mixing ratio of methane (XCH_4) by deriving the regional enhancement of XCH_4 in the Planetary Boundary Layer (PBL). The applicability is proven by comparing the estimated emissions with its a priori emission inventory from a 3-month GEOS-Chem simulation. When applied to TROPOspheric Monitoring Instrument (TROPOMI) observations, sources from well-known oil/gas production areas, livestock farms and wetlands in Texas become clearly visible in the emission maps. The calculated yearly averaged total CH_4 emission over the Permian Basin is 3.06 [2.82, 3.78] Tg a^{-1} for 2019, which is consistent with previous studies and double that of EDGAR v4.3.2 for 2012. Sensitivity tests on PBL heights, on the derived regional background and on wind speeds suggest our divergence method is quite robust. It is also a fast and simple method to estimate the CH_4 emissions globally.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-33C

Globally Significant methane fluxes from African tropical wetlands

Jacob Shaw[1], Grant Allen[2], Patrick Barker[1], Joseph Pitt[3], James Lee[4], Stephane Bauguitte[5], Dominika Pasternak[4], Keith Bower[1], Michael Daly[6], Mark Lunt[7], Anita Ganesan[8], Adam Vaughan[4], Rebecca Fisher[9], James France[9], David Lowry[9], Paul Palmer[7], Prudence Bateson[1], Euan Nisbet[9]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

Airborne measurements of methane (CH4) were recorded over three major wetland areas in Zambia in February 2019 during the MOYA (Methane Observations and Yearly Assessments) ZWAMPS field campaign. Enhancements of up to 600 ppb CH4 were measured over the Bangweulu (11°36’ S, 30°05’ E), Kafue (15°43’ S, 27°17’ E), and Lukanga (14°29’ S, 27°47’ E) wetlands. Three independent methods were used to quantify methane emission fluxes; aircraft mass balance, airborne eddy covariance, and atmospheric inversion modelling. Results yielded methane emission fluxes of up to 30 mg CH4 m-2 hr-1. The estimated emissions were up to an order of magnitude greater than the emission fluxes simulated by 19 different wetland process models (GCP and WetCHARTs model ensembles). Independent column CH4 observations from the GOSAT and TROPOMI instruments were used to verify the measured fluxes, and investigate their applicability for timescales beyond the MOYA flight campaign.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-34A

Improving OMI-NO_2 resolution based on deep learning over central and southern Chile

Santiago Parraguez[1,2], Laura Gallardo[2,3], Axel Osses[2,4,5], Viviana Meruane[1], Mauricio Osses[2,6]
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IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group

Abstract

Satellite-borne instruments have greatly improved our ability to monitor key-tracers and their evolution. The Ozone Monitoring Instrument (OMI) onboard Aura, is one of those instruments, having provided among other products global daily coverage of nitrogen dioxide (NO_2) since 2004, with a spatial resolution of ca. 13x24 km^2. This data, in turn, has allowed, i.a., monitoring surface emissions. Since 2017, the TROPOspheric Monitoring Instrument (TROPOMI) onboard the Copernicus Sentinel-5 Precursor (S-5P) is extending this series of data but now with ca. 7x3.5 km^2 (ca. 5.5x3.5 km^2 as of 6 August 2019) resolution.

In this study, we use a deep learning approach based on Convolutional Neural Networks (CNN) to generate improved resolution OMI NO_2 fields over central and southern Chile. Given the low-resolution data (OMI), a supervised learning is carried out for predicting the high-resolution images (TropOMI). Further, we use a stochastic approach, training the CNN model to infer parameters of a Gaussian distribution for each pixel, by maximizing the probabilities of finding the desired value. Our model outperforms a bicubic interpolation base case in PSNR, SSIM and MAPE, and allows to estimate uncertainty of the prediction. When applying the model to OMI NO_2, we compare with TROPOMI data, as well as against available spatially and temporally distributed NO_x emission inventories at 1x1 km2 for year 2016. Also, we evaluate the robustness of the model with respect to random aggregated noise in the image. Our results show that the proposed approach is robust against noise, presenting only a slight reduction in performance metrics by adding noise of up to 50%. Additionally, the measured metrics were constantly held higher than the interpolation used as the base case. Hence, the methodology appears adequate and robust, which will allow extending the analysis in time to re-construct high-resolution OMI NO_2 over the period 2004-2020.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-35B

High-resolution tropospheric NO2 satellite retrieval in Asia based on OMI

Yuhang Zhang, Jintai Lin
Peking University, Beijing, China

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

Here we present a high-resolution tropospheric NO_2 VCDs satellite retrieval product, POMINO v2.1, over East Asia based on OMI. This new product is based on our improved POMINO retrieval algorithm, in which we fixed the bug of RAA in POMINO v2.0.1, and updated relevant geometric and ancillary parameters. Over the whole domain, the relative difference of POMINO v2.0.1 to POMINO v2.1 is 5.10% in July and 6.08% in December, 2017. Compared to official QA4ECV and OMNO2 v4 product, POMINO v2.1 NO_2 VCDs show stronger hotspot signals over emission source locations and higher values over polluted regions. In July 2017, NO_2 VCDs of POMINO v2.1 averaged in Beijing-Tianjin-Hebei(BTH) region are lower (NMB = 3.76% for QA4ECV and 7.2% for OMNO2), but show higher values over polluted urban and industrial areas. In Yangtze River Delta(YRD), Pearl River Delta(PRD) and Sichuan Basin(SB), POMINO v2.1 NO_2 VCDs are consistently higher on different levels. In December, QA4ECV and OMNO2 both show underestimation of NO_2 columns by 10.35% and 13.81% in BTH region, where retrieval results are highly affected by high aerosol loadings. Interestingly, POMINO v2.1 NO_2 VCDs are higher than QA4ECV in PRD region, but are much lower than OMNO2 with NMB = 40.81%. Sensitivity test shows implicit aerosol correction can lead to underestimation of NO_2 columns by 26.38% in BTH region in December 2017, while the differences in other three regions are relatively small. Other plausible causes of the differences include different surface reflectance, horizontal resolution of a priori NO_2 profiles and sampling criteria.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-36C

Estimation of Marine Isoprene Production and Emission based on Geostationary Satellite Remote Sensing Observations

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, ACAM: Atmospheric Chemistry and the Asian Monsoon, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

China Working Group

Abstract

Isoprene (2-methyl-1,3-butadiene) is the most abundant biogenic volatile organic compound (BVOC) in our biosphere. It influences the oxidative capacity of the atmosphere and acts as an important precursor to secondary organic aerosols, which can affect the radiation balance of the atmosphere and change cloud microphysics. While terrestrial vegetation contributes 90% of atmospheric isoprene emissions, marine originated isoprene is not negligible in the remote ocean region due to its key role in photochemical processes in relatively clean atmospheric environment. As the long-term variation of marine isoprene has been discussed in many previous studies, there is a need to investigate the short-term variation of the oceanic isoprene concentration and flux. In this study, the environmental parameters (i.e., solar radiation, temperature) and chlorophyll-a concentration products from the geostationary satellite Himawari 8 was used to calculate the diurnal fluctuations of isoprene emissions from phytoplankton in 2020. Satellite retrieved phytoplankton functional types and reconstructed 3D ocean thermal structure were incorporated into the phytoplankton isoprene emission model. The dynamic mixed layer depth, obtained by using the temperature threshold method, was used to calculate the temporal and spatial distributions of seawater isoprene concentration. Our results suggest that the zonal distribution of seawater isoprene concentration is comparable to the observed values from cruise measurements. The model simulated isoprene emission flux was further assessed with TROPOMI formaldehyde observation.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-37A

Global-Scale Observation and Evaluation of Nitrous Oxide from IASI: Application to Source Estimates

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

The global-scale distribution of tropospheric nitrous oxide (N_2O) is examined over the year 2011 by means of space-borne observations from the Infrared Atmospheric Sounding Interferometer (IASI) instrument onboard the Metop-A platform. A scientific ground-segment, named Toulouse N_2O Retrieval Version 1.7 (TN_2OR V1.7), has been developed to retrieve N_2O profiles from IASI spectral radiances. It is based on the RTTOV radiative transfer model coupled to the optimal estimation method enabling the retrieval of methane, water vapor, temperature profiles together with surface temperature and emissivity within the spectral micro-window 1240-1350 cm^{-1}. The total error of IASI TN_2OR V1.7 N_2O around 300 hPa is about 0.60-0.65%. The IASI TN_2OR V1.7 N_2O data set has been evaluated against: 1) airborne N_2O observations from the HIPPO and NOAA campaigns, and 2) ground-based N_2O measurements from 10 stations belonging to the international NDACC network. The mean bias between IASI and HIPPO/NOAA N_2O data sets at 300 hPa is 1.6-1.7 ppbv (~0.5%) and, between IASI and NDACC data sets, it is ~2.0, ~4.0 and ~10.0 ppbv over Jungfraujoch, Zugspitze, and Wollongong, respectively. The daily, monthly and seasonally-averaged N_2O distributions at 300 hPa exhibit maxima (>332 ppbv) over the tropics with hot spots over Central Africa and South America and minima (<322 ppbv) at high latitudes whatever the season and the time (day/night). Source inversions were run at a monthly resolution for the year 2011: 1) at the global scale, using with the PyVAR CAMS-N_2O inversion framework with the atmospheric chemistry transport model, LMDz5 and 2) at the regional scale over Europe, using the CHIMERE model. Preliminary results at the global scale show significant uncertainty reductions using TN_2OR V1.7 data over tropical land where ground-based observations are extremely scarce.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-38B

Reconciling Assumptions in Bottom Up and Top Down Approaches for Estimating Aerosol Emissions from Wildland Fires in the Western US using Observations from FIREX-AQ

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group

Abstract

Wildland fires in the Western United States emit a substantial quantity of trace gas and particulate matter that can severely degrade air quality and ultimately influence climate. However, it is difficult to accurately quantify biomass burning emissions. There are two traditional methods to calculate fire emissions, the “bottom-up” approach and the “top-down” approach. The two approaches often disagree by an order of magnitude or more on the mass of PM emitted by fires, but validation is challenging, and it remains difficult to determine which approach is correct. In situ and remote sensing airborne measurements from the recent NASA/NOAA campaign Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) provide the opportunity to evaluate the two traditional approaches to calculate emissions. In this study, we calculate fire PM emission rates from Western US wildland fires sampled during FIREX-AQ using an independent approach that relies on the integration of smoke plume observations and information gleaned from airborne LIDAR measurements from HSRL. We also calculate fire PM emission rates using the traditional bottom-up and top-down style approaches. We compare our PM emission rate estimates from the in situ based approach with the traditional approaches to investigate potential bias. The results of our analysis improve our understanding of how to correctly quantify fire aerosol emissions, and have larger implications for using aerosol optical depth remote sensing observations to estimate the mass of PM emitted by fires.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-39C

3 years of urban CO_2 emissions in the San Francisco Bay Area inferred from a low-cost monitoring network

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group

Abstract

Over 70% of the fossil fuel CO_2 emissions are attributable to urban areas. As such, it is crucial to be able to monitor their emissions. The Berkeley Environment, Air-quality, and CO_2 network ($BEACO_2N$) is a dense and low-cost monitoring network in the San Francisco Bay Area that has been measuring atmospheric CO_2 since 2013. Here we use CO_2 observations from ~70 $BEACO_2N$ nodes and an atmospheric transport model to quantify changes in urban CO_2 fluxes in the San Francisco Bay Area from 2018 through 2020. We estimate hourly CO_2 fluxes at 900-m spatial resolution using Bayesian inference with fully populated error covariance matrices. Atmospheric transport is simulated using the Stochastic Time-Inverted Lagrangian Transport (STILT) model and the biosphere is constrained using observations of Solar-Induced chlorophyll Fluorescence (SIF) from TROPOMI. The time period analyzed here includes the 2020 lockdown due to COVID-19, this allows us to study the temporal response of urban CO_2 emissions to both the abrupt shut down and gradual recovery.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-40A

Applications of satellite-derived NOx emissions

Dr Ronald van der A, Dr Jieying Ding, Dr Bas Mijling, Dr Jos de Laat
KNMI, De Bilt, Netherlands

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

Nitrogen oxides (NOx) emissions play an important role in air quality, the nitrogen cycle, and as precursor for climate gasses. The most important sources of NOx emissions are fossil fuel burning (industry and traffic) and the release from soil.
With the inversion algorithm DECSO (Daily Emissions Constrained by Satellite Observations) we derive quantitative NOx emissions on a mesoscale from Sentinel 5p satellite observations of NO2, taking advantage of the fine spatial resolution (5x 3.5 km) of the TROPOMI instrument. The algorithm has been applied to many regions in the world. In this presentation a few highlights will be shown of the applicability of satellite-derived NOx emissions: the discovery of emissions along Siberian natural gas pipelines and the strong emission changes due to COVID-19.
Furthermore, an assessment will be given of the accuracy of TROPOMI-derived NOx emissions and possibilities for the spatial and temporal resolution.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-41B

Temporal variations of atmospheric NH_3 revealed from space: from intraday cycles to long-term global trends

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Ammonia NH_3 is now widely recognized as a major primary pollutant, deteriorating water, soil and air quality. While the importance of monitoring and regulating atmospheric NH_3 emissions has been underlined for decades by experts in the field and endorsed or ratified by a multitude of international organizations, it is only recently that the issue is making its way onto the political agendas. In the past decade, it was discovered that high-resolution infrared satellites observations can measure atmospheric NH_3, leading to major progress in our understanding of this atmospheric compound and its sources, and to new possibilities for benchmarking or enforcing regulations.

Currently, several polar-orbiting instruments are in orbit that measure NH_3 global distributions twice a day. In this talk, we present the first observations of NH_3 from the Geostationary Interferometric Infrared Sounder (GIIRS) onboard the Chinese FY-4A satellite. GIIRS measures almost all of Asia ten times per day. As its spectral range includes a large portion of the thermal infrared, the instrument allows studying for the first time the diurnal and nocturnal variations of atmospheric NH_3. We analyze the daily cycle of NH_3 in detail over two small regions in Pakistan and China, and how it varies across different seasons.

In keeping with the temporal theme, we present in the second part of this talk, long term global trends of NH_3 derived using the 2008-2018 reanalyzed IASI-NH_3 dataset. Trends are presented and analyzed from the regional to the national and global scale.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-42C

Optimizing carbon monoxide emission estimates from Californian wildfires through inverse modeling based on high-resolution satellite observations

M.Sc. Johann R. Nüß[1], Dr. Nikos Daskalakis[1], Dr. Angelos Gkouvousis[2,3], Dr. Oliver Schneising[1], Dr. Michael Buchwitz[1], Prof. Maarten C. Krol[4,5], Prof. Mihalis Vrekoussis[1,6,7]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative

Abstract

Carbon monoxide (CO) emitted from wildfires adversely affects air quality and climate. Modern global bottom-up inventories for these emissions, such as GFED4.1s and FINN2.2, work well on regional to global scales. Especially the inclusion of smaller fires leads to significant improvements in the emission estimates in recent years. In this study, we attempt to further optimize these emission estimates for specific wildfires in California through the top-down approach of inverse modeling. Our model, TM5-4DVAR, is mainly driven by the observations provided by the TROPOMI satellite instrument on-board Sentinel S5P, which feature high spatial resolution (up to 7 km×7 km) and daily global coverage.

On the local scale of the individual wildfire, our model calculates a moderate increase in total carbon monoxide emitted (+38 % compared to FINN2.2+VIIRS). The model also suggests a largely different temporal evolution of the fire, with lower emissions on the first two days, but much higher emissions on days 4 and 5. These findings are consistent over the different inventories used. However, the confidence in the inferred temporal evolution is likely affected by the relatively coarse resolution of the model (1°×1°, roughly 10,000 km²) compared to the size of the burning event (600 km²). Regardless, we show that the model still benefits from the high-resolution satellite observations used.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-43A

Satellite-derived NOx emissions for 80 global megacities between 2005 and 2019

Dr. Daniel L Goldberg[1,2], Dr. Susan C Anenberg[1], Dr. Zifeng Lu[2], Dr. Lok Lamsal[3], Dr. Erin McDuffie[4], Dr. David G. Streets[2]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

Emission inventory development for air pollutants takes many years, and involves extensive multi-national collaboration. The quality of the inventory estimates is often a function of the detail in which each country is monitoring their fuel usage and emissions. A complementary method to estimate air pollution emissions is in the use of satellite remote sensing. We use a satellite-based methodology to estimate aggregated NOx emissions for 80 global cities between 2005 – 2019 using OMI NO_2 measurements combined with re-analysis meteorology. Top-down and bottom-up urban NO_X emissions show excellent agreement in the United States, Canada and Australasia. In Europe, Korea, and Japan temporal trends also show excellent agreement, but bottom-up inventories consistently underestimate the magnitude; the disagreement in magnitude between the top-down and bottom-up methods may be partially related to diurnal emission pattern differences in these countries. In China, bottom-up inventories fail to capture the timing of urban emission reductions, which appear to have occurred faster in the 2012 – 2015 timeframe than currently reported. In developing nations (Latin America, Africa, India) it appears that large projected increases in NO_X emissions have not materialized. As a result, satellite-based measurements show a larger decrease in global urban NO_X emissions than currently reported in the inventories. While many of the discrepancies between top-down and bottom-up emissions estimates represent real differences, some of the discrepancies might be related to the assumptions made to produce the top-down estimates. Our work identifies these uncertainties, and attempts to chart a path forward for the research community.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-44B

Estimation of NO_x, SO_2 and HCHO emissions from the Megacity of Lahore, Pakistan using car MAX-DOAS observations and comparison with regional atmospheric chemistry model and TROPOspheric Monitoring Instrument (TROPOMI) satellite data

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Abstract

Lahore is a megacity of Pakistan having more than 11 million inhabitants that makes the city a strong emission source of atmospheric pollutants. We present results of a top-down procedure for the estimation of emissions of NO_x and SO_2 for Lahore, based on car multi-axis differential optical absorption spectroscopy (car-MAX-DOAS) observations. In addition, also the total flux of HCHO from Lahore is determined which can be seen as an indicator for VOC emissions. Results from two extensive campaigns, which took place in summer 2017 and spring 2018 will be presented. From the measured spectra, we retrieve the vertically integrated concentration (the so-called tropospheric vertical column density, VCD) of the trace gases along the driving route. By combining these observations with ECMWF Re-analysis wind data, the total flux of NO_2, SO_2 and HCHO from the city of Lahore are estimated. We convert the NO_2 flux to NOx (NO_2 + NO) emissions, as only NO_2 (and not NO) can be retrieved from the measured spectra. To do so, we apply corrections for the partitioning between NO and NO_2 as well as for the decay of NO_x between the emission source and the points of the measurements. From both measurement campaigns, we also analysed the seasonal variability of the above-mentioned species.

Derived NO_x and SO_2 emissions are compared to existing bottom-up emission inventory EDGAR. We also compare the spatial distributions of the tropospheric NO_2 and SO_2 VCDs observed by car MAX-DOAS with results of a regional atmospheric chemistry model. NO_x emissions estimated by using car-MAX-DOAS data are also compared to the emissions, estimated from TROPOMI satellite observations.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-45C

Airborne greenhouse gas (CO2 and CH4) measurements in Cyprus

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[3]University of Bremen, Institute of Environmental Physics and Remote Sensing (IUP) & Center of Marine Environmental Sciences (MARUM), Bremen, Germany

Abstract

Cyprus is an island located in the eastern part of the Mediterranean Sea. The sources and sinks of the main greenhouse gases (GHG) in this region remain poorly known because of a lack of atmospheric measurements to constrain available bottom-up emission inventory estimates. This study presents airborne measurements through unmanned aerial vehicles (UAVs) and manned-aircraft of atmospheric carbon dioxide and methane in Cyprus, aiming to obtain a comprehensive understanding of the national GHG source distributions and emission point source intensity. The obtained experimental data and results will allow verification of the hypotheses used for national GHG emission monitoring and reporting.

Validated UAV-GHG sensor systems are used to map specific source emissions close to the ground. The sensors used here are based on the SenseAir AB CO_2 High-Performance Platform (HPP). The CO_2 sensors accuracy and linearity tests were performed in the laboratory. The results were compared against an airborne reference instrument (Picarro G2401-m). Following the above laboratory and airborne tests, the HPP CO_2 sensor was deployed into a quad-copter that allows vertical take-off and landing (VTOL) in urban environments. In addition, the Los Gatos Research HoverGuard Greenhouse Gas Analyzer (LGR-GLA133) was tested in the lab before being integrated on a small manned aircraft and the aim was to map and assess CO_2 and CH_4 emission fluxes at the national (islandwide) scale. These first airborne measurements have shown to provide already with useful insights into GHGs emissions in Cyprus.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-46A

INSIGHTS OF THE ACCURACY OF BOTTOM-UP AND TOP-DOWN LOCAL EMISSION INVENTORIES THROUGH HIGH-RESOLUTION ATMOSPHERIC MODELING

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IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group

Abstract

Road transport emissions are the most important source of pollution in urban environments; therefore, an accurate estimation of such emissions is needed to model air quality and support its management. In this work, the WRF-Chem model was used to test the sensitivity of carbon monoxide (CO), ozone (O_3) and particulate matter (PM_{10} and $PM_{2.5}$) predictions to different road transport emission inventories (EI). Four EI were used to simulate air quality over the Andean city of Manizales, Colombia. The EIs were developed for the same year (2017), but they differ in the emission factors used (IVE vs COPERT) and the estimation techniques (top-down vs bottom-up). In general, all studied pollutants exhibit a strong sensitivity to the emission factors implemented in the EI. Although all the models underestimate CO, PM_{10} and $PM_{2.5}$, and overestimated O_3, the COPERT/top-down EI leads to larger errors compared to the IVE/Top-down EI. The differences between IVE and COPERT estimations could be attributed to the different activity data considered, in the case of IVE the vehicle-specific power (VSP), and average speed for COPERT. Likewise, CO was also sensitive to the estimation technique; indeed, using the COPERT/bottom-up EI improves CO predictions compared to the COPERT/top-down EI (RMSE: 0.52 vs 0.54 ppm). On the other hand, PM_{10} and $PM_{2.5}$ did not vary considerably according to the estimation technique. These results show that the IVE EI is more representative of the vehicle operating conditions for the city of Manizales, characterized by steep roads that exceed 22% slope, as the VSP approach allows to account for the engine stress induced by the road slopes; hence, reducing prediction errors. Furthermore, bottom-up emission inventories provided a better representation of the temporal and spatial distribution of pollutants in the city, due to more detailed vehicle activity information, enhancing the model performance.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-47B

Identification of major air pollutant source location in India using satellite data and statistical-based analysis

Mr Abhishek Chhari
North Eastern Space Application Centre, Meghalaya, India

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Trace gases and particulate matters have a direct adverse impact on human health, ecology, and climate. As most of these pollutants have their residence time in air ranging from days to months, they can very well transport between far locations. In view of this, it is important that source identification studies for these pollutants should be carried out on a regional scale which could aid in regional climate modeling and also help in devising proper pollution mitigation strategies on a regional level. In this study, we have used Ozone Monitoring Instrument, satellite data, and industries location data to identified hot spot locations for these pollutants. One such hotspot location Asansol (23.6N, 86.9E) was identified, and more than two days forward air mass trajectory was carried out from here using the HYSPLIT model. Three stations Vishakhapatnam (17.6N, 83.2E), Kolkata (22.5N, 88.3E), and Chennai (13.7N, 80.2E) were identified over which these trajectories have their passages. In-Situ measurements of trace gases (O3, CO, NOx, NH3, SO2) and particulate matters (PM2.5 and PM10) for the year 2020, were analyzed and variation in their concentrations was observed. These pollutants data along with metrological parameters, for each station were subjected to principal component analysis (PCA). These analyses were done for all four seasons for each measuring station. In all the cases, first, four principal components represented more than 76% of the variation of the original data. Interpretation of PCA, suggests that during the winter season photochemical production of ozone was absent and CO, SO2, and PM10 are strongly influenced by wind speed and direction. Further, Concentrated Weighted trajectory (CWT) analysis was also carried out for each pollutant for all four seasons. Also with data from few additional measuring sites in India, a PCA study was also carried out on individual pollutants measured at different locations.

Early Career Scientist

YES, I am an early career scientist.

AMIGO-48C

Propane emission estimates over Europe using observations and an inverse modelling approach

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

Propane, one of the most abundant non-methane hydrocarbons in the atmosphere, is a widely used fuel in domestic and industrial applications derived from petroleum products during oil and natural gas processing. Emissions from surface sources are mainly due to natural gas losses and biomass burning. Propane is of environmental concern because its oxidation enhances secondary pollutants, such as tropospheric ozone and aerosol but its source fluxes, atmospheric distribution and trends are poorly understood. For the development of better emission control strategies and health risk assessment, it is crucial to have accurate information about the spatial and temporal distribution of propane fluxes. This study provides top-down estimates of propane emissions from Europe, using continuous atmospheric measurements at remote and rural sites in Europe combined with an atmospheric transport model and an inverse modelling technique. The inversion approach is based on backward-in-time simulations of the Lagrangian particle dispersion model, FLEXPART. The model is driven by operational ECMWF analyses with 1◦×1◦ resolution and a 3-h time interval, during which 40000 virtual particles are released at the sites' location and the height of the sampling inlet above the ground, and followed backwards in time for 20 days to calculate the source–receptor relationships (SRRs). The loss of propane due to removal by OH radicals along the trajectories is estimated using pre-calculated OH fields from the GEOS-Chem model. The Bayesian inversion algorithm applied is based on least-squares optimization, to estimate both the spatial distribution and intensity of the emissions in the region affecting the measurement sites. The inversion cascade adjusts the emissions to reduce the difference between the observed and simulated mixing ratio, while also considering the deviation of the a posteriori emission field from a priori emissions. Inversion results confirm significant emissions of propane over the most polluted regions in Europe.

Early Career Scientist

NO, I am not an early career scientist.

AMIGO-49A

Methane and non-methane hydrocarbons concentrations and sources in an Eastern Mediterranean Island (Cyprus)

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Continuous, methane and non-methane hydrocarbon (NMHC) observations are currently performed at a suburban background site of the capital city of Nicosia, Cyprus. Methane is a potent greenhouse gas but its sources remain poorly quantified in the Eastern Mediterranean and Middle East (EMME) region. Light alkanes, such as ethane (C2H6), are co-emitted by fossil fuel (oil and gas) activities and are promising tracers for quantifying the methane emissions from this sector. Cyprus is an ideal location for studying the composition of air masses of varied origin and different emission source signatures at a regional scale. A Picarro G2401 analyzer and two field-based Gas Chromatography Flame Ionization Detectors (GC-FID, airmoVOC and airmoBTX, Chromatotek) are deployed and an extensive dataset is generated. Our aim is to use these observations for identifying regional and local anthropogenic methane sources, for assessing tropospheric background concentrations, while evaluating the significance of long-range transported versus local sources. Methane observations are performed in Nicosia since February 2020. Since February 2021, we are additionally conducting NMHC (C2-C12) measurements, that include both anthropogenic (alkanes, alkenes, aromatics) and biogenic (isoprene, monoterpenes) compounds. These species allow the identification of emissions sources that originate from the industrial, agricultural, urban and energy production sectors. Our initial observations suggest strong local methane and NMHC sources. To evaluate the significance of the hotspots, we perform comprehensive analyses on the static observations and in addition, we are employing mobile measurements using cars and bicycles (with Picarro and LGR-GLA133). We also provide evidence for long-range transport, including the ability to trace and study the contribution of methane emissions from Middle Eastern oil and gas operations. Our measurements will ultimately provide a better understanding of pollution sources at local and regional scale in the Eastern Mediterranean region.

Early Career Scientist

YES, I am an early career scientist.

ANGA-1A

The local and remote climate and human health impacts of Africa's 21st century aerosol emission trajectory

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IGAC Activities

CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Using the Shared Socioeconomic Pathway scenarios (SSPs), 21st century climate simulations were performed in UKESM1, testing the effect of African emissions following the SSP3-RCP7.0 scenario as the rest of the world follows SSP1-RCP1.9, relative to a global SSP1-RCP1.9 control. SSP3 sees higher direct anthropogenic aerosol and CO_2 emissions, but lower biomass burning (BB) aerosol emissions, over Africa, with a net increase in aerosol emissions. Experiments were performed changing BB and nonBB emissions, and both; further experiments additionally accounted for changing future CO_2 concentrations, to investigate the total impact of Africa following a higher emissions pathway. Impacts on climate properties such as radiation fluxes, temperature, circulation and precipitation are investigated, both over the emission region (Africa), where microphysical effects dominate, and remotely, where dynamical influences become more relevant. Also investigated is the impact of $PM_{2.5}$ on human health, both in Africa and more remotely, finding significantly higher annual air pollution-related deaths under higher aerosol emissions scenarios.

Early Career Scientist

YES, I am an early career scientist.

ANGA-2B

Dominant contribution of nitrogen compounds in precipitation chemistry in the Lake Victoria catchment (East Africa)

Adama BAKAYOKO[1], Dr Corinne Galy-Lacaux[2,3], Pr Véronique Yoboué[1], Dr Jonathan E. Hickman[4], Pr Frank Roux[2,3], Eric Gardrat[2], Frédéric Julien[2,3,5], Dr Claire Delon[2,3]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

This work provides a complete chemical characterization of rains collected in the tropical rural site of Mbita (Kenya) on the shores of Lake Victoria (annual rainfall 1259.3 mm). We present a wet nitrogen deposition budget including inorganic and organic dissolved nitrogen in relation with atmospheric sources of gases and particles, precipitation rate and air mass transport. A unique two-year monitoring data set (2017-2019), providing 183 rain samples was collected and analyzed according to international standards (WMO/GAW). Considering that precipitation represents the largest contributor of water to the Lake Victoria (80%), this study gives new insights in the seasonality of nutrients wet deposition inputs in the unique natural resource represented by Lake Victoria and its catchment.
Four main contributions to the chemical composition of precipitation, were identified: (1) a 28% terrigenous contribution related to crustal and biomass sources (2) a 14% marine contribution related to Indian ocean air masses intrusion, (3) a 15% organic contribution due to volatile organic carbon emissions from biomass burning and vegetation and (4) a predominant nitrogenous contribution of 39% due to livestock and fertilizers, biomass burning and neighboring agricultural fires. Ammonium and nitrate volume weighed mean concentrations are 36.75 and 8.88 µeq L-1, respectively. Rain in Mbita is alkaline (pH=5.8) highlighting neutralization by heterogeneous chemistry. Total nitrogen wet deposition is 8.54 kgN ha-1 yr-1, 58,760 tN yr-1 for the entire lake, with 26% attributed to dissolved organic nitrogen. A total atmospheric deposition of 15 kgN ha-1 yr-1 is estimated taking into account dry deposition
estimate from literature, showing that the Lake Victoria ecosystem is exposed to eutrophication. An extensive and regular monitoring of wet and dry nitrogen deposition is highly recommended both in-shore and off-shore to help improving the efficiency of nitrogen use in agricultural areas and reduce nitrogen losses around Lake Victoria.

Early Career Scientist

YES, I am an early career scientist.

ANGA-3C

Characterization of aerosol oxidative potential over African cities: a metric for relating air pollution and health effects

Dr Cathy Leal-Liousse[1], Sylvain Gnamien[2], Keitumetse Segakweng[3], Eric Gardrat[1], Dr Micky Josipovic[3], Pr Véronique Yoboué[2], Dr Benjamin Guinot[1], Dr Pieter Van Zyl[3], Pr Armelle Baeza-Squiban[4]
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IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Recently, it has been shown that Africa could be an emerging giant in terms of anthropogenic emissions if no mitigation occurs with huge impacts on air quality and health in African cities. However, there is a lack of data of health measurements.

Recently, it has been seen that oxidative potential (OP) of aerosols could be a good proxy to reflect aerosol biological effects and health impacts. This metric is non-invasive and easy to set in place since directly measured on collected filters.

In that context, since a few years, aerosols were collected in our different programs over Africa, to perform chemical composition and OP measurements mainly using the DTT methodology which tracks the aerosol depletion of dithiothreitol antioxidant.

Data were obtained for the following different urban sites in West and South Africa : (1) in Sasolburg, a residential site in the Vaal triangle (Josipovic et al. 2019) and in Zambela and Jouberton townships, both in the frame of GDRI-ARSAIO program in South Africa (2) in Abidjan (domestic fire site, traffic site and landfill site) and in Cotonou (traffic site) in the frame of DACCIWA program in Cote d'Ivoire and Benin; (3) in Abidjan and Korhogo (urban sites) in the frame of PASMU program in Cote d'Ivoire.

In this paper, OP(DTT) results will be presented for the different sites. When available, comparison with in vitro cytokine expression and release measurements such as IL8 and/or with other OP methods such as the depletion of ascorbic acid in a synthetic lung lining fluid, will be shown.

Finally, comparison between OP(DTT) and size-speciated aerosol chemical composition and mass will be proposed.

Our results will underline the interest to construct a network of long term crossed measurements of aerosol mass and composition and oxidative potential.

Early Career Scientist

NO, I am not an early career scientist.

ANGA-4A

Assessment of Respirable Crystalline Silica Exposure among Miners of Konkola Underground Mine

Miss Mwaba Sifanu[1], Mr Patrick Hayumbu[2], Dr Kennedy Kabaso Kalebaila[3], Mr Lubinda Nabiwa[4]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Abstract

Objective:

Respirable crystalline silica (RCS) is one of the harmful components in found mine dust of interest to occupational hygiene programs of the mining industry worldwide. Zambia, a developing country is yet to implement a baseline occupational hygiene survey at Konkola Underground Mine to protect miners from harmful silica health effects that unfortunately ensues excessive RCS exposure.

Methodology:

The incipient dust laboratory of the Copperbelt University has just procured a portable Fourier Transform Infrared Spectrometer that will be used to characterize personal dust samples of Konkola Mine miners in this baseline survey of respirable crystalline silica.

Results:

The study will obtain respirable crystalline silica exposure levels of sampled miners. Since Zambia does not have a respirable crystalline silica occupational exposure limit, measured respirable crystalline silica levels of Konkola Mine will be compared to occupational exposure limits of the best occupational hygiene practice for miners in the world.

Implications:

The study findings will be added to the nascent national database of respirable crystalline silica measurements in Zambian mines and will be available for use by the Mine Safety Department in their regulatory duties. It is anticipated that these results may contribute to the periodic improvement of the government's newly promulgated national occupational safety and health policy.

Keywords: Respirable crystalline silica, harmful mine dust, occupational hygiene, Konkola Mine

Early Career Scientist

YES, I am an early career scientist.

ANGA-5B

REVIEW OF OCCUPATIONAL EXPOSURE TO RESPIRABLE CRYSTALLINE SILICA TO MINEWORKERS AT MOPANI MUFULIRA MINE IN ZAMBIA

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Copperbelt University, Kitwe, Zambia

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Zambia's Gross Domestic Product (GDP) largely depends on the mining sector. One of the country's big mines since 1933 is Mufulira Underground Mine that started as a private enterprise, was nationalised in 1973 and reprivatised in 2000 and operates under Mopani Copper Mines (MCM) plc. This mine's ore is known to have the highest crystalline silica content. Since 2005, the occupational hygiene monitoring of respirable crystalline silica (RCS) has been fairly robust, to a point that the company started operating personal dust monitoring occupational hygiene laboratory that characterises respirable dust and RCS using an FTIR spectrometer. Despite this RCS surveillance improvement, RCS health effects of long latency have been observed among miners. For examples, the number of recorded cases of Pneumoconiosis from 2011 to 2013 at this mine was the highest in the country. Furthermore, a study conducted at this mine in 2008 to measure RCS exposure found that out of the 101 samples collected; 58.4%, 66.3% and 69.3% were above three international exposure limits. Regardless of all these challenges around RCS, very few studies in the open literature have documented exposure to RCS for this mine. It is not known whether miners face overexposure to RCS since the last documented study was conducted in 2008. Furthermore, lung cancer is yet to be a government-regulated occupational lung disease like TB and silicosis and the current exposure levels to ionising radiation seem not to be documented for the mine despite the fact the RCS is a human carcinogen. If radon levels at this mine are significant, its carcinogenic effect can be confounded by RCS and silently overlooked.

Keywords: Occupational hygiene, silicosis, respirable crystalline silica, Mufulira Mine

Early Career Scientist

YES, I am an early career scientist.

ANGA-6C

Evidence of Long-Term Trend of Visibility in the Sahel and Coevolution with Meteorological Conditions and Vegetation Cover during the Recent Period

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

In this study, the long term trend of the observed visibility data used directly (without conversion into dust concentrations) over Sahel was investigated between 1957 and 2013. Then, to review the influence of atmospheric factors and land surface conditions on this trend, the coevolution between the visibility and the dust surface mass concentration from MERRA-2 (Modern-Era Retrospective analysis for Research and Applications) reanalysis, the in-situ surface meteorological data (rainfall, relative humidity, wind speed, and air temperature), as well as the Normalized Difference Vegetation Index (NDVI) were analyzed from 2000 to 2013. We showed that the horizontal visibility has significantly decreased since the 1970s. The coevolution between the visibility and the dust surface mass concentration revealed that visibility decreased significantly with increments in dust concentrations. Visibility increases with rainfall and relative humidity. It is greater in areas of high vegetation cover than in deforested areas. Visibility is weakly correlated with wind speed and air temperature but generally, wind leads to a decrease in visibility, while warm air temperature is associated with a clearer sky and hence, high visibility. The worst visibility in the dry season results from high dust concentrations due to warm and dry wind conditions and less vegetation cover. Rainfall, relative humidity and vegetation cover are the dominant factors contributing to the decrease of dust loading in the Sahel.

Early Career Scientist

NO, I am not an early career scientist.

ANGA-7A

^{14}C-based Source Apportionment of Black Carbon in $PM_{2.5}$ aerosols in Urban Nairobi

Leonard Kirago[1], Dr. August Andersson[1], Prof. Michael G. Gatari[2], Prof. Orjan Gustafsson[1]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

To formulate effective pollution control policies, adequate and long-term observational data is required. However, such data is lacking in the sub-Saharan Africa region. In this study, ^{14}C isotope characterization was employed to differentiate between fossil and biomass sources of black carbon (BC) in Nairobi City. The BC concentrations on average contributed 15 ± 3 % to the total $PM_{2.5}$ loadings, with a year-round average of 3.9 ± 1.2 μg m^{-3}. Black carbon is one of the more toxic components of $PM_{2.5}$, and the highly elevated levels suggest larger health implications than would be apparent from $PM_{2.5}$ levels. Large contributions from fossil sources (85 ± 3 %), with little annual variability, was observed. Thus, BC emissions from fossil sources, likely from old and poorly controlled vehicles, appear to be a major source of air pollution in Nairobi City.

Early Career Scientist

YES, I am an early career scientist.

ANGA-8B

Learning the lessons of more than 150 years of air quality management: recommendations for future efforts to reduce air pollution

Dr Aderiana Mbandi
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IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

The control of air pollution has been highlighted as necessary for human well-being for thousands of years. While air quality has improved in mostly high income countries over the last 20 years, high levels of pollution persist in the low and middle-income developing countries. A salient characteristic in most countries in the past decades in the early stages of industrialization has been growth pursued with limited investment in environment protection leading to high levels of pollution in urban areas, as well as the continued burden from household air pollution exposure in urban and rural areas for families cooking using solid biomass fuels. This paper therefore explores the evolving approach to air quality management by examining air quality policy at multiple scales: global, regional and national scale over a 150-year timeframe. In doing so, we seek to identify barriers and enablers to successful air quality management for governments in low and middle-income countries in the initial stages of implementing air pollution control strategies. In the assessment of the chronology of air quality policies at the national scales, we find a common theme of evolution from emission sources control approach to management of ambient air quality through an effects-based approach. In each case, we demonstrate the emergence of an element of management and implementation that is decentralized to a local level of governance. We find early attempts in developing air quality laws in some of these countries were not initially supported by the infrastructure necessary to make them effective. In examining air quality and emissions agreements at multiple scales, a case is made for urban ambient air pollution reductions from 2010 onwards in some regions. However, we find there is limited investments in generating atmospheric composition evidence from regional, national and urban ground based measurement networks in most middle and low-income countries.

Early Career Scientist

YES, I am an early career scientist.

ANGA-9C

Optical Properties of Water-Soluble Carbonaceous Aerosols at the Rwanda Climate Observatory

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[2]University of Rwanda, Kigali, Rwanda

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Aerosol emissions from biomass burning (BB) in sub-Saharan Africa (SSA) contributes 57% of global BB mass (Werf et al., 2010). However, the characterization of these emissions is poorly understood due to minimal ground-based measurements. This lack of characterization parameters is reflected in the global climate models with regard to SSA carbonaceous aerosols emissions. This study is designed to investigate the optical properties of water soluble organic carbonaceous (WSOC) aerosols from SSA region.

Samples were collected at the Rwanda Climate Observatory, located at the top of Mt. Mugogo in western Rwanda between April 2015 and April 2016. Samples were collected on quartz filters using a high-volume sampler operating at 30 m3 h-1 fitted with a PM2.5 inlet. WSOC was extracted in 20 ml Milli-Q water, ultrasonicating for 15 minutes, centrifuging for 10 minutes at 1500 rpm and filtering the supernatant using a 0.02µm cutoff aluminum syringe filters. The filtrate was analyzed for WSOC concentration using a high temperature catalytic oxidation instrument. The absorbance of the WSOC samples was measured in the wavelength range of 190 to 1100 nm using a Hitachi U2010 UV-vis absorption spectrophotometer. Mass absorption cross-section of the WSOC (MAC WS-BrC) was computed for 365 nm and AAE was fitted within the range of 330 to 400 nm.

The average WSOC concentration was 3.7±2.7 µg m-3 and the observed time dependent concentration of WSOC showed biannual peaks for the months of June/July and January/February. These two periods are meteorologically categorized as “dry seasons” and are reported to be characterized by extensive biomass burning events (Andersson et al., 2020). The calculated mass absorption cross-section at 365nm (0.73±0.15 m2 g-1) and absorption Ångström exponent (6.5±1.2) of the WSOC were constant throughout the sampled period implying probable stability of the WSOC sources in this equatorial region.

Early Career Scientist

YES, I am an early career scientist.

ANGA-10A

Urban emissions inventories development for air quality modelling in Abidjan and Korhogo cities

Sekou KEITA[1], Cathy LIOUSSE[2], N'doufou GNAMIEN[3], Madina DOUMBIA[1], Siélé SILUE[1], Véronique YOBOUE[3]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

West Africa suffers from poor air quality due to the influence of high local emission sources and transboundary emissions from the rest of Africa. A fine resolution of anthropogenic emissions inventory is a prerequisite for accurate air quality modelling. However, there is a lack of inventories for West African cities. This study will first present a new fine-scale spatialized anthropogenic emission inventory for aerosols (BC, OC and $PM_{2.5}$) and gases (CO, NO_x, SO_2 and NMVOC) with a resolution of 1km by 1km including six activity sectors (residential and commercial, industry, energy, transportation, open waste burning and resuspended road dust) in Abidjan and Korhogo. The methodology used to derive these emission inventories is based on national activity databases for traffic, residential/commercial and waste burning consumption estimates and on DACCIWA emission data (Keita et al., 2021) for industries and thermal power plant sources in Côte d'Ivoire. Road dust $PM_{2.5}$ emissions are based on road conditions (silt loading, width and length …), traffic data (e.g. average weighted vehicle run over the paved and unpaved road (tons/day)) and rainfall frequency. The spatial distribution keys used depend on the activity. For example domestic fires (residential and commercial) used population density associated to poverty indexes while road density and occupancy are used for traffic. Finally, after a comparison of these new inventories to regional estimates, and a discussion on the relative contribution of the different activities for all the pollutants at the city scale, we will present the spatial distribution maps of the pollutants for these six sectors.

Early Career Scientist

YES, I am an early career scientist.

ANGA-11B

HDM-4 Model Calibration and Estimation of Vehicular Emissions in Nairobi, Kenya

Mr. Ezekiel Waiguru NYAGA[1], Dr. Andrea Mazzeo[2], Prof. Michael James Gatari[1], Prof. Michael Burrow[2], Prof. Elijah Mwangi[3], Prof. Andrew Quinn[2], Prof. Francis D. Pope[4]
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IGAC Activities

GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Urban air pollution data is scarce in Kenya despite the rapidly growing urban population and increasing number of on-road vehicles and other road users. In Landrigan et al. (2018), and references therein, air pollution was understood to be important causative agent of many non-communicable diseases. It was concluded that in absence of mitigation, ambient air pollution will result in increased number of deaths worldwide to more than 50% by 2050. There is no spatiotemporal monitoring of air pollution in Nairobi to support comprehensive policy decision making other than short duration studies which implicate on-road vehicles as the main contributors to poor air quality. Estimation of source emitted species, using available modelling tools will help in developing policies for managing air quality. The Highway Development and Management (HDM-4) model was calibrated for Nairobi and used to predict CO, NOx, SO_2 and $PM_{2.5}$. Thirteen roads were selected to represent the Nairobi road network and were defined in the Network data manager of the model. Attributes of road sections were extracted from the Kenya Urban Road Authority including the pavement geometry and vehicle fleet data. Calibration of the Engine Output involved adjustment of default emission coefficients of the specified pollutants. The modelled output emissions were compared with Edgar v3.4.2 (Crippa et al., 2018) and DICE-Africa (Marais and Wiedinmyer, 2016) emission inventories. High and Low traffic growth scenarios were generated by adding and subtracting 14% respectively from the normal traffic growth. Traffic congestion and fuel consumption attributed to traffic growth raised $PM_{2.5}$ and CO emission by approximately 11.5 and 2.2% respectively while NOx reduced by 0.22%. However, traffic reduction resulted in decreased $PM_{2.5}$ and CO by 1.33 and 0.1% respectively, while NO_x increased by 0.5%. Annual emissions of CO, NOx, SO2, and PM2.5 were then predicted at 60000, 5000, 2000, and 4000 tonnes, respectively.

Early Career Scientist

YES, I am an early career scientist.

ANGA-12C

How Has Sub-Saharan Africa's Air Quality and Climate Been Altered by Recent Land Use and Land Cover Change and Emissions Changes?

Dr. Timothy W Glotfelty[1], Diana Ramírez-Mejía[2], Dr. Jared Bowden[3], Dr. Adrian Ghilardi[2], Ashley Bittner[4], Dr. Andrew Grieshop[4], Dr. Robert Bailis[5], Dr. J. Jason West[1]
[1]University of North Carolina at Chapel Hill, Chapel Hill, NC, USA. [2]Universidad Nacional Autónoma de México, Morelia, Mexico. [3]North Carolina State University, Raliegh, NC, USA. [4]North Carolina State University, Raleigh, NC, USA. [5]Stockholm Environment Institute, Somerville, MA, USA

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Southern Hemisphere Working Group

Abstract

Land use and land cover change (LULCC) affects regional meteorology and therefore air quality, while emissions of air pollutants directly modify air quality and can also affect regional meteorology. Here we use the Weather Research and Forecasting model with Chemistry (WRF-Chem) to assess the climate and air quality impacts of anthropogenic LULCC and emissions change in Sub-Saharan Africa during the period 2001-2017. We conduct three WRF-Chem simulations spanning 2001-2017, including a baseline simulation in which LULC and emissions vary annually. The WRF-Chem baseline simulation is then compared against two sensitivity simulations, in which LULC and emissions are held constant at 2001 conditions, respectively. The difference between the first sensitivity and baseline simulations reveals the impacts of LULCC on the climate and air quality of Sub-Saharan Africa, while the difference between the second sensitivity and baseline simulations reveals the impacts of emission changes. Additionally, we conduct the same baseline and LULCC sensitivity experiments with the meteorology-only WRF model to assess the impacts of LULCC on Sub-Saharan Africa's regional climate independent of atmospheric chemistry feedbacks. LULCC is represented using simulated maps of LULC from the Dinamica EGO land use model, based on observed trends during the first half of the simulated period from the Moderate Resolution Spectroradiometer (MODIS) MCD12Q1 land cover product. To couple the effects of LULCC and air quality, leaf area index and soil erodibility are linked to MODIS LULC classes at the regional level to account for the impact of LULC on biogenic VOC and dust emissions in WRF-Chem. This study will be the first to link LULC to biogenic pollutant emissions in WRF-Chem and investigate both the impacts of LULCC and emission change with year to year variability. Additionally, This methodology provides a framework for investigation of future LULCC and emission changes under various scenarios.

Early Career Scientist

NO, I am not an early career scientist.

ANGA-13A

Atmospheric Particulate Matter and gases at high altitude: a case study at 4760 m on Mt. Kenya

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[1]University of Brescia, Brescia, Italy. [2]University of Nairobi, Nairobi, Kenya

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

One of the biggest challenges of the 21st century is climate change. It has also been linked to extreme global weather conditions including thinning of glaciers and snow cover. Among the causes of climate change is elevation in the amounts of atmospheric aerosols and greenhouse gases, mainly as a result of anthropogenic activities. In order to quantify and mitigate these effects, it is important to have adequate observational aerosol data, from which; formation, chemical composition, transformations and trends can be obtained. Studies reports receding glacier on Mt. Kenya (Njeri, 2018), Mt. Kilimanjaro (Thompson *et al.,* 2009) and Mt. Rwenzori (Taylor *et al.* 2006). Our study focused on fine particulate matter ($PM_{2.5}$), Black carbon (BC) and gaseous pollutants at an altitude of 4760 m above sea level. Real time measurements of BC, SO_2, NO_x, NH_3, NO_2, H_2S, TVOC, CO_2, CO, O_3 and $PM_{2.5}$ to PM_{10} particles counts were obtained using a BC monitor, gas monitor and a particle counter. The $PM_{2.5}$ was sampled using a cyclone sampler for gravimetric evaluation and elemental analysis using the Energy dispersive X-ray fluorescence spectrometer (EDXRF). Total reflection X-ray fluorescence spectrometer (TXRF) was used for elemental characterization of the water and glacier collected at the sampling site. $PM_{2.5}$ in this study was observed in the range 11.8 to 148 ng m^{-3} with elemental composition dominated by Ca and Fe at concentration ranges of 3.0 to 5.2 ng m^{-3} and 0.9 to 1.0 ng m^{-3} respectively. BC concentration ranged from 78 to 107 ng m^{-3}. Gases detected at very low concentrations were CO_2, H_2S, NO_2, TVOC and NO_x. It was evident that $PM_{2.5}$ with substantial amount of mineral dust was depositing on the glaciers. Mineral dust deposition on Mt. Kenya implied warming contribution and subsequently receding process of the Glaciers that has been witnessed over many decades.

Early Career Scientist

YES, I am an early career scientist.

ANGA-14B

Occupational exposure and spatial distribution of BTEX concentrations at Lanseria International Airport

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University of the Witwatersrand, Johannesburg, South Africa

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Airports are expanding globally due to the increased demand for economic development. However, air travel produces air contaminants that yield a range of human health effects. Of major concern are the air pollution impacts from hazardous air pollutants released from airport activities and/or related ground services. BTEX (benzene, toluene, ethylbenzene, and xylene) are one group of volatile organic compounds (VOCs) emitted from airports. BTEX compounds are of particular interest due to the environmental issues it manifests and the adverse health effects they give rise to when humans are exposed. Thus this study investigated the occupational exposure risk of the employees and the spatial distribution of the BTEX compounds at the Lanseria International Airport in Johannesburg, South Africa; using Radiello Passive Samplers. Iso-concentration maps using the kriging interpolation technique were also utilised; to identify the BTEX concentration hotspot areas within the vicinity of the airport, which were further used to conduct a health risk assessment (HRA) to evaluate the exposure risk of the employees to the BTEX compounds over their employment period. The findings of this research study revealed that the average BTEX concentration level for the winter campaign (57.87 $\mu g/m^3$) fell within the concentration levels range (4.46 $\mu g/m^3$ – 214 $\mu g/m^3$) of the winter sampling campaign for studies conducted globally. The average summer campaign results (i.e. 120.5 $\mu g/m^3$) were greater than the summer campaign BTEX concentration levels (5.17 $\mu g/m^3$ – 112 $\mu g/m^3$) for the globally conducted studies on urban areas and industrial areas (Zheng *et al.,* 2012; Alghamdi *et al*., 2014; Zabiegala *et al.,* 2010). The HRA indicated that employees have a potential risk of developing carcinogenic health effects, due to cancer risks that were greater than WHO and EPA standard acceptable limit. Based on the results the HRs calculations, employees present a negligible hazard risk of exposure to non-carcinogenic health effects.

Early Career Scientist

NO, I am not an early career scientist.

ANGA-15C

Air pollution in West African cities and some strategies for particulate pollutant emissions reduction.

Prof Veronique Yoboue[1], Sekou Keita[2], Julien Bahino[1], Sylvain Gnamien[1], Ange Brida[1], Cathy Liousse[3], Mohamed Diaby[1], Evelyne Toure[1], Madina Doumbia[2], Eric Gardrat[3]
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IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Air pollution in West Africa and Africa in general, is increasing associated with anthropogenic activities. Other the past three decades, we have put in place air pollution research strategies based on four axis which are (1) in-situ measurements of the atmospheric concentrations of particulate and gaseous pollutants as well as rainfall chemical composition and acidity; (2) emission inventories elaboration using new emission factors specific to the African context; (3) modeling of the chemical composition of the atmosphere and air quality forecasting and (4) assessing the impacts of air pollution on climate, health and ecosystems and, development of mitigation scenarios for these impacts in West Africa.

Through different research projects and collaborations, a database on gaseous and particulate air pollution at different time scales was made. A new emission inventories of particles and gas for Africa and more refined over West Africa have been developed, using new emission factor values from field measurements and new spatialization keys (population, roads, point sources). These inventories are therefore used to model the atmospheric pollutants concentrations and assessed their impacts in Africa.

These research strategies results show that urban areas and large agglomeration of West Africa and particularly Côte d'Ivoire have PM2.5 concentration levels well above the thresholds recommended by the WHO and even higher than those reported in large European cities. Moreover, these high concentrations are mainly located over domestic and heavy road traffic areas. This important air pollution which is expected to increase due to the combined effects of population growth and rapid urbanization in these regions, impact morbidity and mortality. Therefore, in such context of Africa, it is not only necessary to strengthen pollution regulation, but also important to develop and implement effective mitigation strategies that reduce population exposure to air pollutants and adopt changes in daily activities in West African mega-cities.

Early Career Scientist

NO, I am not an early career scientist.

ANGA-16A

THE AFRICA INTEGRATED ASSESSMENT OF AIR POLLUTION, CLIMATE CHANGE & SUSTAINABLE DEVELOPMENT IN AFRICA

Youba Sokana[1], Alice Kaudia[2], Brian Mntlana[2], Andriannah Mbandi[2], Philip Osano[2], Kevin Hicks[2], Valentin Foltescu[2], Anderson Kebhila[2], Eve Palmer[2], Cynthia Sitati[2]
[1]African Assessment. [2]

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

The Climate and Clean Air Coalition (CCAC) is developing an assessment on air pollution, climate change and sustainable development in Africa to identify priority measures that reduce emissions while maximizing the multiple-benefits for human wellbeings, health, ecosystems, climate, and food security. This scientifically led process is being conducted in partnership with the United Nations Environment Programme's (UNEP) Regional Office for Africa (ROA), the African Union Commission (AUC) and the Stockholm Environment Institute (SEI). It brings together academics, experts, and practitioners working across Africa to address the growing air pollution and associated climate threats while promoting capacity mobilisation and building, and action to reduce air pollution and climate change. The analysis being undertaken is framed around 'development pathways for Africa and their air quality and climate consequences' to determine how Africa can meets its development aspirations and priorities as articulated in the African Agenda 2063 and considering SDGs while reducing emissions that drive climate change and air pollution. The assessment is particularly significant to Africa where emissions of short-lived climate pollutants (SLCPs) such as black carbon and methane are very high due to current overdependence on wood fuel for cooking which leads to emission of black carbon, and open dumping of waste which is major source of methane (a major precursor of tropospheric ozone). The assessment will deliver a tailored package of responses for climate and clean air for Africa that link meaningfully to the Sustainable Development Goals (SDGs) and the Nationally Determined Contributions (NDC) under the Paris agreement, as well as the Agenda 2063 for Africa. The paper will outline how the Africa Assessment process has been actively linking to the African Group on Atmospheric Sciences (ANGA) and highlight the capacity building and consultation processes to develop the modelling and scenarios and present the emerging results.

Early Career Scientist

NO, I am not an early career scientist.

AMERICAS-1A

Amazonian biogenic volatile organic compounds under global change

Dr. Ana M Yañez-Serrano[1,2], Dr. Efstratios Bourtsoukidis[3], Dr. Eliane Alves[4], Dr. Maite Bauwens[5], Dr. Trissevgeni Stavrakou[5], Dr. Joan Llusia[2], Dr. Iolanda Filella[2], Dr. Alex Guenther[6], Dr. Jonathan Williams[3], Dr. Paulo Artaxo[7], Dr. Katerina Sindelarova[8], Jana Doubalova[8], Dr. Juergen Kesselmeier[3], Dr. Josep Peñuelas[2]
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IGAC Activities

GEIA: Global Emissions Initiative, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group

Abstract

Biogenic volatile organic compounds (BVOCs) play important roles at cellular, foliar, ecosystem and atmospheric levels. The Amazonian rainforest represents one of the major global sources of BVOCs, so its study is essential for understanding BVOC dynamics. It also provides insights into the role of such large and biodiverse forest ecosystem in regional and global atmospheric chemistry and climate. We review the current information on Amazonian BVOCs and identify future research priorities ex- ploring biogenic emissions and drivers, ecological interactions, atmospheric impacts, depositional processes and modifications to BVOC dynamics due to changes in cli- mate and land cover. A feedback loop between Amazonian BVOCs and the trends of climate and land-use changes in Amazonia is then constructed. Satellite observa- tions and model simulation time series demonstrate the validity of the proposed loop showing a combined effect of climate change and deforestation on BVOC emission in Amazonia. A decreasing trend of isoprene during the wet season, most likely due to forest biomass loss, and an increasing trend of the sesquiterpene to isoprene ratio during the dry season suggest increasing temperature stress-induced emissions due to climate change.

Early Career Scientist

NO, I am not an early career scientist.

AMERICAS-2B

Air pollution measurements in Coyhaique, Patagonia

Dr Zoe L Fleming[1,2], Luis Gomez[3,4], Manuela López Arancibia[5], Claudio Herranz[3], Camilo Rodríguez Beltrán[1], Pablo Ortiz Baez[1], Nicolás Fierro Viedma[1], Andres Velez Pereira[3]
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Abstract

Coyhaique is frequently quoted as being in the top 10 most polluted towns in South America. The air pollution in winter is particularly visible as strong temperature inversions form and the surrounding mountains trap the smoke from domestic wood-burning. The city has installed two monitoring stations in the centre of the town but with its varied topography and the poorer neighbourhoods situated on the hillsides, there are large differences in air pollution across the town. The community is very aware of this issue and the local council is very active in measures that attempt to tackle this issue.

A month long measurement campaign was carried out in July 2019, involving mobile monitoring of Particulate Matter and Black Carbon, ground-based measurements and measurements of the Boundary Layer profile and local winds. We used several members of the local community to carry out walking experiments with Particulate Matter sensors, producing maps that display the strong spatio-temporal variability in Coyhaique. These were combined with data from the monitoring stations, meteorological instrumentation and complemented by air quality modelling studies and compared to their air quality event forecasting models.

Early Career Scientist

NO, I am not an early career scientist.

AMERICAS-3C

Assessing population exposure to air pollution in Metropolitan Lima and Callao, Peru: Creating a high-resolution spatial emissions inventory with limited data, supported by air quality monitoring

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group

Abstract

Some parts of the Metropolitan area of Lima-Callao, Peru are experiencing poor or very poor air quality and this is likely to have negative health impacts. The population of the Lima-Callao area is 10 million, and so population weighted exposure to pollution is significant. In 2017, atmospheric concentrations of particulate matter exceeded the WHO Guidelines by more than a factor of 3 or 4 at many monitoring locations in the city.

This complex study has built a high-resolution spatial emissions inventory for eighteen pollutants including NOx and PM, which has subsequently been utilised to model air pollutant concentrations across the metropolitan area. The study included a complex urban environment located between the South Pacific Ocean and the Andes mountain range, and included many sources from all sectors including aviation and shipping. The contribution of emissions to the urban pollution climate from background sources such as the marine aerosol and agricultural activities was also assessed.

A major challenge has been creating an inventory with limited activity data, in some cases associated with high uncertainties. The Ricardo team have worked with local partner, Deuman, to identify and process 5000 pieces of activity data. Emission factors appropriate to the technology used have been taken from EMEP/EEA and US EPA. Internationally accepted EMEP/EEA methodologies have been used to generate estimates of emissions. The Ricardo team have used quality control procedures employed in the UK NAEI to maximise the quality of the Lima and Callao air emissions inventory and have “gap filled” data to create complete sets of activity data. Local continuous monitoring data has been used to calibrate the air emissions inventory and the estimated atmospheric concentrations.

Using this inventory, the important sources of air emissions in Lima-Callao can now be identified, helping to target mitigation actions and minimise population exposure.

Early Career Scientist

NO, I am not an early career scientist.

AMERICAS-4A

Ammonia temporal variability from urban ground-based FTIR measurements

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group

Abstract

The most abundant alkaline compound in the atmosphere is ammonia (NH_3). NH_3 neutralizes acids and contributes to formation of aerosols and particulate matter, with potential consequences to the environment, human health, and radiative forcing. NH_3 is primarily emitted by agricultural sources; however, it is also present in urban environments. NH_3 has a short lifetime on the order of hours to a few days. NH_3 emissions and depositions depend strongly on environmental conditions; temperature and moisture play a crucial role in determining NH_3 concentrations on diurnal to annual scales. Several studies have used satellite measurements to assess the global variability of NH_3; however, the interannual variability does not reveal clear trends and is not possible to determine the diurnal variability as a consequence of the limited satellite observations per day.

This work investigates the seasonal and diurnal variability of NH_3 over urban areas using solar absorption ground-based measurements from Fourier transform infrared (FTIR) spectrometers located at seven cities. Six sites are part of the Network for Detection of Atmospheric Composition Change (NDACC): Boulder, Bremen, St. Petersburg, Toronto, Tsukuba, and Wollongong. The seventh site is Mexico City, which is not part of NDACC due to the low spectral resolution of the instrument; however, these measurements provide information about the megacity of Mexico City, which is the largest metropolitan area in North America with a high population density and major pollution episodes.

Early Career Scientist

YES, I am an early career scientist.

AMERICAS-5B

Air-borne measurements of CH2O, C2H2O2, and C3H4O2* and CO over the Amazon and their biomass burning emission ratios and emission factors in biomass burning plumes

Flora Kluge[1], Tilman Hüneke[1], Matthias Knecht[1], Simon Rosanka[2], Meike Rotermund[1], Hans Schlager[3], Ben Schreiner[1], Domenico Taraborrelli[2], Klaus Pfeilsticker[1]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

We report on simultaneous air-borne measurements of CO, CH2O, C2H2O2, and C3H4O2* (i) taken over the Amazon from aboard the HALO (High Altitude and LOng range) aircraft during the ACRIDICON-CHUVA field campaign in September 2014. In-situ CO was measured using the AMTEX instrument, and CH2O, C2H2O2, and C3H4O2* were inferred from the limb observations of the mini-DOAS (Differential optical absorption Spectroscopy) instrument.

The measurements allow us to distinguish between background tropical air, where the concentrations of the measured species are primarily due to the oxidation of biogenically emitted VOCs (mostly isoprene), and moderately to strongly polluted air masses affected by directly emitted or secondarily formed CH2O, C2H2O2, and C3H4O2*, and CO directly emitted by biomass burning and urban emissions, and/or formed in their plumes. From collocated visual imagery and the measurements performed near the ground, biomass burning plumes are identified and the normalized excess mixing ratio (NEMR) for C2H2O2, and C3H4O2* with respect to CH2O as well as the respective emission factors are inferred, and compared with previous studies.

We present the first simultaneous measurements of these bicarbonyls over prominent, though mostly natural source regions of VOCs, and the relative contributions from local as well as regional pollution sources. The findings are extended to other atmospheric regimes based on additional measurements of the targeted species over continental Europe (EMeRGe-EU in 2017), southeast Asia (EMeRGe-Asia in 2018), the west African coast (CAFE in 2018), as well as the southern Atlantic (SOUTHTRAC in 2019), and compared with respective simulations of the ECHAM/MESSy Atmospheric Chemistry (EMAC) model, thus enabling the characterization of different carbonyl sources and sinks as well as a more detailed insight into the photochemistry of the target species.

(i) Here, C3H4O2* denotes C3H4O2 (methylglyoxal) and other substituted bicarbonyls with visible absorption structures similar to that of C3H4O2.

Early Career Scientist

YES, I am an early career scientist.

AMERICAS-6C

MODELING AND ASSIMILATION OF ATMOSPHERIC AEROSOLS OVER SÃO PAULO - BRAZIL WITH THE REGIONAL CHEMISTRY TRANSPORT EURAD-INVERSE MODEL ON HIGH-RESOLUTION

Dr. Ediclê de Souza Fernandes Duarte[1], Dr Philipp Franke[2,3], Dr. Anne Caroline Lange[2,3], Dr. Fábio Juliano da Silva Lopes[4], Dr. Elmar Friese[2], Dr Cláudio Moises Santos e Silva[1], Dr. Hendrik Elbern[3], Dr. Judith Johanna Hoelzemann[1], MSc Jean Reis[1]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

A high-resolution air quality study over the Metropolitan Area of São Paulo (MASP), Brazil is presented using the EURopean Air Pollution Dispersion - Inverse Model (EURAD-IM). In these first case studies modeled data are evaluated with observational in-situ data from 24 surface stations. The two presented case studies, focusing on July 10-13 and October 22-25, 2016, show how different meteorological conditions affect the transport of pollution plumes over the MASP originating from (i) central South America, (ii) from the interior of the state of São Paulo (SP), (iii) the metropolitan region of Rio de Janeiro (RMRJ). Three simulations were carried out, the first using the emissions inventory of EDGAR v4.3.2, the second replacing the category of land transport emissions with data from the Vehicle Emissions Model (VEIN) with high spatial resolution and the third using the three-dimensional variational data assimilation technique (3D-VAR) for PM2.5. The performance of the model varied within the standard deviations of the observations and elucidated the role of long-range transport of particulate matter from central South America and local transport within SP, affecting the air quality at MASP. For the period from July, the results of PM10 and PM2.5 in the simulations without assimilation for the domain with 1 km x 1 km resolution underestimated the observations, and the bias varied between 8 - 41%. For MASP center, EURAD-IM performed better using VEIN emissions. The second case study in October revealed that air pollution plumes from the MASP and MARJ interact with each other, through two possible routes: via the Vale do Paraíba or via the ocean between the coast of Rio de Janeiro and São Paulo. EURAD-IM 3D-Var scheme was adapted and used in the MASP for first time. The assimilation significantly reduced errors, which improved the subsequent performance of PM2.5 during July 10- 13.

Early Career Scientist

YES, I am an early career scientist.

AMERICAS-7A

An atmospheric perspective on Amazon fire emissions

Maarten Krol[1,2], Stijn Naus[1,3], Lucas G Domingues[4,5], Ingrid T Luijxk[1], Luciana V Gatti[5,6], John B Miller[7], Emanuel Gloor[8], Sourish Basu[9], Caio Correia[5,6], Gerbrand Koren[1], Helen M Worden[10], Johannes Flemming[11], Gabrielle Pétron[12], Wouter Peters[1,13]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Despite consensus on the overall downward trend in Amazon forest loss since the previous decade, data from local logging activity and remotely sensed biomass, fire, and burned-area changes still vary widely in their estimated yearly carbon emissions from deforestation. Here, we use sixteen years of satellite-derived carbon monoxide (CO) columns to constrain fire CO emissions from the Amazon basin between 2003 and 2018. Through data assimilation, we produce 3-daily maps of fire CO emissions over the Amazon that we verified to be consistent with a long-term monitoring program of aircraft CO profiles over five sites in the Amazon.Our new product independently confirms a long-term decrease of 54% in deforestation-related CO emissions over the study period. Interannual variability is large, with known anomalously dry years showing a more than fourfold increase in basin-wide fire emissions. At the level of individual Brazilian states, we find that both soil moisture anomalies and human ignitions determine fire activity, suggesting that future carbon release from fires depends on drought intensity as much as on continued forest protection. Our study shows that the atmospheric perspective on deforestation has become a valuable additional monitoring instrument that complements existing methods. Extension of such a perspective to an operational framework is timely considering the increased fire intensity in 2019–20.

Early Career Scientist

NO, I am not an early career scientist.

AMERICAS-8B

Changes in Mortality in Response to Decreases in Ozone and PM2.5 Concentrations Across the United States from 1990 to 2019

Revathi Muralidharan[1], Omar Nawaz[2], Yuqiang Zhang[1], Daniel Tong[3], Aaron van Donkelaar[4], Randall Martin[5], Marc L Serre[1], J J West[1]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

Americas Working Group

Abstract

O_3 and $PM_{2.5}$ concentrations have decreased significantly since 1990 in the United States due to the success of air quality regulations such as the 1990 Clean Air Act Amendments. It is estimated that between 1990 and 2019 maximum daily 8 hour average (MDA8) O_3 decreased by 25%, and from 2000 to 2019 annual average $PM_{2.5}$ concentrations decreased by 43%. This decrease in O_3 and $PM_{2.5}$ is expected to have caused a corresponding decrease in mortality. In order to assess the health impacts of decreasing air pollutant concentrations across the United States, mortality attributable to O_3 and $PM_{2.5}$ in the continental United States is assessed each year from 1990 to 2019 using multiple concentration datasets for comparison. We create a 28-year dataset by performing Bayesian Maximum Entropy kriging on observations (1990-2017). We also use a long-term simulation (1990-2010) from a regional air quality model (CMAQ), as well as CMAQ simulations from the North American Chemical Reanalysis project (2009-2019), and a satellite-derived $PM_{2.5}$ dataset (1999-2018). We also use annual county-level mortality statistics from the US Centers for Disease Control and Prevention, and separate the trends caused by the change in concentrations vs. the changes in population and baseline mortality rates. In using multiple concentration datasets, we aim to investigate whether trends in mortality are consistent across different concentration datasets and to account better for uncertainty. We hypothesize that the different datasets will show similar decreases in premature mortality.

Early Career Scientist

YES, I am an early career scientist.

AMERICAS-9C

Ozone trends at Tololo (30.17° S, 70.80° W, 2154 m a.s.l.) GAW monitoring station in Chile: an update and attribution study.

Prof Laura Gallardo[1,2], Camilo Menares[1,2], Dr Carmen Vega[3], Claudia Villarroel[3], Dr Nikos Daskalakis[4], Prof Maria Kanakidou[5,6], Charlie Opazo[1,2], Dr. Rodrigo Seguel[1,2]
[1]Center for Climate and Resilience Research, Santiago, Chile. [2]DEpartamento de Geofísica, Universidad de Chile, Santiago, Chile. [3]Dirección Meteorológica de Chile, Dirección General de Aeronáutica Civil, Santiago, Chile. [4]4. Institute of Environmental Physics, University of Bremen, Bremen, Germany. [5]Institute of Environmental Physics, University of Bremen, Bremen, Germany. [6]5. Environmental Chemical Processes Laboratory, Chemistry Department, University of Crete, Heraklion, Greece

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

The Chilean Meteorological Service (In Spanish Dirección Meteorológica de Chile, DMC), under the auspices of the Global Atmospheric Watch Programme (GAW), has maintained the Tololo station (30.17° S, 70.80° W, 2154 m a.s.l.) in the premises of the Interamerican Southern Astronomical Observatory since late 1995. The site is located about 50 km east of the Chilean coast at 30°S, where the fast-growing conurbation of La Serena- Coquimbo is located. This conurbation has grown by ca. 20% over the period of observation, reaching today roughly 485 k inhabitants. Smaller towns are situated nearby: Vicuña (20 km NE), Paihuano (30 km NE), Andacollo (30 km SW), show population increases of 7 to 17%, reaching today ca. 44 k inhabitants, while Ovalle (60 km SW), has grown in 26% hosting today ca. 758 people. Along the Elqui-Valley, with a roughly E-W direction ca. 15 km N of Tololo shows a distinctive agricultural activity. The site is impacted by the surrounding area but also by long-range transport of pollution potentially including the influence of Santiago megacity, located ca. 500 km south of the Tololo site. Previous trend estimates considered the period 1995-2016. This analysis is here extended until 2020 and various signal decomposition and trend analysis methods are applied and discussed to provide a robust estimate. By comparing different periods, we find an accelerated rate of change in ozone at Tololo in recent years. The effects of changes in meteorology, local emission of ozone precursors, long-range transport and other drivers of ozone trends are disentangled. For this, the observations are statistically analyzed, using deep learning techniques together with emission estimates, trajectory analysis of air masses originating from Santiago, and results of a long interannual simulation performed with a global chemistry transport model.

Early Career Scientist

NO, I am not an early career scientist.

AMERICAS-10A

ASSESSMENT OF TOAR OZONE METRICS DISTRIBUTIONS OVER LATIN AMERICAN CITIES

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

Americas Working Group

Abstract

Tropospheric ozone is considered an important detrimental gas that can affect human health, ecosystem processes, and climate. To evaluate the pollution in a specific region, numerical metrics by averaging or aggregating ozone data on different time scales are estimated. The present study focuses on evaluating ozone metrics over Latin America with data from the TOAR platform, relationships with local and regional conditions are analyzed. Stations were selected according to available information since 2000, being the continuity on data and representativeness, the selection parameters. Nineteen stations were evaluated in function of ozone levels, station type, altitude (ranging from 133 m.a.s.l in San Lorenzo – Paraguay to 2651 in Bogota – Colombia), population density, and weather conditions. The ozone metrics included the daily MDA8, SOMO10, and W90 to assess the human health effects as well as the AOT40 and W126 metrics for ecosystem effects. The preliminary analysis revealed a direct correlation between metrics on South American cities (such as Colombian and Brazilian cities) and monthly patterns, which present the highest ozone values around March and September. Meanwhile, countries such as Mexico has a maximum during the beginning of summertime (April). Daily patterns in all data showed an increment of at least 12% during weekend days compared to weekdays. An accumulation of precursor during the weekdays that shifts the chemical atmosphere balance towards a higher generation of ozone can be suggested as an explanation for the patterns, this was more evident in the traffic stations (18% of increment). By altitude, the highest values were observed between 2000 to 2500 m.a.s.l in Mexico traffic stations and Chile urban background stations. In general, this historical and current ozone assessment becomes a necessity to improve the management plans which are aimed at mitigating and protecting the population from the harmful effects in the short and long terms

Early Career Scientist

YES, I am an early career scientist.

AMERICAS-11B

Assessing brown carbon light absorption from aerosol optical properties in Mexico City

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

The abundance of brown carbon (BrC) in Mexico City was assessed through aerosol optical properties and chemical speciation of particles < 1 µm in size (PM_1). A multiwavelength Aethalometer and an Aerosol Chemical Speciation Monitor (ACSM) were run together for a six-month period (Dec. 2018 - May 2019), covering the dry- cold and warm seasons of the city. The latter was affected by regional wildfires, whose plumes blanketed the city's sky at times. Absorption coefficients at 370 nm (geometric mean, percentiles 25^{th} - 75^{th}) of 21.2, 12.8 – 35.3, and 6.9, 4.1 – 11.3 Mm^{-1} were observed for black carbon (BC) and BrC, respectively, which means that BrC increased 36% the light absorption over that attributed to BC. In presence of biomass burning plumes, this increase went up to 43%. The loads of non-refractory (NR) aerosols and equivalent black carbon covered 86% and 11% of the PM_1 budget. Organic aerosols dominated the load of NR-PM_1(62%), sulfate, nitrate and ammonium were also important contributors (15%, 12% and 10%, respectively). Among the organic fraction, aged aerosols (i.e., more oxidized oxygenated organic aerosols, MO-OOA) were the largest contributor (49%) on regular days but had a negligible effect on light absorption. Fresh organic aerosols associated with traffic emissions (i.e., hydrocarbon-like aerosols, HOA, and less oxidized oxygenated organic aerosol, LO-OOA) were less important contributors individually to the total burden of organic aerosols (21% and 15%, respectively), but together dominated the light absorption by up to 75%. However, during wildfire smoke episodes, biomass burning aerosols (BBOA) had an influence of 55%. Thus, we concluded that light absorption in Mexico City responds to aerosols originated from vehicular traffic and regional wildfire emissions.

Early Career Scientist

NO, I am not an early career scientist.

AMERICAS-12C

Hourly variation of polycyclic aromatic hydrocarbons in a receptor site in Mexico City during the cold dry season

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Polycyclic Aromatic Hydrocarbons (PAHs) are mutagenic and carcinogenic for humans (IARC 2012). They are generated by the incomplete burning of fossil and non-fossil fuels. In this study, PAHs were determined for the first time in particles ≤2.5 µm ($PM_{2.5}$) with hourly resolution in Mexico. A thermal desorption Aerosol coupled to a Gas Chromatograph - Mass Spectrometer (TAG-GC-MS) (William *et al.* 2006) was used. The measurements were carried out from November 5 to December 14, 2018 (cold dry season) at southwest of Mexico City, considered as pollutant receptor site.

Thirty out of 33 PAHs analyzed were found. The medians of the total PAH concentration ranged between 24 and 18,843 pg m^{-3}. The most abundant PAHs were benzo[*ghi*]perylene (238 pg m^{-3}), benzo[*b*]fluoranthene (160 pg m^{-3}), indeno[*1,2,3-cd*]pyrene (156 pg m^{-3}) and benzo[*a*]pyrene (BaP) (152 pg m^{-3}) (Amador-Muñoz *et al.* 2020). The hourly variation of carcinogenic PAHs presented two maximums, one in the morning (7:00-8:00 h) and another at night (21:00 - 22:00 h). Distribution that coincides with the hourly behavior of CO and NOx, related to vehicular flow. Unlike the rest of PAH, retene (PAH marker of biomass burning) showed higher abundance in the night period probably coming from the surroundings of the sampling site (cooking of food and heating of homes), or by homogeneously mixed air parcels originated from other states in the south of the country.

BaP considered as human carcinogenic (IARC, 2012) was <1 ng m^{-3} established by European Directive but greater to 0.12 ng m^{-3} estimated by the WHO. More effort is needed to control their emissions.

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Amador-Muñoz *et al.* (2020). http://www.aire.cdmx.gob.mx/; IARC (2012). v. 100 F; William *et al.* (2006), *Aerosol Sci. & Technol*, 40, 627.

Early Career Scientist

NO, I am not an early career scientist.

BB-1A

Evolution of organic aerosol from wood smoke influenced by burning phase and solar radiation

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

China Working Group

Abstract

Emissions of carbonaceous aerosols (black carbon BC, and organic aerosol OA) from biomass burning have important climate and human health impacts. Not only the primary emissions are complicated by combustion phases, but also the evolution after emission is not well understood. In this study, single plumes from residential wood burning, extracted from either flaming or smoldering phase, were injected into our novel chamber, to investigate their evolution in real atmospheric conditions with or without solar radiation. Initial compositions of flaming or smoldering plumes were dominated by BC or OA respectively, with higher NO_x emission in flaming. Replicable results showed that in light, smoldering plumes had faster secondary OA (SOA) formation than flaming, due to the higher emissions of volatile organic compounds in smoldering. Furanic and carboxylic acid compounds were found to be the main gaseous precursors and products, respectively. Evaporation and photooxidation concurrently caused increased oxidation in the beginning, but at later stage of evolution, SOA evolution showed remarkable divergence: enhanced oxidation for smoldering but decreased for flaming plumes, leading to a higher oxygen-to-carbon ratio for smoldering than flaming up to 0.25. We found the higher NO_x emission in flaming promoted the gaseous fragmentation reactions, while the seeding particles dominated by OA in smoldering may cause these contrasting tendencies of OA oxidation between combustion phases. Distinct particulate/gas emissions and resultant evolutions in producing SOA at different combustion phases should be therefore considered in evaluating the impacts of biomass burning emissions.

Early Career Scientist

NO, I am not an early career scientist.

BB-2B

Uncertainty in fire emission factors and the impact on modeled atmospheric CO and O_3

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, TOAR: Tropospheric Ozone Assessment Report

Abstract

Fire emissions are an important component of global models, which help to understand the influence of sources, transport and chemistry on atmospheric composition. Global fire emission inventories can vary substantially due to the assumptions made in the emission creation process, including the defined vegetation type, fire detection, fuel loading, fraction of vegetation burned and emissions factors. Here, we focus on the uncertainty in emission factors and the resulting impact on modeled composition.

Our study uses the Community Atmosphere Model with chemistry (CAM-chem) to model atmospheric composition for 2014, a year chosen for the relatively quiet El Niño Southern Oscillation activity. We focus on carbon monoxide (CO), a trace gas emitted from incomplete combustion and also produced from secondary oxidation of volatile organic compounds (VOCs). Fire is a major source of atmospheric CO and VOCs. Modeled CO from four fire emission inventories (CMIP6/GFED4s, QFED2.5, GFAS1.2 and FINN1.5) are compared after being implemented in CAM-chem. Multiple sensitivity tests are performed based on CO and VOC emission factor uncertainties. We compare model output in the 14 basis regions defined by the Global Fire Emissions Database (GFED) team and evaluate against CO observations from the Measurements of Pollution in the Troposphere (MOPITT) satellite-based instrument. For some regions, emission factor uncertainty spans the results found by using different inventories. Finally, we use modeled ozone (O_3) to briefly investigate how emission factor uncertainty influences the atmospheric oxidative environment. Overall, accounting for emission factor uncertainty when modeling atmospheric chemistry can lend a range of uncertainty to simulated results.

Early Career Scientist

NO, I am not an early career scientist.

BB-4A

Employing the model to reproduce aerosol transport characteristics over Southeast Asia: comparison of different biomass burning emission inventories

Mr Shuo Wang, Mr Jason Blake Cohen
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

China Working Group, Americas Working Group, MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The focus of this work is to quantify the transportation path of aerosols. During the dry season (January-April) in northern Southeast Asia, a large amount of aerosol is released into the atmosphere. A large number of studies have proved that these aerosols moved eastward during the Indian Ocean monsoon, but due to thousands of kilometers of clouds, a large number of combustions did not detect satellites, so the actual aerosol model transported was much higher than expected.

This work uses a new approach to enhance the model's ability to reproduce the spatiotemporal distribution of total aerosol emissions over the 2016 extreme fire burning season monsoon Asia (Thailand, Myanmar, Laos). The description of aerosol distribution is one of the weaker aspects of atmospheric science. In this way, we can more accurately predict aerosol column emissions and understand the physical mechanisms of aerosols, in-depth understanding of the aerosols' movement and formation. Through sensitivity analysis, a new perspective is provided to reduce the uncertainty (dynamic mechanism, multiple data coupling, etc.) of model aerosol modeling capabilities.

We find that ground and column observations throughout Southeast and East Asia are most consistent with our model results using the new blended emissions. The results show that first, a significant amount of the smoke is lofted into the lower free Troposphere and subsequently transported thousands of kilometers downwind. Second, a significant increase in biomass burning emissions were observed when using remotely sensed measurements, leading to a new approximation several times the current inventory. Finally, compared with existing inventories, the use of these multiple techniques leads to a better spatial and temporal match with measured peak aerosol events.

Early Career Scientist

YES, I am an early career scientist.

BB-5B

The impact of biomass burning emissions on Protected Natural Areas in central and southern Mexico

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Biomass burning from agricultural practices results in large amounts of gases and particles emitted into the atmosphere, which affect air quality, population health, crop development and vegetation. Regional atmospheric circulations can transport plumes of pollutants over hundreds and even thousands of kilometers, affecting particularly vulnerable environments such as Protected Natural Areas (PNA). In this study we evaluate the spatio-temporal distribution of fires detected in central and southern Mexico from MODIS and VIIRS data between March-June 2017, in order to estimate the impact of the plume of smoke on vegetation in PNA. The region selected is located in tropical Mexico, characterized by a wet season (May-Oct) and dry season (Nov-April) when most of the fires are observed. The largest number of fires were detected in April both in Central Mexico and the Yucatan Peninsula. In the latter, more than a factor of 3 fires were observed but they were more widely spatially distributed than in Central Mexico. However, they were much closer to a number of PNA. Emissions were evaluated by two methods based on fire characteristics in a regularly-spaced grid and determined emission factors for both gases and particles. Estimated forward trajectories from point sources in April indicate that PNA in both regions were affected. Moreover, plumes from some of the fires observed in the Yucatan peninsula probably affected regions of the southern United States during the fire season of 2017.

Early Career Scientist

YES, I am an early career scientist.

BB-6C

Effects of fire diurnal variation on U.S. air quality during FIREX-AQ based on the Multi-Scale Infrastructure for Chemistry and Aerosols (MUSICA-V0)

Wenfu Tang
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IGAC Activities

CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Fires and associated emissions of trace gases and aerosols usually have strong diurnal cycles, which affect fire impacts on atmospheric composition and air quality. We evaluate the improvement of the Multi-Scale Infrastructure for Chemistry and Aerosols Version 0 (MUSICA-V0) simulations with the inclusion of diurnal cycle of fire emissions (DCFE) against observations during the Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) field campaign. Model comparisons with the DC-8 aircraft measurements show that applying DCFE improves model agreement with airborne CO observations in plumes during FIREX-AQ (reduces root-mean-square error; RMSE by ~21–43 ppb), and such effect is larger than the difference caused by using different emission inventories (difference in RMSE is 12 ppb). Model comparisons with EPA Air Quality System (AQS) surface PM2.5 show that the simulations with DCFE (mean bias of ~-0.5–-0.9 mg/m3) agree better with observations compared to the two simulations without DCFE but uses different emission inventories (mean bias of ~-2.5–-3.0 mg/m3) over the northwestern U.S. during FIREX-AQ. Model comparisons with TROPOMI CO and tropospheric NO_2 show that applying DCFE over the CONUS increases modeled CO column and Tropospheric NO_2 column over the Pacific Northwest by ~10% during FIREX-AQ. To understand the aforementioned model improvements, we analyze the interactions of DCFE with meteorology/transport and atmospheric chemistry using the 2019 Williams Flats Fire as a case study. Trace gases and aerosols emitted during different times of a day are subject to different meteorology and atmospheric chemistry because meteorology and atmospheric chemistry also have strong diurnal variations. Overall, including DCFE improves MUSICA-V0 simulations of fire impacts on atmospheric composition and air quality. Therefore, we suggest that DCFE should be considered in atmospheric chemistry models, especially when studying the impacts of fires on local and regional air quality, and airborne-model comparisons over fire-impacted regions.

Early Career Scientist

YES, I am an early career scientist.

BB-7A

Characterizing the Physical and Chemical Evolution of Organic Aerosol in Biomass Burning Smoke using Gas- and Particle-phase Molecular Tracers from Laboratory and FIREX-AQ Observations

Miss Melinda Schueneman[1,2], Douglas Day[1,2], Demetrios Pagonis[1,2], Seonsik Yun[1,2], Olivia Jenks[1,2], Pedro Campuzano-Jost[1,2], Hongyu Guo[1,2], Benjamin Nault[3,1,2], Wyatt Brown[1,2], Julia Lee-Taylor[1,2,4], Joost de Gouw[1,2], Jose Jimenez[1,2]
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Abstract

Fire plumes introduce large amounts of diverse gas- and particle-phase species into the atmosphere, which have been shown to negatively impact human health and the environment. This diversity makes characterizing fire impacts challenging. The abundant emissions of volatile organic compounds (VOCs), particles, and NOx suggest that substantial organic aerosol (OA) formation should occur downwind of fires. However, typically no enhancement of total OA is observed in most cases. One explanation that we are exploring is that primary OA (POA) evaporation is balanced by the condensation of less-volatile oxidized VOCs from VOC precursors onto existing aerosols (forming SOA). During the NASA/NOAA FIREX-AQ mission, for the first time, an Extractive Electrospray Soft Ionization Time-of-Flight Mass Spectrometer (EESI) was used to perform an extensive study of the OA composition in fire plumes. While the identity of some key molecules is clear based on previous literature and other evidence, most of the hundreds of OA species detected in the fire plume are not identified. These species hold essential information needed to understand the overall chemical evolution of OA. A suite of laboratory chamber experiments using the EESI and Vocus-PTR-ToF were conducted, targeting known and suspected biomass burning SOA precursors (e.g., phenol, catechol, and styrene). Catechol, nitrophenol, nitrocatechol, 5-nitro-1,2,3-benzenetriol, dinitrocatechol, and two ring-opened products were identified in the particle phase. Many of those species were also identified in the gas phase with the Vocus PTR-ToF-MS. A box model was constructed to represent these experiments, along with selected wildfire plumes from FIREX-AQ, to aid us in interpreting and chemically quantifying the evolution of aerosols in biomass burning plumes. Both the chamber and field models match measured nitrocatechol well. Chemical budgets were created using direct measurements from the field and chamber studies.

Early Career Scientist

YES, I am an early career scientist.

BB-8B

Global Wildfire Plume-Rise Data Set and Parameterizations for Climate Model Applications

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CATCH: the Cryosphere and Atmospheric Chemistry, GEIA: Global Emissions Initiative, CCMi: Chemistry Climate Model Initiative, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Americas Working Group

Abstract

The fire plume height (smoke injection height) is an important parameter for calculating the transport and lifetime of smoke-induced pollutants, which can significantly affect regional and global air quality and atmospheric radiation budget. An observation-based global fire plume-rise dataset has been developed by using a modified one-dimensional plume-rise model with observation-based fire size and Maximum Fire Radiative Power (MFRP) data. By comparing to the Multiangle Imaging SpectroRadiometer (MISR) plume height measurements, the resulting dataset captured the observed plume height distribution well. The fraction of fire plumes penetrating above the boundary layer is relatively low at 20% at the time of MISR observation (10:30 am LT) but increases to an average of ∼55% in the late afternoon, implying that the MISR observation data sampled in the late morning underestimate the average daytime fire plume heights and plume mixing potential into the free troposphere. Therefore, adjustments are required through dynamic modeling or parameterization of fire plume height as a function of meteorological and fire conditions when the MISR data set is applied in climate model simulations. We conducted sensitivity simulations using the Community Atmospheric Models version 5 (CAM5). Model results show that the incorporation of fire plume rise in the model tends to significantly increase fire aerosol impacted regions.

Early Career Scientist

YES, I am an early career scientist.

BB-9C

Persistent Influence of Biomass Burning Aerosols during Clean Air Conditions in the Western United States

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Abstract

Wildfires are an important source of aerosols that directly influence air quality, human health, and climate, however their impacts on the remote troposphere remain poorly understood. In this study, we deployed a high-resolution time-of-flight soot particle aerosol mass spectrometer (SP-AMS) coupled with a thermodenuder (TD) at the Mt. Bachelor Observatory (MBO) in central Oregon to characterize the chemical composition and properties of wildfire-influenced aerosols during the summer of 2019 (Aug. 1 – Sept. 8). MBO is a high altitude site (~2800m a.s.l.) which has been used previously to examine long-range transport and biomass burning plumes. During the sampling period, relatively low submicron aerosol concentrations (PM_1) were seen (2.2±1.9 μg sm^{-3}) compared to previous years. Through positive matrix factorization analysis, an oxidized BB organic aerosol (BBOA; atomic oxygen-to-carbon ratio of 0.84) was found to comprise 18% of OA mass on average, and above 50% during mild plume events during which peak aerosol concentrations reached 18.0 μg sm^{-3}. This BBOA factor showed a low volatility and a strong correlation with BC and furfural. Five BB plumes were further analyzed with transport times estimated to vary from ~10 hours to >10 days. The plumes showed ΔOA/ΔCO values ranging from 0.064-0.116 μg sm^{-3} ppb^{-1}, indicating significant BBOA loss relative to CO during transport**.** Additionally, the more aged plumes showed lower volatility, and an increase in the peak of mass-based size distribution from 400nm to 700nm, suggesting more pronounced aqueous phase processing. This work suggests that BB emissions impact aerosol concentration in remote locations in the western U.S. even during clean conditions. Additionally, aged BBOA can alter aerosol properties by significantly affecting aerosol extinction and may represent an important source of low and extremely low volatility organic compounds.

Early Career Scientist

YES, I am an early career scientist.

BB-10A

Submicron Particle Composition and Acidity in Fire Plumes during FIREX-AQ aircraft study

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

During the Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) aircraft study, the chemical composition of fire-emitted submicron particles was quantified with a High-Resolution Aerosol Mass Spectrometer (AMS). The western US wildfire particles show similar composition across the plumes and are overwhelmingly dominated by organic aerosol (OA). The agricultural fires sampled in the eastern US show larger variability in particle composition with a higher inorganic fraction, in particular, Cl and K. Fast (up to 5Hz) measurements of K in fire plumes, which show excellent correlation with collocated IC filter measurements, allow a quantitative closure of the particle ion balance. Although lab experiments suggest variable AMS instrumental response of K for several K inorganic salts, field observations indicate a uniform response for fresh fire-emitted particles dominated by OA. AMS sulfate in some fresh biomass burning plumes had major contributions from organosulfur species, in contrast with typically a few percent in the regional background air. The AMS inorganic-only SO_4 agrees better with IC sulfate, as expected. The organosulfur appears to be dominantly primary for a similar aging profile with a PMF primary factor and the evidence from lab studies (FLAME-III). Ultrahigh-resolution analysis of FIREX-AQ filter samples is used to aid in the identification of the organosulfur species that include both organosulfonates and organosulfates. Lastly, we use thermodynamic models to estimate aerosol pH, an important lever on many particulate physical and chemical processes, based on AMS-quantified K, inorganic-only SO_4, NO_3, and collocated gas-phase NH_3 and HNO_3 measurements. The gas-particle partitioning was reasonably reproduced by the model. We find that fresh western biomass burning submicron particles had near-neutral pH (on average ~6-7), which was buffered by high levels of NH_3 and contrasts with regional background particles with moderate acidity (pH~2-3) and remote oceanic particles (pH~0).

Early Career Scientist

YES, I am an early career scientist.

BB-11B

Does Combustion Condition Impact Biomass Burning Aerosol Hygroscopicity?

Rudra P Pokhrel, Megan Mouton, Markiesha James, Marc Fiddler, Solomon Bililign
North Carolina A&T State University, Greensboro, NC, USA

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Emissions from biomass burning are the major sources of aerosol and trace gases on a global scale. Carbonaceous aerosol from biomass burning impacts climate directly, indirectly, and semi-directly but these estimates have large uncertainties. To quantify the role of biomass burning aerosol in climate forcing, haze formation, and visibility, characterization of their physical, optical, chemical, and hygroscopic properties is needed. Emissions from Africa are the major sources of global carbon emissions however they are poorly quantified due to limited studies. In this study, we present the data from a laboratory measurement of hygroscopicity of biomass burning emissions from different African fuels including animal dung. Enhancement in light extinction coefficient (f(RH)) is estimated based on the ratio of extinction coefficient measured at elevated humidity to that of extinction coefficient measured at humidity below 30%. The role of fuel types on the hygroscopicity of biomass-burning aerosol will be explored by burning several different fuels. In addition, the role of burning conditions will also be explored by burning the same fuel under different burning conditions quantified by modified combustion efficiency and black carbon to total particulate matter mass ratio. Finally, the optical hygroscopicity parameter (κ) for different fuels and their variabilities under different burning conditions will be presented.

Early Career Scientist

YES, I am an early career scientist.

BB-12C

Sources and characteristics of paddy-residue burning derived carbonaceous aerosols using dual carbon isotopes

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, CATCH: the Cryosphere and Atmospheric Chemistry, GEIA: Global Emissions Initiative, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Post-harvest crop-residue burning emits a large amount of particular matter in the atmosphere that has adverse effects on air quality and climate. A large scale paddy-residue burning happens every year in the northwest Indo-Gangetic Plain (IGP) during post-monsoon season, and the wind carries pollutants from the source to the northern Indian Ocean. In this study, day night pair of fine aerosol samples were collected everyday during October–November over Patiala (30.2° N, 76.3° E, 250 m amsl). This period includes pre-burning (P1), Diwali (P2), burning (P3), and post-burning (P4) episodes. Carbonaceous aerosols were characterised using dual carbon isotopes (^{13}C and ^{14}C) to estimate bio vs non- bio contributions and understand source characteristics. Average bio carbon concentrations were 28.5 ± 12.4, 65.2 ± 10.8, 78.1 ± 51.1, 35.4 ± 6.7 μg/m^3 during P1, P2, P3, and P4, respectively, but non-bio carbon concentrations remained more or less similar (~ 8.2 ± 2.9 μg/m^3) during the study period (except P2). Bio carbon varied from 73% to 96% of the total carbon during the study period. Average $\delta^{13}C$ values were -26.82 ± 0.28, -26.94 ± 0.24, -27.67 ± 0.62, -26.96 ± 0.48 ‰ during P1, P2, P3, and P4, respectively. Further, average BC370/880 ratio was ~2 for paddy-residue burning dominated samples, and reduced with increasing non-bio contributions to aerosols, attesting the use of this ratio as biomass burning marker. Variability in $\delta^{13}C$ (-28.64 to -25.96 ‰) reflects changes in their major primary/secondary bio/non-bio sources; whereas, variability in $\Delta^{14}C$ (-233 to 15 ‰) shows primary source dependence. Dual carbon analysis suggests a significant variability in carbonaceous aerosols sources during day and night as well as during different episodes. Such studies are important in assessing the effect of large scale biomass burning on regional and global air quality and climate.

Early Career Scientist

YES, I am an early career scientist.

BB-13A

A top-down method of estimating NO_2 emissions over South, Southeast and East Asia based on OMI NO_2 observations

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SYSU, Zhuhai, China

IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

China Working Group

Abstract

Urban development and the broad usage of biomass burning in South, Southeast, and East Asia, lead emissions inventories in these regions to be missing significant sources. A lack of ground stations outside of China, Korea, Japan, and Singapore, means that satellites are required to provide a consistent dataset required to improve existing bottom-up estimates. In this work, we use remotely sensed measurements of NO_2 to estimate a new daily emissions database, taking advantage of the wide coverage and the fact that NO_2 is a by-product of both heat and combustion. We can apply a mass-conserving relationship between emissions of NO_2, dynamical transport of NO_2, and the chemical loss of NO_2 by taking advantage of its relatively short atmospheric lifetime (2 to 8 hours) and measurements of the change in NO_2 column loading. Existing a priori emissions from FINN, MEIC, and EDGAR-HTAP are used to constrain our daily emissions of NO_2 for the year 2016. Our product is the "total emissions" of NO_2, including contributions from anthropogenic, biomass burning, and other sources, in a single framework. To demonstrate the efficacy, we run a few different versions of our emissions for 2016 using WRF-CHEM, with all species other than NO_2 and BC co-emitted following FINN, MEIC, and EDGAR-HTAP, and BC following Cohen and Wang, 2014. The resulting spatial-temporal distributions of NO_2, CO, BC, OC, AOD, and HCHO are compared with ground station measurements and measurements from AERONET, MODIS, MOPITT, and OMI, using the EOF approach (Cohen 2014, Lin et al., 2020) to determine how well the emissions sets fit the extremes of the main observed features in space and time. We demonstrate significant underestimations in rural areas in Myanmar, Northern Thailand, Laos, and Eastern India, as well as in urban areas in the Pearl River Delta, Wuhan, Nanchang, Changsha, and Dhaka.

Early Career Scientist

YES, I am an early career scientist.

BB-14B

Aerosol Emissions Factors for Agricultural Fires in the Southeast United States

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative

Abstract

Biomass burning smoke emissions have important impacts on air quality and climate over regional-to-global scales. A substantial subset of these emissions come from prescribed burning of agricultural crop residues. Such fires, which are small but numerous, are of specific importance because of their close proximity to communities, because they are not effectively detected by satellite, and because they are difficult to model. The shallow injection heights of their concentrated smoke plumes also make it hard to sample these emissions from aircraft, the most powerful platform for obtaining statistically significant in situ statistics. Further, the small size of the plumes demands the use of state-of-the-art, high time resolution instruments suitable for resolving sub-second (tens of meters from aircraft) length scales. Consequently, there are relatively few gas-phase measurements of agricultural smoke emissions available in the literature, and even fewer aerosol measurements.

We present aerosol number and mass emissions factors for agricultural fires measured predominantly in the Mississippi River Valley during the 2019 NASA/NOAA Fire Influence on Regional to Global Environments Experiment – Air Quality (FIREX-AQ) field campaign. The NASA DC-8 made repeated sorties to the southeastern United States to obtain data for roughly 100 different agricultural fires. The DC-8 instrument payload included a comprehensive suite of aerosol and trace gas sensors, including measurements of particle number and speciated mass concentrations, volatile and non-volatile particle size distributions, dry and humidified particle light scattering and absorption. Carbon monoxide and carbon dioxide mixing ratios are used to relate the particle extensive parameters to the fire emissions and to account for smoke plume dilution. The relationship between calculated aerosol emissions factors and fuels will be discussed.

Early Career Scientist

NO, I am not an early career scientist.

BB-15C

Photolysis of biomass burning organic aerosol, chemical transformations and photo-bleaching

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Abstract

Brown carbon (BrC) in aerosol particles and cloud droplets can contribute to climate warming by absorbing solar radiation in the visible region of the solar spectrum. Large uncertainties remain in our parameterization of this warming, in part due to a lack of knowledge about atmospheric lifetimes for the chromophores (the light absorbing structures in BrC molecules). An important removal pathway includes chemical transformations that fragment the chromophore, thus removing its ability to absorb visible light. However, the photochemical loss rates measured in the laboratory often do not match what is observed in ambient measurements. There are also different amounts of photo-resistant BrC, which is a fraction of the mixture that does not rapidly bleach. An important BrC source in the atmosphere is biomass burning and the overall photochemical decay rates for these emissions are important to quantify to improve our parameterizations of their radiative effects. Here we show results for laboratory studies of FIREX filter samples probing the role of water vapor for aerosol particles irradiated on a filter. Kinetic analysis of photobleaching in aqueous solutions demonstrates that an intermediate photolysis rate should be included to improve predictions for BrC lifetimes in the atmosphere.

Early Career Scientist

NO, I am not an early career scientist.

BB-16A

A Machine Learning Approach for Identifying Smoke Plumes Based on GOES Satellite Observations Over the United States Using the Trained on the Hazard Mapping System Fire and Smoke Product

Benjamin E Brown-Steiner, Archana Dayalu, Matthew J Alvarado, Anirudh Ashok, Tom Connor
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Abstract

The identification of smoke plumes from satellite imagery over the United States based on geostationary GOES imagery is difficult for many reasons. Smoke plumes can vary widely in color, size, and spatial extent and need to be differentiated from dust plumes, cloud layers, and surface features. Currently, NOAA analysts examine GOES and other available observations and, on a case-by-case basis, draw polygons over regions where they determine smoke plumes can be seen (the Hazard Mapping System (HMS) Fire and Smoke Product). In this work we used a neural network machine learning framework to emulate the smoke plume identification done by these analysts during historical smoke seasons over the continental United States on a pixel-by-pixel basis. Inputs into the emulator include all available GOES satellite imagery (16 bands). The emulator is trained on the a binary “smoke”/”no smoke” determination based on the HMS Fire and Smoke Product. Temporal correlations are included using a long short-term memory (LSTM) approach, while spatial correlations are included using a variety of approaches. Standard machine learning challenges were encountered, such as the determination of the training and testing datasets, the time scales which to include, and the various machine learning hyperparameters. Additionally, the subjective nature of the human-derived assessments within the HMS product results in challenges with the classification of the “truth” of our training and testing data. We compare this approach to other potential smoke plume identification schemes, and discuss how this work can be extended to additional classification of aerosol or dust plumes.

Early Career Scientist

NO, I am not an early career scientist.

BB-17B

Aerosol properties and processing during wintertime under hazy condition

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Abstract

Atmospheric aerosols emitted into the atmosphere often as externally mixed compounds coagulate or condense on each other due to aging to exist in internally mixed state. Variability in mixing state of atmospheric aerosols play a major role in uncertainties associated with the estimated radiative forcing. Meteorological condition plays a major role in determining the mixing state of particles in the atmosphere. We collected samples during wintertime and under hazy condition from a polluted region which is impacted by biomass burning from household activities and agricultural burning. The collected samples were analyzed using multi-modal micro-spectroscopy and chemical imaging techniques such as computer controlled scanning electron microscopy, transmission electron microscopy and scanning transmission X-ray microscopy/near edge X-ray absorption fine structure spectroscopy to determine the size resolved morphology and chemical composition of individual particles. Due to extensive fire activities during winter the K-rich particles are dominant in the atmosphere. We also observed an abundance of sulfates in the sample which could be the result of aqueous phase reaction due to regional haze. Furthermore, we investigated phase state of individual particles with and without inorganic inclusions and our results suggest that particles with inclusions are in semi-solid state while particles without inclusions are in solid-state. The results from this study will help in understanding different mixing state of particles in an urban polluted region and the impact of mixing states on particle phase state.

Early Career Scientist

YES, I am an early career scientist.

BB-18C

Investigating the effect of wildfire on $PM_{2.5}$ in southeastern U.S. in November 2016

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

The biomass burning has been known to play an important role in modulating the air quality in particular of the concentration of particulate matter with diameter of 2.5 μm or less. In this study, the two-way coupled Weather Research and Forecasting model and Community Multiscale Air Quality (WRF-CMAQ) model was used to elucidate the impact of biomass burning on air quality in the southeastern United States. Albeit of the overall good air quality in U.S., the biomass burning may substantially deteriorate air quality by enhancing the PM concentrations. Thus, the episodic fire events (November 6 to 9 and November 13 to 16, 2016) were selected with a focus on eastern U.S. so as to dilute the effect of fire on $PM_{2.5}$ concentration. The results show that the mean contribution to fine particulate matter ($PM_{2.5}$) in the southeastern United States from wildfires reached 9.6 to 42.5 μg m^{-3} and 10.9 to 26.1 μg m^{-3}, with mean relative contributions of 41% and 49%, respectively, during these two events. Moreover, this study took a further step to reveal the mechanism of the aerosol direct effect on the deterioration of air quality during wildfire. The aerosol direct effect is mainly to reduce the planetary boundary layer height and 2 meters temperature by decreasing the surface downward shortwave radiation, thereby promoting the accumulation of pollutants. Quantification analysis showed the aerosol direct effect led to an average of 10% to 14% extra enhancement of $PM_{2.5}$ during the November 6 to 8.

Early Career Scientist

YES, I am an early career scientist.

BB-19A

Salting-out effects on evolvement of light-absorbing SOA in atmospheric aerosols

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Atmospheric aqueous-phase reactions contribute significantly to the formation of secondary organic aerosols (SOAs), but scarce data are available for reactions occurring in liquid water content (LWC) carried by aerosols that is characterized with high ionic strength. Coupling AIM-IV estimated LWC with ionic species in urban $PM_{2.5}$ measured during 2011–2015 renders an ionic strength ranging from 4–64 M that is 5–90 times higher than that in sea water (~0.7 M). The extremely high ionic strength yields a localized salting-out aqueous environment with substantially lowered dissolved oxygen (DO) therein. To simulate such reaction environment with limited DO hosted by fine particulates, this study investigates evolvement of light-absorbing SOAs formed from reactions of guaiacol, a semi-volatile organic emitting from biomass burning. Guaiacol of an initial concentration of 0.8 mM underwent hydroxyl-radical initiated reactions with a DO of 1.3 mg/L, ~16% of that in cloud water (8.2 mg/L). After continuous 10-hr simulated solar irradiation, the total absorbance from 300–450 nm increased >20 times at a rate of 1.4 Absorbance Unit (AU)/hour, and peaked at the 9th hour, corresponding to >2 days in tropical atmosphere. This indicates SOAs formed in a DO-deficient aqueous environment exhibit strong and lasting light absorptivity. Interestingly, the absorbance increased the most within the first 30-min reactions, yielding the fastest absorption rate of 16.0 AU/hour, coinciding with the most significant decrease in guaiacol (0.96 mM/hour) following a corresponding pseudo-first order rate constant of $3\times10\text{-}4\ s^{-1}$. This evidences that SOAs formed under DO deficient conditions rapidly enhance light absorptivity. Taken together, results show that reactions in LWC of aerosols with strong ionic strength and limited DO can be an important process rapidly forming SOAs and substantially increasing aerosol light absorptivity for a prolonged duration, interfering regional radiative forcing.

Early Career Scientist

YES, I am an early career scientist.

BB-20B

Mechanism development and model studies on the chemical multiphase processing of key biomass burning tracers with the new CAPRAM BBM1.0 module

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Abstract

Biomass burning (BB) emissions contribute significantly to air pollution in many parts of the world. So, BB emissions impact air quality, public health and climate on global, regional and local scale. Anhydrosugars (e.g., levoglucosan, mannosan and galactocan) and methoxyphenols (e.g., guaiacol, creosol, etc.) are important tracer compounds emitted from BB and, in part, represent important primary organic aerosol (POA) compounds. After their emission, such BB tracer compounds can undergo a complex multiphase chemical processing in the atmosphere contributing to secondary organic aerosol (SOA). However, at present, their tropospheric multiphase chemical processing is not yet well understood and investigated by chemical process models because no detailed oxidation mechanism was developed so far. Thus, the present study aims at a better understanding of the multiphase chemistry of these BB trace species by means of detailed process model studies applying the newly developed CAPRAM biomass burning module (CAPRAM-BBM1.0). This module was developed based on the kinetic data from the laser flash photolysis measurements in our lab at TROPOS, other kinetics studies from literature as well as state-of-the-art kinetic estimation methods. The developed CAPRAM-BBM1.0 module contains 2991 processes including 9 phase transfers and 2982 aqueous-phase reactions. After the mechanism development, CAPRAM-BB1.0 was coupled to the multiphase chemistry mechanism MCMv3.2/CAPRAM4.0 and the extended CAPRAM aromatics (CAPRAM-AM1.0) and halogen modules (CAPRAM-HM3.0). The developed complex multiphase mechanism was then applied for process model studies focusing onsome residential wood burning scenarios in Europe. Our first model results show that the BB chemistry can significantly increase the SOA formation mainly through in-cloud oxidations. Particularly, the fraction of brown carbon and contribution of substituted organic acids to the SOA mass is increased. Furthermore, the oxidation of BB traces compounds leads to substantially reduced concentrations of key radical oxidants, such as OH and NO_3, in the aqueous-phase.

Early Career Scientist

NO, I am not an early career scientist.

CATCH-1A

Heterogeneous ice nucleation in the WRF-Chem model and its influence on the cloud response to volcanic aerosols

Louis Marelle[1], Gunnar Myhre[2], Jean-Christophe Raut[1], Setigui Aboubacar Keita[3]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Heterogeneous ice formation on aerosols is the main primary cloud ice formation process above temperatures of -38°C, and as a consequence it plays a major role in the formation of mixed-phase and ice clouds. Improving our understanding of ice processes could help better constrain the radiative forcing of cloud aerosol interactions, which remains a major source of uncertainty in climate projections. Despite their importance, most atmospheric models do not represent aerosol-cloud ice processes explicitly.

We extend in the WRF-Chem 3.9.1 model a recent parameterization of deposition-mode ice nucleation to also include immersion-mode nucleation, based on the classical nucleation theory (CNT) description. We also couple this parameterization with the aerosol-liquid cloud parameterization of Abdul Razzak and Ghan already included in WRF-Chem 3.9.1. This allows us to model the effect of aerosols on mixed-phase and ice clouds. We use volcanic eruptions as case studies, especially focusing on the 2014/2015 Holuhraun/Bárðarbunga eruption in Iceland. Specifically, we investigate how volcanic aerosols influence modeled cloud microphysical properties with and without the explicit ice nucleation parameterization, comparing the model against MODIS satellite observations. We also investigate the effect of these processes on the cloud response in terms of optical properties, radiative fluxes, and precipitation during the eruptions.

Early Career Scientist

NO, I am not an early career scientist.

CATCH-2B

Characterization and chemical imaging of aerosol in West Antarctica.

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Abstract

Environmental implications of climate change exhibit profound regional variations both within and between the polar regions and substantial complexity in their interactions. Direct measurements have shown noteworthy spatial variability in temperature biases in Antarctica. Rather than being inert, snow is highly active, with snowpack impurities being photolyzed to release reactive trace gasses such as OH, NO/NO_2, and O_3 into the troposphere. The increase of solar UV radiation flux over Antarctica due to the stratospheric ozone depletion creates the optimal conditions for photochemical reactions on the snow, especially by the heterogeneous gas-to-particle reaction, modifying the chemical and physical properties of aerosols substantially. This study shows evidence of atmospheric processing, via microscopic and molecular speciation. Single particles of sea salt aerosol were collected at the Brazilian module Criosfera 1 (West Antarctica) and analyzed by scanning transmission X-ray microscopy with near-edge X-ray absorption fine structure spectroscopy (STXM/NEXAFS), and Computer-controlled scanning electron microscopy (CC-SEM) with energy dispersive X-ray (EDX) microanalysis. The displacement of chlorine relative to sodium was observed over most of the sea salt particles. STXM reveals an accurate fraction of internally mixed particles with chemical composition consistent with NaCl-NO3 contributed up to 30% of atmospheric particles. The scattering efficiency of sea salt particles may decrease as a consequence of the external nitrate covering since the hygroscopicity of a mixed nitrate-salt particle is weak. The unique signal of Cl_xO_y-type-molecules revealed could be associated with OH radical oxidation products of NaCl particles. Considering the perchlorate (ClO_4) has a supercooling property, it is possible to assume that Antarctica successively underwent interglacial warming phases created salty perchlorate crusts. These findings can be useful to assist in reducing modeling uncertainties and provide new insights into the aerosol chemical composition in the polar environment.

Early Career Scientist

YES, I am an early career scientist.

CATCH-3C

Impact of biomass burning aerosol from Amazon associated with changes of snow albedo over the Central Andes mountains using satellite remote sensing data

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Americas Working Group

Abstract

Each year, biomass burning in Amazonia (BBA) remains to release large amounts of aerosol particles into the South American atmosphere. The orographic control of the Andes favoring winds in a north-south direction. This situation conducive BBA aerosols to travel thousands of km to reach the Central Andes mountains (CA) of Argentina and Chile (30ºS to 40ºS) where it can reach the snowy areas and deposit it there, reducing its surface albedo and therefore increasing its melting rate. In 2019 there were more sources of burning than the historical average. Also, the high BBA emissions coincided with prevailing northerlies winds from August 22 to 27 of this year and smoke plumes that reached the east side of CA. An analysis of the daily variations of albedo snow and aerosol optical depth (AOD) are performed using MODIS images on CA to understand how it relates to the arrival of BBA aerosols. The results show the arrival of this aerosol plume is related to the increase in AOD during these days and the decrease in snow albedo. In addition, estimations of Black Carbon (BC), known as one of the most efficient aerosols for darkening and melting snow, from the Fire INventory from NCAR (FINN) and the Quick Fire Emissions Dataset (QFED) show that a BC plume covered this region during the days studied. This work enhances the knowledge of BBA aerosols and its impact on snowpack variability over CA, as well as to focus actions to reduce them.

Early Career Scientist

YES, I am an early career scientist.

CATCH-4A

Role of oceanic ozone deposition in explaining short-term variability of surface ozone at high-Arctic sites

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report

Abstract

Dry deposition is an important removal mechanism for tropospheric ozone (O_3). Its deposition to oceans is generally represented in atmospheric chemistry transport models using constant surface uptake resistances. However, observations show quite large spatiotemporal variability expressing differences in solubility, waterside turbulence and O_3 reacting with iodide and dissolved organic matter. We hypothesize that for the Arctic O_3 deposition is overestimated with consequences for background concentrations and lifetime of O_3 also due to changes in long-range transport of O_3 and its precursors. These are focal points of a project on observing and modelling of Arctic climate-active trace gas exchange as a contribution to the MOSAiC observational campaign with the icebreaker Polarstern being trapped in the Arctic sea-ice for ~1 year.

We have coupled the Coupled Ocean-Atmosphere Response Experiment Gas transfer algorithm (COAREG) to the mesoscale meteorology and atmospheric chemistry model Polar-WRF-Chem (PWRF-C). This includes a further development including a two-layer scheme for O_3 deposition to oceans and coupling to recently updated ocean water composition databases. We have also reduced the deposition of O_3 to sea ice based on a previous study of snow-ice O_3 deposition.

In this study, we evaluate the performance of PWRF-C with hourly-averaged surface O_3 measurements above 60 ºN. We show that the more mechanistic representation of O_3 deposition over oceans and strongly reduced deposition over snow and ice results in improved simulated Arctic O_3 mixing ratios. We found that it is important to nudge PWRF-C to the ECMWF ERA-Interim wind fields which secures a fair comparison of the model with measurements regarding their footprint. Our study indicates that representation of ocean and sea-ice O_3 deposition in atmospheric chemistry models must be revised to improve the representation of Arctic O_3 concentrations and chemistry.

Early Career Scientist

YES, I am an early career scientist.

CATCH-5B

3-D modeling of bromine chemistry and boundary-layer mercury depletion across the springtime Arctic

Kenjiro Toyota[1], Andrei Ryzhkov[2], Ashu P. Dastoor[2], Jack Chen[3], Craig A. Stroud[1], Alexandru Lupu[1], Junhua Zhang[1], Verica Savic-Jovcic[1], Qiong Zheng[1], Michael D. Moran[1], Ralf Staebler[1], Alexandra Steffen[1], Stoyka Netcheva[1], Chris A. McLinden[1], Holger Sihler[4], John W. Halfacre[5], William R. Simpson[6], Paul Shepson[7], Christopher W. Moore[8], Daniel Obrist[9,10], Udo Friess[11], Johannes Zielcke[11], Nicolas Theys[12]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Gas-phase bromine radical chemistry is the main driver for the frequent and concurrent depletion of ozone and mercury (Hg) in the polar boundary layer during the spring. Snow on sea ice and coastal snow cover are the key elements in the production of reactive bromine in polar spring. Three-dimensional models, developed to simulate the impact of bromine chemistry on Hg oxidation at both global and arctic-basin regional scales, have generally relied upon indirect representations of the sources, sinks and photochemical transformation of bromine radical species in the polar atmosphere. Within Environment and Climate Change Canada's air-quality model, GEM-MACH, we have developed a process-oriented representation for the coupled bromine-ozone-Hg chemistry and the exchange of bromine, ozone and Hg species between air and snow/ice surface. The model is run at 15-km horizontal resolution in a limited-area domain of the Arctic and is capable of capturing the evolution of high BrO column densities associated with synoptic weather disturbances as can be seen from satellite. The concurrent depletion of ozone and Hg is simulated by consistent model formulations, where the release of reactive bromine from the frozen surfaces is facilitated by the presence of ozone in air. The measurements of ozone and speciated Hg in the surface air and the vertical column densities of BrO measured optically from ground stations and buoys drifting with sea ice demonstrate the skill of the model at fine temporal scales even though limited in spatial coverage. Over the period of 7 months from February to August 2012, this model computes the net deposition of Hg at 77 and 28 Mg in the oceanic and terrestrial portions, respectively, of the Arctic Circle, with the former predominantly driven by springtime bromine chemistry and the latter arising mainly from the dry deposition of elemental Hg during the summer.

Early Career Scientist

NO, I am not an early career scientist.

CATCH-6C

Molecular simulations on potassium-rich feldspar surfaces interacting with ions and possibility of ice nucleation

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Chemistry Department, The University of British Columbia, Vancouver, Canada

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CATCH: the Cryosphere and Atmospheric Chemistry, CCMi: Chemistry Climate Model Initiative

Abstract

Ice clouds play an important role in the Earth's radiative budget and hence climate. Heterogeneous ice nucleation, a major pathway for ice formation in cirrus and mixed-phase clouds, is induced by active sites present on atmospheric aerosol particles termed as ice-nucleating particles. Recent studies have established the superior ice nucleating abilities of feldspars and the varying effects of inorganic solutes on their ice nucleating abilities. However, little is known about the mechanism of ice nucleation by feldspar at the microscopic level, as well as how the presence of ionic solutes might alter feldspar surfaces, and hence influence ice nucleation. To explore these questions, we use molecular dynamics simulations to examine the interactions of monovalent cations (H_3O^+, Li^+, K^+, Cs^+, NH_4^+) with the (001), (010) and (100) surfaces of potassium feldspar mineral (microcline phase) at 300 K, and the corresponding interfacial water structure in supercooled solutions (230 K). Both semi-rigid (only lattice K^+ free to move) and fully flexible (all lattice atoms free to move) microcline slabs are considered. Results show that on simulation timescales, lattice vibration is necessary for ion exchange between added cation and lattice K^+, albeit at different exchange rates for the 3 planes. None of the 3 flexible surfaces show any preference for NH_4^+ over K^+ in terms of ion exchange within the simulation timescale. Both the semi-rigid and flexible surfaces show higher adsorption of polyatomic cations (H_3O^+ and NH_4^+) compared with the simple spherical cations. We do not observe any sign of ice nucleation on pristine nor NH_4^+-adsorbed/exchanged microcline surfaces (both semi-rigid and flexible) at 230 K within the simulation timescales. This contrasts with the laboratory experiments, and strongly suggests that simple, unreconstructed, planar surfaces are not responsible for the excellent ice nucleating ability of potassium feldspar.

Early Career Scientist

YES, I am an early career scientist.

CATCH-7A

Oxidation of methanesulfonate into sulfate at inland Antarctica evidenced by ^{17}O-excess signature

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Japan National Committee

Abstract

^{17}O-excess ($\Delta^{17}O = \delta^{17}O - 0.52 \times \delta^{18}O$) of sulfate trapped in Antarctic ice cores has been proposed as a potential tool for assessing past oxidant chemistry, because the signature reflects the relative contribution of oxidants such as O_3, OH, and H_2O_2, through SO_2 oxidation to form sulfate. However, insufficient understanding of atmospheric sulfate formation around Antarctica has hampered its interpretation. To explore regional specific chemistry, we compared year-round observations of $\Delta^{17}O$ of non-sea-salt sulfate in aerosols ($\Delta^{17}O(SO_4^{2-})_{nss}$) at Dome C and Dumont d'Urville, inland and coastal sites in East Antarctica, throughout the year 2011. $\Delta^{17}O(SO_4^{2-})_{nss}$ at both sites showed consistent seasonality with summer minima (~1.0 ‰) and winter maxima (~2.5 ‰) owing to sunlight-driven changes in the relative importance of O_3-oxidation ($\Delta^{17}O(SO_4^{2-})_{SO2+O3}$ = ~6.5 ‰) to OH- and H_2O_2-oxidation ($\Delta^{17}O(SO_4^{2-})_{SO2+OH,\ H2O2}$ < 1 ‰). Aside from those general trends, we observed specifically high $\Delta^{17}O(SO_4^{2-})_{nss}$ at inland (2.0 ± 0.3 ‰) than the coastal site (1.2 ± 0.3 ‰) during austral spring–summer (October to December), which cooccurred with decrease of methanesulfonate (MS^-, or MSA) in aerosols at inland. This result, combined with our first estimate of $\Delta^{17}O(MS^-)$ as high as ~16 ‰ based on isotope mass-balance calculation for detailed DMS oxidation chemistry, indicates that MS^- is oxidized to produce sulfate with remarkably high $\Delta^{17}O(SO_4^{2-})_{nss}$. If contributing to the known post-depositional decrease of MS^- in snow, this process should also cause a significant post-depositional increase in $\Delta^{17}O(SO_4^{2-})_{nss}$ over 1 ‰, that can reconcile the discrepancy between $\Delta^{17}O(SO_4^{2-})_{nss}$ in the atmosphere and ice. This finding highlights the importance of MS^- oxidation as one of the controlling processes for $\Delta^{17}O(SO_4^{2-})_{nss}$ both in the atmosphere and ice.

Early Career Scientist

YES, I am an early career scientist.

CATCH-8B

Simulating brown carbon aerosol over High Mountain Asia: WRF-Chem model implementation and application

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[3]University of Arizona, Tucson, AZ, USA

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

High-mountain Asia (HMA) (also known as the Third Pole) functions as a "water tower" of Asia, with its glacier and snowpack providing water resources for billions of people for drinking, irrigation, and other activities. The deposition of light-absorbing particles (LAPs), including black carbon (BC), dust, and brown carbon (BrC), has been known to significantly reduce snow albedo and hence accelerate snow melting and glacier retreat in this region. Particularly, most previous studies have focused on the effects of BC and dust over HMA in the past decade, whereas much less is known for BrC climatic effects in the region partly due to the lack of modeling capabilities for BrC evolution during its lifecycle in terms of concentration and optical properties. Recent advances in the scientific understanding of BrC atmospheric evolution allow an improved representation of BrC aerosol in chemistry-climate models. In this study, we implement a series of BrC-relevant processes into the widely-used Weather Research and Forecasting (WRF) model coupled with chemistry (WRF-Chem) to represent the BrC atmospheric evolution. Specifically, we add representations of direct emissions, secondary formation, aerosol-radiation interaction, aerosol-cloud interaction, deposition (dry and wet), and aerosol-snow interaction for BrC in the model. We apply the enhanced WRF-Chem model to HMA to quantify the effects of BrC on aerosol concentrations and optical depths (AOD), atmospheric radiative effects, and influences on snowpack albedo and melting in this region. We evaluate the model simulations against available satellite and ground-based observations over Asia in terms of chemistry (e.g., AOD, surface aerosol concentration, aerosol in snow) and meteorology (e.g., surface temperature and albedo, snow cover, precipitation).

Early Career Scientist

YES, I am an early career scientist.

CATCH-9C

Investigating the relationship of meteorology and atmospheric composition to snow cover: A comparative study over High-Mountain Asia and Andes

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, AMIGO: Analysis of eMIssions usinG Observations, ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The glacial extent and runoff of the ranges in High-mountain Asia (HMA) and Andes (A) are a significant source of hydrological resources in Asia and South America respectively. Melting of snow and reduction of snow albedo has long been known to be facilitated by the deposition of light absorbing particles (LAPs *viz.* black carbon and dust), especially over HMA and A in the spring.

In this study, we explore the relationships between snow cover and albedo (Moderate-Resolution Imaging Spectroradiometer (MODIS) aboard Terra and Aqua satellites) and surface parameters, both at a spatial resolution of 0.1^{o} like air temperature, downward surface solar radiation, relative humidity, and mean sea level pressure (ERA5 Reanalysis), precipitation (Integrated Multi-satellite Retrievals or Global Precipitation Measurement (IMERG) dataset) along with black carbon and dust aerosol loading (CAMS global reanalysis EAC4) during 2003 – 2018. A correlation study is performed initially to understand the association between meteorological and snow pollution parameters in two distinct glacier regions in two distinct hemispheres. The reanalysis dataset from CAMS for aerosol loading is utilized to examine the impact of LAPs on the variability of snow parameters. The relative contribution of the meteorological and pollution parameters on snow cover and albedo are assessed further by means of multivariate regression. Feature selection techniques like principal component analysis (PCA) are used to search for dominant patterns in the snow and atmospheric parameters of interest and assess the variability across both summer and winter hemispheres.

Early Career Scientist

YES, I am an early career scientist.

CATCH-10A

The importance of alkyl nitrates and sea ice emissions to atmospheric NO_x sources and cycling in the summertime Southern Ocean marine boundary layer.

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Atmospheric nitrate originates from the oxidation of nitrogen oxides (NO_x=NO+NO_2) and impacts tropospheric chemistry and climate. NO_x sources and NO_x to nitrate formation pathways are poorly constrained in remote marine regions, especially the Southern Ocean (SO) where pristine conditions serve as a useful proxy for the preindustrial atmosphere. Here, we measured the isotopic composition ($\delta^{15}N$ and $\delta^{18}O$) of atmospheric nitrate in coarse-mode (> 1μm) aerosols collected in the summertime marine boundary layer of the Atlantic SO from 34.5°S to 70°S, and across the northern edge of the Weddell Sea. $\delta^{15}N$-NO_3^- decreased with latitude from -2.7‰ to -43.1‰, which is attributed to varying NO_x sources from lightning at the low latitudes, oceanic alkyl nitrates at the mid latitudes, and photolysis of nitrate in snow at the high latitudes. There was no evidence of any influence from anthropogenic NO_x sources or equilibrium isotopic fractionation. Using air mass back trajectories and an isotope mixing model, we calculate the $\delta^{15}N$ signature of aerosol nitrate from oceanic alkyl nitrate emissions to be -21.7‰ ± 7.9‰, which may be useful for detecting their contribution in other oceanic regions. $\delta^{18}O$-NO_3^- values consistently below 70‰ indicate that daytime processes involving OH dominate NO_x oxidation during summer. Unusually low $\delta^{18}O$-NO_3^- values (less than 37‰) were observed over the western Weddell Sea where air mass history shows extensive interaction with sea ice. Since sea ice enhances peroxy radical production, low $\delta^{18}O$-NO_3^- is attributed to increased exchange of NO with peroxy radicals, which have a low $\delta^{18}O$, instead of ozone, which has a high $\delta^{18}O$. This study suggests that the mid- and high-latitude surface ocean may serve as a more important NO_x source than previously thought, and that the ice-covered surface ocean impacts the reactive nitrogen budget as well as the oxidative capacity of the marine boundary layer.

Early Career Scientist

YES, I am an early career scientist.

CATCH-12C

^{14}CO in Glacial Ice from Law Dome, Antarctica as a Tracer of Changes in Atmospheric OH Abundance from 1870 AD to Present

Dr. Peter D Neff[1,2], Vasilii V Petrenko[2], David Etheridge[3], Andrew M Smith[4], Edward Crosier[2], Benjamin Hmiel[2], David Thornton[3], Lenneke Jong[5], Ross Beaudette[6], Christina Harth[6], Ray L Langenfelds[3], Blagoj Mitrevski[3], Mark Curran[7], Christo Buizert[8], Lee Murray[2], Cathy M Trudinger[3], Michael Dyonisius[2,9], Jessica Ng[6], Jeff Severinghaus[6], Ray F Weiss[6]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Hydroxyl, OH, is the main tropospheric oxidant and determines the lifetime of methane and most other atmospheric trace gases, thereby controlling the greenhouse warming produced by these gases. Changes in OH concentration ([OH]) in response to large changes in reactive trace gas emissions (which may occur in the future) are uncertain. Measurements of ^{14}C-containing carbon monoxide (^{14}CO) and other tracers such as methyl chloroform over the last ≈25 years have been used to monitor changes in [OH], but no observational constraints exist further back in time. Ice core reconstructions of ^{14}CO could provide such constraints but are complicated by in-situ production of ^{14}CO by cosmic rays directly in the ice. Recent work in Antarctica and Greenland shows that this in-situ component is relatively small and can be accurately corrected for at sites with very high snow accumulation rates. A US and Australian team sampled and measured firn air and ice at Law Dome, Antarctica (2018-19, site DE08-OH, 1.2m a^{-1} ice-equivalent snow accumulation), to a depth of 240m. Trapped air was extracted from the ice using an on-site large-volume ice melting system. Preliminary comparisons of methane measured in the samples to existing ice core records and atmospheric measurements suggest ice core air ages spanning from the 1870s to the early 2000s. Firn-air samples from the surface to 81m depth capture air from the early 2000s to present. Analyses of [CO] and halocarbons in the samples show a low, stable procedural CO blank and demonstrate that the samples are unaffected by ambient air inclusion. ^{14}CO analyses in these samples have been completed, and corrections for in-situ ^{14}CO production, validated against direct atmospheric measurements for the more recent samples, have allowed us to develop a preliminary ^{14}CO history. This will be interpreted with the aid of the GEOS-Chem model to place first observational constraints on the variability of Southern Hemisphere [OH] since ≈1870AD.

Early Career Scientist

NO, I am not an early career scientist.

CATCH-13A

Urban inland wintertime N_2O_5 deposition and snowpack $ClNO_2$ production

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Americas Working Group

Abstract

The atmospheric multiphase reaction of dinitrogen pentoxide (N_2O_5) with chloride-containing aerosol particles produces nitryl chloride ($ClNO_2$), which has been observed across the globe. The photolysis of $ClNO_2$ produces chlorine radicals and nitrogen dioxide (NO_2), which alter pollutant fates and air quality. However, the effects of local meteorology on near-surface $ClNO_2$ production are not yet well understood, as most observational and modeling studies focus on periods of clear conditions. During a wintertime field campaign in Kalamazoo, Michigan from January-February 2018, N_2O_5 and $ClNO_2$ were measured using chemical ionization mass spectrometry, with simultaneous measurements of atmospheric particulate matter and meteorological parameters. We examine the impacts of atmospheric turbulence, precipitation (snow, rain) and fog, and ground cover (snow-covered and bare ground) on the abundances of $ClNO_2$ and N_2O_5. Both N_2O_5 and $ClNO_2$ mole ratios were lowest, on average, during rainfall and fog because of scavenging, with N_2O_5 scavenging by fog droplets likely contributing to observed increased particulate nitrate concentrations. N_2O_5 mole ratios were lowest during periods of lower turbulence and were not statistically significantly different between snow-covered and bare ground. In contrast, $ClNO_2$ mole ratios were highest, on average, over snow-covered ground, due to saline snowpack $ClNO_2$ production. This is consistent with vertical gradient measurements during the same study, which showed N_2O_5 deposition and an average positive (production) $ClNO_2$ flux over snow-covered ground, and snow chamber experiments showed that synthesized N_2O_5 reacted with the local saline snow to produce $ClNO_2$. These observations, specifically those during active precipitation and with snow-covered ground, highlight important processes, including N_2O_5 and $ClNO_2$ wet scavenging, fog nitrate production, and snowpack $ClNO_2$ production, that govern the variability in observed atmospheric chlorine and nitrogen chemistry and are missed when considering only clear conditions.

Early Career Scientist

YES, I am an early career scientist.

CATCH-14B

Using 1D-modelling to study Arctic chlorine activation, transport and VOC oxidation during Arctic springtime

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Polar halogen chemistry has long been known to have an important influence on the lifetime of some volatile organics, ozone, and mercury, particularly during spring. Recently, very high concentrations of molecular chlorine (Cl_2) were recorded at Utqiaġvik, Alaska during the Ocean-Atmosphere-Sea Ice-Snowpack (OASIS) campaign in spring 2009, with a correlation between daytime Cl_2 mixing ratios, ozone concentrations and sunlight. However, the chlorine radical concentrations inferred from these Cl_2 measurements, with the observed VOC abundances and lifetimes, cannot yet be fully explained via chemical box modelling alone. To explain these discrepancies, modelling that includes surface snow Cl_2 formation processes, subsequent atmospheric chemistry and vertical mixing is needed and is essential in understanding the roles of transport, chemistry and emissions in modulating boundary layer chemical concentrations and VOC lifetimes.

In this work, we use a one-dimensional atmospheric chemistry and transport model (Platform for Atmospheric Chemistry and Transport in 1-Dimension, PACT-1D) to investigate surface Cl_2 production from snow, snowpack recycling, vertical transport and reactivity with VOCs at Utqiaġvik, Alaska during the OASIS campaign. We implement and test a new surface parameterization of chlorine emissions from the snowpack based on the solar radiation and surface ozone levels and consider the role of vertical mixing processes. By considering both production and transport mechanisms, we are able to obtain good agreement between the model predicted Cl_2 mixing ratios and observations at 1.5 meters. Model predicted Cl_2 can be seen to reside within the lowest 15 m of the boundary layer, resulting in increased chemical reactivities and oxidation rates of VOCs in the lowest part of the atmosphere. The proposed surface emission parameterization of chlorine in this work could be used to develop current 3D numerical models in order to explore chlorine emissions and reactivity over the entire Arctic.

Early Career Scientist

YES, I am an early career scientist.

CATCH-15C

Modeling large dust deposition events to alpine snow and their impacts: the role of model resolution

Foteini Baladima[1], Jennie Thomas[1], Didier Voisin[1], Marie Dumont[2], Christophe Lavaysse[3], Rajesh Kumar[4], Clementine Junquas[1], Louis Marelle[5], Francois Tuzet[2], Romain Biron[1]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Mineral dust is an important aerosol present in the atmosphere and cryosphere and has implications for both regional and global climate. Dust acts as a light absorbing impurity upon deposition with potential impacts on albedo, snowpack evolution and timing of snow-melt. Simulating dust deposition events in mountain regions is challenging due to the complexity of aerosol-cloud interactions and the specifics of mountain meteorological systems. Between 30 March and 5 April 2018 a strong dust deposition event was observed within the seasonal snowpack at the Lautaret pass in the French Alps. We use this case study to investigate the role of model resolution in capturing both mountain meteorology and precipitation, and the resulting model predicted dust deposition.

The regional Weather Research and Forecasting model with Chemistry (WRF-Chem) is used with three nested domains, including the primary dust emissions region in Africa, a second domain that includes Europe, and a third high resolution domain over the Alps, to simulate the sources, processing, and deposition of dust to the alpine snowpack. We compare WRF-Chem predicted aerosol and meteorological properties (at different model resolution) with in-situ, remote sensing, and reanalysis products to validate the model and quantify the added value of high resolution modelling within the Alps. We conclude that predicted mountain meteorology, including precipitation, is significantly better when using the high resolution configuration (3 x 3 km horizontal resolution domain). Moreover, this improved meteorology predicted by the model influences significantly the predicted dust deposition. We discuss the implications of this finding, including improved resolution within models that consider the full aerosol lifecycle in the atmosphere and in snow covered mountain regions.

Early Career Scientist

YES, I am an early career scientist.

CATCH-16A

Atmospheric nitrogen deposition and watershed budget at the Lautaret Pass

Jim Grisillon[1], Professor Didier Voisin[1], Arnaud Foulquier[2], Jean-Martial Cohard[1], Aniket Gupta[1], Jean-Gabriel Valay[3]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

The nitrogen cycle is heavily perturbed by human activities, and interacts strongly with climate and the water cycle. Those interactions are particularly complex in mountain areas: ecosystems there are adapted to snow and to low external nitrogen input. The former is affected by climate change, and the latter by direct (agriculture) and indirect (deposition of N-bearing air pollution) human activities, which makes the evolution of those ecosystems and the fluxes they control very uncertain in the coming decades. There is therefore a strong need for studies in mountains to better understand those interactions and provide comprehensive datasets to test the available land models.

A watershed at the Lautaret Pass in the French Alps was chosen as it is small enough to minimize most heterogeneities. N-bearing compounds concentrations were measured in atmospheric dry and wet depositions, in the snowpack, in the stream water and in aerosols. Analysis included Ion Chromatography, colorimetry for Total Dissolved Nitrogen (TDN) assessment, and isotopic measurements including $\Delta^{17}O$, $\delta^{18}O$ and $\delta^{15}N$ for NO_3^- from stream water and $\delta^{15}N$ for $NH_4^+{}_{atm}$. Atmospheric depositions, aerosols and stream water were collected on a weekly basis. Snow was collected at different locations once and for all at the peak of the winter.

This extensive data set is used to evaluate several aspects of the nitrogen cycle. First the global N budget for this catchment during one hydrological year is evaluated, with a critical assessment of uncertainties related to collection strategies and spatial heterogeneity. Then, estimations of dry deposition from the model MOCAGE with aerosol data is compared to direct measurements. The importance of organic nitrogen in the depositions is evaluated. Processes occurring in the watershed are investigated, especially the potential transformations in the snowpack, and the ecosystem processes. We also aim at identifying the sources of $NH_4^+{}_{atm}$thanks to $\delta^{15}N$ values.

Early Career Scientist

YES, I am an early career scientist.

CATCH-17B

What we learn from fundamental laboratory studies at the Swiss Light Source about atmospheric chemistry.

Dr. Thorsten Bartels-Rausch
Paul Scherrer Institut, Villigen PSI, Switzerland

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Interfaces are of great importance in atmospheric chemistry and physics. Here, we present our recent work investigating interfaces on a molecular scale using X-ray excited electron spectroscopy, which provides access to core and valence electronic levels. The experiments were performed at the Swiss Light Source of the Paul Scherrer Institute and address questions such as nucleation processes relevant for the formation of aerosol particles, cloud droplets; acid-base equilibria at the interface relevant for chemical reactions and the structure on a molecular level at the interface relevant for gas exchanges across the interface.

Early Career Scientist

NO, I am not an early career scientist.

CATCH-18C

Reactive nitrogen species in polar environments: a laboratory-based study of nitrous acid gas (HONO) production from snow.

Ms Amelia M H Bond[1,2], Dr Markus M Frey[1], Prof Jan Kaiser[2], Dr Anna E Jones[1], Dr Jörg Kleffmann[3]
[1]British Antarctic Survey, Cambridge, United Kingdom. [2]University of East Anglia, Norwich, United Kingdom. [3]University of Wuppertal, Wuppertal, Germany

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Measurements of nitrous acid gas (HONO) in the polar boundary layer and snowpack interstitial air suggest a photolytic snowpack source but the exact mechanism for HONO production is poorly understood; models of HONO sources and sinks often cannot rationalise the measured HONO concentrations.[1] In the polar regions the usual OH formation pathway (ozone photolysis and reaction of $O(^1D)$ and H_2O) is limited by the low water vapour concentration. Other reactions that can increase OH levels are therefore important; snowpack reactive nitrogen emissions (NO_x and HONO) can lead to OH production through rapid cycling of $RO_2 \rightarrow HO_2 \rightarrow OH$ and photolysis of HONO.[2] Research into reactive nitrogen species in polar environments has predominantly focused on the photolysis of nitrate, which it has been established produces NO_x,[3] but with far less investigation into HONO. When reported HONO concentrations are put into models, computed HO_x levels are often higher than measured levels, suggesting measurements may have overestimated the HONO present.[2]

Our approach is to use a LOng Path Absorption Photometer (LOPAP)[4] to accurately measure HONO production from Antarctic snow samples irradiated with UV under controlled laboratory conditions. This allows for simultaneous detailed analysis of the snow physical and chemical properties that influence HONO release, such as nitrate concentration and pH, as well as investigation into other factors such as the UV light wavelength and intensity. These findings will help further our understanding of the atmospheric budgets of reactive nitrogen and HO_x above snow-covered regions.

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Early Career Scientist

YES, I am an early career scientist.

CATCH-19A

Short-term variability in atmospheric carbon dioxide as observed from coastal Antarctica

Dr Freya A Squires[1], Dr Anna Jones[1], Dr James France[2,1], Joshua Eveson[1], Dr Neil Brough[3], Dr Thomas Barningham[1], Dr Rolf Weller[4], Julia Loftfield[4], Linda Ort[4]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Halley is a British Antarctic Survey research station located on the Antarctic coast, upon the floating Brunt Ice shelf. The station was established in 1956 and since then meteorological and atmospheric observations have provided invaluable insight into changes in the global system. Halley's coastal location provides an ideal platform to explore air-sea CO_2 exchange in the Southern Ocean region. The Southern Ocean is a globally important carbon sink, estimated to account for ~75% of global ocean CO_2 uptake but a sparsity of observations in the region has contributed to uncertainty around the inter-annual and seasonal nature of the Southern Ocean sink.

CO_2 mixing ratios have been measured at Halley at high temporal resolution since 2013, most recently as part of the SONATA project (Southern OceaN optimal Approach To Assess the carbon state, variability and climatic drivers). Due to instabilities in the Brunt ice shelf the instrument was relocated to the German coastal Antarctic research station, Neumayer, at the end of 2017. Both the Halley and Neumayer records show short-term variability in CO_2 mixing ratios during the summer, with up to ~0.5 ppb decreases in CO_2 over the course of a day. This corresponds to about 1/6 of the average annual growth rate. Trajectory analysis suggests that these decreases in mixing ratio correspond to periods where the air sampled has spent time over the Southern Ocean, suggesting CO_2 uptake has occurred.

This work will discuss the potential drivers of short-term variability in CO_2 mixing ratios measured in coastal Antarctica. The ongoing changes in Halley station operations in response to Brunt ice shelf activity, including work to automate and restart *in-situ* CO_2 measurements at the site, will also be presented.

Early Career Scientist

YES, I am an early career scientist.

CATCH-20B

Trend analysis of aerosol particle physical properties at Villum Research Station, Northern Greenland

Jakob B Pernov[1], David Beddows[2], Henrik Skov[1], Daniel C Thomas[1], Manuel Dall´Osto[3], Roy Harrison[2], Andreas Massling[1]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

Abstract

Atmospheric aerosols can alter the planetary radiation balance directly through scattering and absorption and indirectly through modification of cloud properties. The Arctic environment has undergone significant changes in recent decades, including temperature rise and sea ice retreat. Understanding the direction and magnitude of recent changes in the Arctic aerosol population is key to elucidating the implications for the changing Arctic climate.

All measurements were obtained at Villum Research Station in northeastern Greenland. Particle number size distributions (PNSD) were measured using a Scanning Mobility Particle Sizer from 2010–2018.

We have utilized k-means clustering to group PNSDs into eight distinct clusters. Five in the ultrafine size range: Pristine, Nucleation, Bursting, Nascent, and UF Bimodal (Dall´Osto et al., 2017) and three in the accumulation size range: Acc Bimodal, Haze, and Aged (Lange et al., 2018).

The data were prewhitened according to Collaud Coen et al. (2020). The trends in these parameters were identified and quantified using the Mann-Kendal test and Theil Sen slope on the 90th % confidence level. Trends in different seasons were analyzed using monthly cluster occurrence.

Air mass history was investigated through the HYSPLIT trajectory model (Draxler and Hess, 1998). Time spent within the mixed layer and over surface types (sea, land, snow, and sea ice) was calculated according to Dall´Osto et al. (2017). Accumulated precipitation was also calculated from HYSPLIT.

• Pristine and Nucleation cluster occurrence is increasing in autumn and summer, respectively at Villum during the previous decade.

• The time that air masses have spent within the mixed layer and over the sea surface is increasing in spring, summer, and autumn.

• Accumulated precipitation increasing in autumn.

• Pristine and Nucleation clusters were associated with the time air masses spent within the mixed layer and over the sea surface as well as experiencing high amounts of accumulated precipitation.

Early Career Scientist

YES, I am an early career scientist.

CATCH-21C

Acidity-driven enhancement of sulfate formation after SO_2 emission control evidenced by ^{17}O-excess of ice core sulfate.

Dr. Shohei Hattori[1], Dr. Yoshinori Iizuka[2], Dr. Becky Alexander[3], Dr. Sakiko Ishino[4], Dr. Koji Fujita[5], Dr. Shuting Zhai[3], Dr. Tomás Sherwen[6], Dr. Naga Oshima[7], Dr. Ryu Uemura[5], Mr. Akinori Yamada[8], Ms. Nozomi Suzuki[1], Dr. Sumito Matoba[2], Ms. Asuka Tsuruta[1], Dr. Joel Savarino[9], Dr. Naohiro Yoshida[1]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Japan National Committee

Abstract

After the 1980s, atmospheric sulfate reduction is slower than the dramatic reductions in sulfur dioxide (SO_2) emissions. However, a lack of observational evidence has hindered the identification of causal feedback mechanisms. One tool for providing insight into sulfate formation mechanisms is offered by the mass-independent oxygen isotopic composition ($\Delta^{17}O$). Here, we present the changes in the Northern Hemisphere $\Delta^{17}O$ of sulfate between 1959 and 2015, based on a continuous and high-resolution ice core record from a high-elevation dome site in southeast Greenland called SE-Dome (Iizuka et al. 2018). We found an increase in $\Delta^{17}O$ of sulfate in a Greenland ice core, implying an enhanced role of acidity-dependent in-cloud oxidation by ozone (up to 17 to 27%) in sulfate production since the 1960s (Hattori et al. 2021). Besides, a global chemical transport model (GEOS-Chem) reproduces the magnitude of the increase in observed $\Delta^{17}O$ of sulfate with a 10 to 15% enhancement in the conversion efficiency from SO_2 to sulfate in Eastern North America and Western Europe. With an expected continued decrease in atmospheric acidity, this feedback will continue in the future and partially hinder air quality improvements.

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Early Career Scientist

NO, I am not an early career scientist.

CATCH-22A

Unprecedented snow darkening and melting in New Zealand due to 2019–2020 Australian wildfires

Dr Wei Pu
Lanzhou University, Lanzhou, China

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

China Working Group

Abstract

Wildfire events have recently shown a rapid increase in frequency and scale due to the warmer present-day climate; however, their potential effects on the cryosphere are difficult to assess. Catastrophic wildfires in Australia during 2019–2020 emitted large amounts of light-absorbing particles (LAPs) to the atmosphere. Satellite observations indicate that these LAPs caused unprecedented snow-darkening of glaciers in New Zealand through long-range transport and deposition, with their effects lasting for up to three months in January–March 2020, influencing >90% of total glacier/snow and leading to a mean broadband snow-reflectance reduction of 0.08 ± 0.03. This snow darkening accelerated snowmelt by ~0.41 ± 0.2 cm day^{-1} during the southern summer, equivalent to that caused by a ~1.8°C increase in air temperature. This indicates the significant impact of the 2019–2020 Australian wildfires on the hydrologic cycle in New Zealand, exceeding that of the local climate warming of ~1.5°C since the preindustrial period. Wildfire-induced snow darkening is not limited to New Zealand. Future projections of wildfire incidence indicate widespread effects of snow darkening on the global cryosphere.

Early Career Scientist

YES, I am an early career scientist.

CATCH-23B

An overview of the role of atmospheric composition within the CRiceS project

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

The polar regions are experiencing some of the most rapid climatic changes on Earth, manifesting in dramatic warming, loss of sea-ice at both poles and changing oceans. Sea ice is an integral part of the Earth system and provides key resources and services for people within the Arctic (including Indigenous peoples); supports polar ecosystems and affects human operations (e.g. shipping) in the polar regions. The newly established EU H2020 funded project CRiceS (Climate Relevant interactions and feedbacks: the key role of sea ice and Snow in the polar and global climate system) focuses on improved understanding and model descriptions of ocean-ice-snow-atmosphere chemical and biogeochemical interactions within the polar regions. This presentation provides an overview of the project, which includes four main research themes: (1) Heat, mass and momentum exchanges, (2) aerosols & clouds, (3) biogeochemical cycles/greenhouse gas exchange, and (4) integrated system understanding. Specifically, the role of aerosols and clouds within the project will be highlighted.

Early Career Scientist

NO, I am not an early career scientist.

CATCH-24C

Increasing scientific impact through combined field and modelling studies – Example: sea salt aerosol from blowing snow above polar sea ice

Dr Markus M Frey
British Antarctic Survey, Natural Environment Research Council, Cambridge, United Kingdom

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Close interaction between field scientists and modellers from the planning to the scientific exploitation of a project can ensure the legacy of scientific discovery and thereby increase its impact. I'll discuss this from the point of view of an experimental field scientist for the case of the blowing snow source of sea salt aerosol:

Recent field campaigns provide evidence of a hypothesised source of sea salt aerosol (SSA) from blowing snow (BSn) above sea ice, which can account for SSA winter/spring time maxima observed in the polar regions. A multi-disciplinary approach guided by input from modellers is used at the British Antarctic Survey to plan and carry out in-situ measurements of snow and air above sea ice in the Antarctic and Arctic under the challenging conditions of polar winter/spring. These observations are used to validate and update current model parameterisations of the blowing snow mechanism. Implementation of the updated parameterisations and sensitivity studies are then carried out in collaboration with atmospheric modelers to assess regional and global impacts on the atmospheric SSA burden, the bromine budget and tropospheric ozone. I'll discuss challenges and lessons learned for similar field-modelling studies in the future.

Early Career Scientist

NO, I am not an early career scientist.

CATCH-25A

The evolving sources of cloud condensation nuclei in the Arctic and North Atlantic: preliminary results from the SEANA project

Alexander Kurganskiy[1], Jo Browse[1], Manuel Dall'Osto[2], Amelie Kirchgaessner[3], Congbo Song[4], Roy Harrison[4], David Beddows[4], James Brean[4], Agung Ghani Kramawijaya[4], Anna Jones[3], Thomas Lachlan-Cope[3], Neil Harris[5], Valerio Ferracci[5], Zongbo Shi[4]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Shipping is one of the most significant sources of aerosols in the marine atmosphere, contributing 5-8% of global SO_2emissions and 2% of BC emissions. Secondary aerosols formed from shipping emissions, such as sulfate can directly reflect short-wave radiation and can change cloud droplet number by acting as cloud condensation nuclei (CCN). Increasing CCN can both cool and warm the surface with the forcing response (at high-latitudes) highly dependent on underlying sea-ice conditions. Quantifying the impact of shipping is challenging due to large uncertainties in the natural marine aerosol baseline, particularly at high-latitudes. Evidence suggests that in sea-ice zones CCN are primarily sourced from ocean surface fluxes, including both primary aerosol (i.e. sea-salt) and secondary precursors (i.e. dimethyl sulphide).Thus, any shipping impact will occur in conjunction with changes in the natural baseline, as sea-ice retreats. The SEANA (Shipping Emissions in the Arctic and North Atlantic Atmosphere) project aims to quantify the contribution of shipping to high-latitude CCN in the Arctic and North Atlantic region over the next 50-years in the context of evolving legislation and a rapidly shifting natural baseline, driven by sea-ice retreat.

Here we use a novel variant of the global model of aerosol processes model (GLOMAP) capable of simulating aerosol mixing state, daily sea-ice condition and salinity dependent sea-salt emissions to quantify the contribution of shipping to Arctic and North Atlantic CCN up until 2050 for a variety of anthropogenic scenarios. Our results suggest that (in some regions) present day shipping may contribute significantly to boundary layer cloud condensation nuclei (up to 14%). However, future contribution remains uncertain due to uncertainty in the evolution of natural baseline processes, which may diminish or increase background aerosol concentrations in the former sea-ice zones.

Early Career Scientist

YES, I am an early career scientist.

CATCH-26B

Modelling Study of the Arctic Clouds

Dr. Roya Ghahreman, Dr. Wanmin Gong, Dr. Stephen R. Beagley, Dr. Ayodeji Akingunola, Dr. Paul A. Makar
Environment and Climate Change Canada, Toronto, Canada

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, CCMi: Chemistry Climate Model Initiative

Abstract

Indirect effects of aerosols can occur through their impact on cloud microphysical processes and amount. In this study, aerosol effect on cloud microphysics are investigated using a fully coupled version of GEM-MACH, the Environment and Climate Change Canada's online air quality forecast model, over the Arctic during a summertime period. The model simulated thin low clouds, with liquid water path < 50 g m^{-2}, prevailing in summertime Arctic, which can have a significant effect on cloud radiative forcing in the Arctic. The model simulation confirms that aerosols smaller than 100 nm are commonly activated in most regions of the Canadian Arctic, and even smaller aerosols (< 50 nm) can activate during the relatively pristine periods.

The inclusion of atmospheric dimethyl sulfide (DMS) in the model, as a biogenic source of aerosols, leads to an increase in cloud droplet number concentrations (CDNC) with smaller sizes. Overall, smaller cloud droplets result in less precipitations, longer cloud lifetime and more clouds. The inclusion of DMS in model also improves the simulated aerosol size distribution/concentrations considerably, particularly in the size range between 60 - 200 nm. The enhancement of CDNC due to DMS is more significant (e.g. > 50 %) in the regions with higher DMS(g) mixing ratios, resulting in higher sulfate mass increases in these regions.

Early Career Scientist

NO, I am not an early career scientist.

CATCH-27C

Sea Spray Aerosol Generation Experiments in the Summertime High Arctic Pack Ice

Dr. Jessica Mirrielees[1], Dr. Rachel Kirpes[2], Dr. Carlton D. Rauschenberg[3], Allison Remenapp[4], Yao Xiao[1], Nurun Nahar Lata[5], Dr. Vanessa Boschi[4], Dr. Swarup China[5], Dr. Andrew Ault[1], Dr. Amanda M. Grannas[4], Dr. Patricia Matrai[3], Dr. Kerri Pratt[1]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Americas Working Group

Abstract

Sea spray aerosol is produced from sea ice leads under elevated wind speed conditions in the summertime High Arctic. To study the connections between seawater and sea spray aerosol composition, a series of sea spray aerosol experiments were carried out in a 210 L marine aerosol reference tank (MART) on board the icebreaker Oden during August – September 2018 as part of the Arctic Ocean 2018 Expedition (AO18) – Microbiology-Ocean-Cloud Coupling in the High Arctic (MOCCHA). Sea spray aerosol was generated during nine experiments using seawater locally collected at the marginal ice zone, the North Pole, and open leads next to an ice floe during the drift portion of the expedition. The number concentration and size distribution of the generated aerosol particles were measured during each MART experiment. Aerosol particles were also collected for subsequent offline analysis by Raman microspectroscopy, providing individual particle functional group analysis, including identification of marine organic compounds, and computer-controlled scanning electron microscopy with energy-dispersive x-ray analysis (CCSEM-EDX), providing individual particle morphology and elemental composition. Additionally, the salinity, carbon content, nitrogen content, chlorophyll concentration, and concentration of single-celled organisms in the seawater were measured for each experiment. I will discuss observed connections between seawater and sea spray aerosol composition.

Early Career Scientist

YES, I am an early career scientist.

CATCH-28A

Using both a blowing snow source and a snowpack source to model reactive bromine in GEOS-Chem

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Field studies have shown that unique chemical processes involving reactive halogens and sunlight dominate springtime photochemistry in the Arctic. These studies have also indicated that multiple mechanisms are involved, but their relative importance is still debated, both at local scales and regionally throughout the Arctic. To understand implications of these mechanisms on a pan-Arctic scale, we simulate Arctic reactive bromine chemistry using the GEOS-Chem model. Two mechanisms are included: 1) a blowing snow sea salt aerosol formation mechanism and 2) a snowpack molecular bromine production mechanism. We compare simulations including both mechanisms, either one alone, and neither to examine conditions where one process may dominate, or the mechanisms may interact. We compare the models using these mechanisms to observations of bromine monoxide (BrO) from the O-Buoy instruments and coastal observations at Utqiaġvik, Alaska during spring 2015. We find that using both mechanisms as described in literature parameterizations in conjunction leads to significant overprediction of observed BrO. In the prior modeling of the snowpack source of molecular bromine, it was assumed that yields were much larger when snow was sunlit than at night, which contributes to the observed model overprediction of BrO. Model estimations of BrO are improved by assuming a constant yield of molecular bromine from the snowpack upon ozone deposition. Using both mechanisms in conjunction improved several features of BrO observations during spring 2015, adding evidence that these mechanisms are both active and affect BrO with a similar magnitude.

Early Career Scientist

YES, I am an early career scientist.

CATCH-29B

Using gas phase, particle, and snow composition data to understand the spring shutdown of reactive bromine cycling in the Arctic boundary layer

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Americas Working Group

Abstract

Enhanced levels of reactive bromine trace gases have been observed in the springtime polar boundary layer. Bromine radicals react with elemental mercury and tropospheric ozone, causing near-surface ozone depletion events (ODEs), affecting the tropospheric oxidation capacity. A typical seasonal cycle of reactive bromine trace gases is an increase upon Polar sunrise and decline near the end of the spring until its complete shutdown. Previous studies have pointed to the correlation between the onset of snowmelt and the end of bromine recycling. However, the relative importance of factors contributing to this shutdown is uncertain. This work investigates the seasonal shutdown of reactive bromine in the Arctic boundary layer by combining trace gas, particle, and snow composition observational data from March - May 2016 during the Photochemical Halogen and Ozone Experiment: Mass Exchange in the Lower Troposphere (PHOXMELT) campaign in Utqiaġvik, Alaska, USA. Reactive bromine trace gases, including HOBr, Br_2, BrCl, and BrO, were measured using a chemical ionization mass spectrometer, and inorganic ion composition of particles and snow were analyzed with ion chromatography. Consistent with previous observations of BrO decreasing below observational limits of detection upon snowmelt, reactive bromine trace gases declined below detectable immediately upon snow melt, as confirmed by decreasing surface albedo. We examine the reservoirs of bromide in the particle and snow phases in the context of these reactive bromine trace gas data and local meteorology. With a changing climate, the onset of snowmelt is occurring earlier in the spring, affecting the recycling of reactive bromine species and its resulting impact in the Arctic boundary layer.

Early Career Scientist

YES, I am an early career scientist.

CATCH-30C

Impacts of anthropogenic emissions on tropospheric reactive halogens and the oxidation capacity of the atmosphere

Shuting Zhai[1], Xuan Wang[2], Joseph R. McConnell[3], Lei Geng[4], Jihong Cole-Dai[5], Koji Fujita[6], Shohei Hattori[7], Becky Alexander[1]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Tropospheric reactive halogen (Cl, Br, I) compounds exert wide and profound impacts on atmospheric oxidation capacity and climate. Here we use new Arctic ice core records of halogens and historical simulations from a chemical transport model to show how tropospheric halogens have been impacted by anthropogenic emissions since the 1940s. Model simulations are able to capture the observed halogen trends in the ice cores while only considering changes in anthropogenic emissions. Results suggest that anthropogenic contribution of non-sea-salt chlorine significantly influenced total chlorine and its trends after the 1940s. The modeled regional 170% inorganic reactive chlorine (Cl_y) increase from preindustrial to the 1970s was driven by acid displacement from sea-salt-aerosol, direct emission of hydrochloric acid (HCl) from combustion, and chemical reactions driven by anthropogenic nitrogen oxide (NO_x) emissions. Since the 1970s, the modeled 6% Cl_y decrease was caused mainly by reduced anthropogenic HCl emissions from air pollution mitigation policies. Our findings suggest that anthropogenic emissions of acidic gases and their emission control strategies have substantial impacts on Cl_y with implications for tropospheric oxidants, methane, and mercury.

Early Career Scientist

YES, I am an early career scientist.

CATCH-31A

Observations of iodine monoxide over three summers at the Indian Antarctic bases, Bharati and Maitri

DR Anoop S Mahajan[1], Mr Mriganka Biswas[1], Dr Steffen Beirle[2], Dr. Thomas Wagner[2], Dr Anja Schönhardt[3], Dr Nuria Benavent[4], Prof. Alfonso Saiz-Lopez[5]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Iodine plays a vital role in oxidation chemistry over Antarctica, however, observations across Antarctica are still rare, and have hitherto been mostly focused on the West Antarctic. Here, we present multi axis differential absorption spectroscopy (MAX-DOAS) based observations of IO over three summers (2015-2017) at the Indian Antarctic bases, Bharati and Maitri. IO was observed during all the campaigns, with mixing ratios below 2 pptv for the three summers, which are lower than the peak levels observed in West Antarctica. This suggests that sources in West Antarctica are different or stronger than sources of iodine compounds in East Antarctica. Vertical profiles estimated using a profile retrieval algorithm showed decreasing gradients, with a peak in the lower boundary layer. The ground-based instrument retrieved vertical column densities (VCDs) were approximately a factor of three-five higher than the VCDs reported using satellite-based instruments, which is most likely related to the sensitivities of the measurement techniques. Airmass back-trajectory analysis failed to highlight a source region, with most of the airmasses coming from coastal or continental regions. This study adds to the sparse observational database of iodine compounds in Antarctica and highlights the variation in iodine chemistry in different regions in Antarctica.

Early Career Scientist

NO, I am not an early career scientist.

CATCH-32B

Changes in the Structure of the Freeze-Concentrated Solution in the Veins of Ice due to Various Freezing Rates

Jan Zezula, Dr Gabriela Ondrušková, Mikita Bandarenka, Dr. Dominik Heger
Masaryk University, Brno, Czech Republic

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Polycyclic aromatic hydrocarbons (PAHs) are abundant atmospheric pollutants. They undergo long-distance transports, are capable of reacting, and can be deposited in water or on the surfaces of aerosols and ice. Most PAHs and their metabolites constitute toxic, carcinogenic, and mutagenic compounds which facts stress the importance of the knowledge of their fate in the environment. When water freezes, crystals of pure Ih ice are formed, and all other impurities are concentrated in the freeze-concentrated solution (FCS) in the veins between ice crystals and in puddles on the ice surface. The FCS is a specific environment differing significantly from not only the pure compounds but also the aqueous solutions.

Here we show that the rate of freezing and the cooling temperature both influence the composition of FCS, affecting the behavior of the impurities in it. We utilized the fluorescence spectroscopy of naphthalene and 1-methylnaphthalene, the models for PAHs, to study the aggregation and speciation in FCS. Most of the freezing conditions result in the vitrified glass of concentrated aromatic compounds and water. In contrast, ice-seeded samples at -5 °C, allows crystalized aromatics. Furthermore, glasses of various plasticities were observed under different conditions of cooling: cooling at 77 K resulted in a plastic glass with high water content, allowing molecular rearrangements, while slow cooling at 254 K produced a more concentrated and drier glass in the FCS. The role of sea salt concentration in the freezing processes will be also discussed.

The research shows the variability in possible outputs of the freezing processes and formation of FCS in the veins for atmospherically relevant conditions, including seawater.

Early Career Scientist

YES, I am an early career scientist.

CATCH-33C

Halogen elements in two sub-Antarctic ice cores and their suitability as sea ice proxies

Delia Segato[1,2], Dr. Elizabeth R. Thomas[3], Dr. Amy King[3,4], Dr. Bradley Markle[5], Dr. Joel Pedro[6], Dr. Andrea Spolaor[1,2]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Bromine and iodine chemistry are particularly active in the polar atmosphere and have been linked to Antarctic sea ice variability (Spolaor et al., 2013).

Here, we present the first ever bromine and iodine records from two sub-Antarctic ice cores retrieved from Bouvet and Young Island and covering approximately 16 years. Bouvet and Young Island sites have very different environmental conditions: Bouvet Island is a dominantly marine aerosol sourced location, while Young Island ocean surroundings are ice covered for most of the year. The study of halogen records from sub-Antarctic sites, together with available Antarctic coastal and interior records, allows us to better understand halogen emission from sea ice, its transport and deposition over the Antarctic region.

We find that Bouvet and Young bromine enrichment record is depleted with respect to sea-water ratio in both sites, likely meaning that bromine species are sustained in the marine boundary layer by halogen chemistry and are not prone to be deposited. Bouvet and Young iodine show a clear link with sea ice edge variability, suggesting that iodine species emitted from the thin marginal sea ice are deposited more efficiently in the sub-Antarctic region.

Bibliography

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Early Career Scientist

YES, I am an early career scientist.

CATCH-34A

Perspectives of an early career researcher in the polar ocean-ice-atmosphere interactions community

Dr. Megan Willis
Colorado State University, CO, USA

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

This presentation, or contribution to a panel discussion, will focus on my own experience as an early career scientist engaged in the polar ocean-ice-atmosphere interactions community. I will discuss the benefits and challenges, from my own experience, of engaging with IGAC and CATCH early in my career, and how these experiences have shaped both my approach to research and, mentoring of early career scientists in my own research group. I will give an overview of my groups research interests at Colorado State University, and how my research has grown out of interdisciplinary science enabled by the CATCH community.

Early Career Scientist

YES, I am an early career scientist.

CATCH-35B

Geographic distribution of fluorescent bioaerosols and roles of marine biological particles in the cloud processes over the Arctic Ocean

Kaori Kawana[1], Fumikazu Taketani[1], Kazuhiko Matsumoto[2], Takuma Miyakawa[1], Yutaka Tobo[3], Yoko Iwamoto[4], Akinori Ito[1], Yugo Kanaya[1]
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Japan National Committee

Abstract

Marine bioaerosols originating from marine biological activities are uplifted from the ocean surface to the atmosphere by wind and they could drive climate change via cloud processes by acting as cloud condensation nuclei (CCN) and ice-nucleating particles (INP). To investigate the bioaerosols over the ocean and their relationship with the marine biogenic sources, cruise observation was conducted on R/V MIRAI from 28 Sep to 10 Nov 2019, over the Arctic Ocean, the Bering Sea, and the North Pacific.

Bioaerosol particles in the ambient air were identified with an online waveband integrated bioaerosol sensor (WIBS-4) and categorized based on the fluorescence patterns in particle size. Organic gel particles from marine biota, i.e., the polysaccharidic transparent exopolymer particles (TEP) and the proteinaceous Coomassie stainable particles (CSP), were extracted from surface seawater and quantified. Additionally, physicochemical properties of aerosol particles (number-size distribution, number concentration, and chemical composition) and cloud properties as CCN and INP were also obtained by in-situ observation. Using these comprehensive data, we will discuss (1) geographic distribution and abundance of bioaerosols and their fluorescence pattern with the meteorological condition and sources, (2) the relationship between bioaerosols and oceanic biological activity underlining air-sea interaction, and (3) roles of bioaerosols for activation in the cloud processes based on the observed CCN and INP.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-1A

Understanding of the space-time variations of hydroxyl (OH) using methyl choloroform (CH_3CCl_3)

Dr. Prabir K. Patra[1,2], Prof Maarten C Krol[3], Prof. Ronald G Prinn[4], Dr Masayuki Takigawa[1], Dr. Jens Mühle[5], Dr. Steven A Montzka[6], Prof. Shyam Lal[7], Dr. Yousuke Yamashita[1], Dr. Stijn Naus[3], Dr. Naveen Chandra[1], Prof Ray F Weiss[5], Dr. Paul Krummel[8], Dr. Paul Fraser[8], Prof Simon O'Doherty[9], Dr. James W Elkins[6]
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IGAC Activities

CCMi: Chemistry Climate Model Initiative, TOAR: Tropospheric Ozone Assessment Report, ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

Trends and variability in hydroxyl (OH) radicals in the troposphere influence the production or loss of many anthropogenically produced species in the Earth's atmosphere. However, indirect estimations and process-based numerical models of OH interannual variability (OH) and northern to southern hemispheric (NH/SH) ratio produce conflicting results. Here we have used the JAMSTEC's Model for Interdisciplinary Research On Climate (MIROC, version 4.0) atmospheric chemistry-transport model (MIROC4-ACTM) for simulations of well-mixed gaseous species. MIROC4-ACTM is a well-validated chemistry-transport model for El Niño-Southern Oscillation (ENSO) related transport variabilities and interhemispheric mass-exchange time suitable for simulating atmospheric methyl chloroform (CH_3CCl_3) in the atmosphere. Firstly, we show that our ability to model the rise of CH_3CCl_3 (until 1992) and subsequent decay have improved significantly by explicitly accounting for the oceanic sink of CH_3CCl_3 (based on Wennberg et al., GRL, 2004). Based on model-observation CH_3CCl_3 mismatches we have computed consistent trends and anomalies in OH + CH_3CCl_3 reactivity using measurements from two global observational networks (NOAA and AGAGE) for the period 1985-2018. The NOAA network is managed by Montzka et al. (Science 2011; https://www.esrl.noaa.gov/gmd/hats/) and the AGAGE network is by Prinn et al. (ESSD, 2018; https://agage.mit.edu/). We conclude that global mean OH reactivity anomalies at monthly time intervals, are strongly anti-correlated with ENSO. We estimate decadal mean OH reactivities: -1.7±2.8, -1.2±2.9 and -0.12±3.0 % for the periods 1995-1999, 2000-2009 and 2010-2018, respectively, based on the NOAA network, and those using 5 AGAGE sites are 3.7±2.3, -1.3±2.7 and -1.6±3.9 % for the periods of 1995-1999, 2000-2009 and 2010-2017, respectively. The results have significant implications for the global methane budget and for other reactive species for estimation of the interannual variabilities in their emissions.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-2B

Coupling interactive fire with atmospheric composition and climate in the UK Earth System Model (UKESM)

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Abstract

Fires constitutes a key process in the Earth system (ES), being driven by climate as well as affecting the climate by changing atmospheric composition and its impact on the terrestrial carbon cycle. However, global modelling studies on the effects of fires on atmospheric composition, radiative forcing and climate have been very limited to date. The aim of this work is the development and application of a fully coupled vegetation-fire-composition-climate ES model in order to quantify the impacts of fire variability on atmospheric composition-climate interactions in the present day. For this, the INFERNO fire model is coupled to the atmosphere-only configuration of the UK's Earth System Model (UKESM). This fire-atmosphere interaction through atmospheric chemistry and aerosols allows for fire emissions to feedback on radiation and clouds changing weather which can consequently feedback on the atmospheric drivers of fire. Additionally, INFERNO was updated based on recent developments in the literature to improve the representation of human/economic factors in the anthropogenic ignition and suppression of fire. This work presents an assessment of the effects of interactive fire coupling on atmospheric composition and climate compared to the standard UKESM1 configuration which has prescribed fire emissions. Results show a satisfactory performance when using the fire-atmosphere coupling (the "online" version of the model) when compared to the offline UKESM that uses prescribed fire. The model can reproduce observed present day global fire emissions of carbon monoxide (CO) and aerosols, despite underestimating the global average burnt area. However, at a regional scale there is an overestimation of fire emissions over Africa due to the miss-representation of the underlying vegetation types and an underestimation over Equatorial Asia due to a lack of representation of peat fires.

Early Career Scientist

YES, I am an early career scientist.

CCMI-3C

Understanding the historical changes in tropospheric halogens and their impacts over the last century

Dr Tomás M Sherwen[1,2], Dr Peter D Ivatt[2], Prof. Xuan Wang[3], Prof. Lei Zhu[4,5], Shuting Zhai[6], William Downs[7], Melissa P Sulprizio[7], Prof. Becky Alexander[6], Prof. Chris D Holmes[8], Prof. Mathew J Evans[1,2], Prof. Lucy J Carpenter[2], Prof. Daniel J Jacob[7], Dr Qianjie Chen[9], Dr Christoph A Keller[10,7,11], Dr Sebastian D Eastham[12]
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Abstract

Key atmospheric species, such as ozone and OH, are profoundly affected by reactive tropospheric halogens (Cl, Br, I). The sources of reactive halogens are varied, with a mixture of natural and anthropogenic origins. In addition to changes in direct emissions over time, changes in atmospheric composition can indirectly drive changes in halogen emissions. For example the large increase in combustion NOx emissions since the 1950s causes an increase in the release of ClNO2 via uptake of N2O5 onto aerosol chloride, whereas the simultaneous increase in ozone concentrations over this period has led to an increase in oceanic emissions of inorganic iodine (HOI and I2). These changes in emissions and atmospheric composition alter the impacts of tropospheric halogens over time and in different regions.

Here we use an updated representation of halogen chemistry and emissions in the atmospheric model GEOS-Chem to explore changes in tropospheric halogen speciation, burden, and impacts over the last hundred years. We present the calculated burdens of halogens over time and explain their changing impacts on key atmospheric metrics such as oxidation capacity, surface ozone concentrations, methane lifetime, and radiative forcing. We show how the importance and impact of reactive halogens differ by decade and region, and highlight where and when omitting a representation of tropospheric halogens in climate and air-quality models could lead to the largest discrepancies.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-4A

Irreversible changes in the future global methane cycle under the aggressive-mitigation SSP1-2.6 scenario, simulated with a fully coupled, dynamic methane cycle process model in UKESM1.0.

Dr. Gerd A. Folberth, Dr. Chris D. Jones, Dr. Fiona M. O'Connor, Dr. Nicola Gedney, Dr. Alsitair A. Sellar, Dr. Andrew Wiltshire
UK Met Office Hadley Centre, Exeter, United Kingdom

Abstract

Methane (CH_4) is the second most important anthropogenic greenhouse gas. Its Global Warming Potential over 100 years (GWP_{100}) exceeds 28 times that of CO_2. Methane surface concentrations have steadily increased since the pre-industrial. In 1850 the CH_4 surface mole fraction was approximately 700 ppbv, and since then it has increased 2.5-fold to slightly more than 1830 ppbv in 2015. Fossil fuel use, raising of livestock, and cultivation of rice are the dominant contributions to the atmospheric methane burden at present with significant emissions from natural wetlands also playing a central role.

Here we present results from the UK Earth System Model (UKESM1.0). The default release version of UKESM1.0 has been extended to represent the methane cycle fully interactively, including dynamic wetlands with global CH_4 emissions, full stratospheric-tropospheric CH_4 chemistry, and CH_4 surface deposition. The extended configuration is capable of simulating the climate feedbacks on methane wetland emissions which are typically neglected in current Earth system models. Our simulation is driven with anthropogenic CH_4 emissions from CMIP6. We conducted fully-coupled transient simulations of the atmospheric CH_4 burden from 1850 to 2100 based on the historic and two future scenarios (SSP3-7.0 and SSP1-2.6).

Surface concentrations for the emissions-driven simulation show reasonably good agreement with the concentration-driven simulation, but a low bias in the fully interactive simulation gradually emerges after about 1920 which reaches approximately -250 ppbv in the 2000s. We then present a full-cycle CH_4 budget analysis based on decadal means for every 50 years between 1850 and 2100. We demonstrate that methane burden and surface mole fractions are expected to return to their 1910s values under SSP1-2.6, albeit with the natural methane sources still heavily perturbed from their state in the 1910s. We also produce a detailed analysis of the contribution of wetland CH_4 emissions for the 250 years of simulation.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-5B

Climate-driven chemistry and aerosol feedbacks in Earth system models

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IGAC Activities

Abstract

This presentation addresses the multiple pathways for aerosol and chemical feedbacks in Earth system models. Changes in climate lead to changes in the abundance of aerosols and reactive gases through their emissions and removal processes. These in turn affect climate, so amplifying or dampening the initial effect.

Chemical feedbacks play a fundamental role in determining the magnitude of the response of the climate system to external forcing from anthropogenic emissions. The latest generation of Earth system models (ESMs) include aerosol and chemistry components that interact with each other and with the biosphere. These interactions introduce a complex web of feedbacks which it is important to understand and quantify. In ESMs climate change induces changes in natural emissions of aerosols (dust, sea salt, sulphate) and reactive gases (methane, NOx, VOCs), changes in chemical reaction rates (methane and ozone) and changes in wet/dry deposition of gases and aerosols. In the model setups analysed, methane levels were prescribed, so the expected changes in methane are diagnosed analytically from emissions and loss rates.

We find that the overall climate feedback through chemistry and aerosols is negative in the Earth system model results submitted to CMIP6 due to increased negative forcing from aerosols with warmer temperatures. Through diagnosing changes in methane emissions and lifetime we find that if Earth system models were to allow methane to vary interactively, methane's positive feedbacks (principally wetland methane emissions and biogenic VOC emissions) would offset much of the aerosol feedbacks.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-6C

Turbulence-vegetation-chemistry interactions: Impacts on OH reactivity at a deciduous forest

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Abstract

The oxidation of reactive carbon fuels climate- and pollution-relevant tropospheric chemistry. Organization in turbulence can spatially segregate oxidants and reactants causing their chemical reactions to speed up or slow down compared to the rates that assume well-mixed conditions. Previous work prioritizes complex chemistry over micrometeorology in the multilayer models of forest canopies used to probe ambient oxidation above and within forest canopies. Here we trade complex chemistry for condensed chemistry with resolved atmospheric turbulence interacting with vegetation and chemistry. Specifically, we use the NCAR large eddy simulation (LES) coupled to a multilayer canopy model and a simplified chemical mechanism to quantify the impact of segregation on hydroxyl radical (OH) reactivity. Our mechanism for ozone, NO_x (= NO + NO_2), HO_x (= OH + HO_2), and isoprene chemistry has 41 reactions and 19 species. Simulations mimic summer daytime conditions at a deciduous forest. Soil emissions of NO vary across our simulations by three orders of magnitude. For afternoon conditions, OH-isoprene segregation overestimates OH reactivity inside the canopy by up to 5-12% relative to the estimate that assumes well-mixed conditions. The exact overestimate depends on the amount of NO_x. A simulation with morning sunlight and thus less vigorous turbulence shows that OH-isoprene segregation overestimates the OH reactivity by up to 58% inside the canopy. We discuss the causes of differences in segregation impacts on OH reactivity across simulations. Substantially negative covariances between OH and isoprene due to turbulence may worsen the widespread discrepancy between OH reactivity measurements and bottom-up estimates observed at deciduous forests.

Early Career Scientist

YES, I am an early career scientist.

CCMI-7A

Atmospheric Chemistry in the OpenIFS Model

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IGAC Activities

CCMi: Chemistry Climate Model Initiative

Abstract

The OpenIFS activity provides a global 3D atmospheric forecasting model for teaching and research, which is a portable version of the operational ECMWF Integrated Forecasting System (IFS). In collaborative work KNMI and ECMWF extend the OpenIFS model, based on IFS cycle CY43R3, by an interactive scheme to simulate gas-phase chemistry and aerosol. This will allow studying the interactions of atmospheric composition with processes relevant to Numerical Weather Prediction and to the longer climate time scales. This chemistry module is closely aligned with that developed in IFS for the Copernicus Atmospheric Monitoring Service (CAMS). The OpenIFS model with atmospheric chemistry is expected to form the key atmospheric component of the forthcoming EC-Earth4 community Earth System Model, and after validation this version of OpenIFS will be released to the user community. In order to optimize computing resources, two different chemical schemes are solved in the troposphere and above as detailed in Huijnen et al. (2016). Tropospheric chemistry is described by the CB05 chemical mechanism with 55 tracers and 124 reactions. Stratospheric and mesospheric chemistry is included through the mechanism developed for the Chemical Data Assimilation system BASCOE with 43 additional tracers and 217 reactions. Aerosols will be represented by the M7 model based on its implementation in the TM5 chemistry transport model (van Noije et al., 2014). Here we present an overview of the model setup and first results.

References:

Huijnen, V. et al. (2016). C-IFS-CB05-BASCOE: stratospheric chemistry in the Integrated Forecasting System of ECMWF, *Geosci. Model Dev.*, *9*, 3071–3091, https://doi.org/10.5194/gmd-9-3071-2016.

van Noije, T.P.C. et al. (2014). Simulation of tropospheric chemistry and aerosols with the climate model EC-Earth, *Geosci. Model Dev.*, *7*, 2435–2475, https://doi.org/10.5194/gmd-7-2435-2014.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-8B

Impact of heatwaves and drought stress on isoprene in a UK temperate forest: results from the 2018-2020 WIsDOM campaigns

Dr Valerio Ferracci[1], Dr Conor G. Bolas[2], Mr Frederick Otu-Larbi[3], Mr Thomas King[3], Mr John E. Beale[1], Dr Toby W. Waine[1], Dr Kirsti Ashworth[3], Prof Roderic L. Jones[2], Prof Neil R.P. Harris[1]
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Abstract

A better understanding of the emissions and global distribution of volatile organic compounds (VOCs) is crucial for an accurate characterisation of the composition and oxidising capacity of the atmosphere, especially as global change in the near future is expected to profoundly affect the drivers of VOC emissions.

We used the iDirac, a portable autonomous gas chromatograph designed for long-term VOC measurements, to monitor isoprene concentrations in Wytham Woods (Oxfordshire) throughout the summers of 2018, 2019 and 2020. Wytham Woods is a mixed temperate woodland and Oxford University's research forest. Isoprene abundances were measured continuously at multiple heights within, below and above the canopy throughout the growing season. These observations were complemented with selected ancillary variables, including air temperature, photosynthetically active radiation (PAR), occasional leaf gas exchange measurement and ambient air samples, as well as with satellite retrievals of normalised difference vegetation index (NDVI) as an indicator of ecosystem health.

The 2018 campaign overlapped with a long and uninterrupted heatwave, accompanied by moderate drought. Peak isoprene concentrations during the heatwave-drought were up to a factor of 4 higher than those before or after. However, current models of isoprene emissions could not fully account for the observed enhancement and our findings suggest that isoprene emissions increased in response to the drought. This was confirmed by the observations from the 2019 campaign, during which shorter, but more intense, heatwaves took place while the soil was fully moist, and from 2020, when short periods of high temperature were accompanied by low soil moisture. The implications of these results will be discussed in the light of projections of more frequent heatwaves and droughts at mid-latitudes in the near future.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-9C

Characterisation and Molecularly Resolved Source Apportionment of Brown Carbon Absorption by UV-Vis Spectroscopy and Atmospheric Pressure Chemical Ionisation-Mass Spectrometry

Ms. Liudongqing Yang[1,2], Dr. Sri Hapsari Budisulistiorini[3], Mr. Guorong Chen[4], Dr. Xianfeng Wang[1,2,5], Dr. Mikinori Kuwata[4,1,2,5]
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Abstract

Atmospheric brown carbon (BrC) significantly affects Earth's radiative forcing. To better understand the climatic impacts of BrC, its emission sources and atmospheric transformations are investigated. Commonly adopted techniques such as Aerosol Mass Spectrometry often involves thermal decomposition and ionization-induced fragmentation. It is thus difficult to elucidate the connection between chemical functionality and light absorptivity. As a result, molecular level characterization is needed to apportion the component contributions of BrC absorption. In this study, we conducted offline analyses of PM2.5 particles collected in Singapore from March to May 2019. Water and methanol extracts of filter samples are measured via atmospheric pressure chemical ionization-mass spectrometry (APCI-MS). To complement APCI-MS detection, sample extracts are measured with a time-of-flight aerosol chemical speciation monitor (ToF-ACSM). The chromophoric properties of samples are recorded using UV-Vis and fluorescence spectrometers. We employ statistical methods such as positive matrix factorization (PMF), non-negative least squares (NNLS), and parallel factor analysis (PARAFAC) to develop a framework to associate chemical compositions with absorption profiles. There is a good agreement (r=0.5) found between grouped factors derived from APCI-MS and ACSM. APCI-MS allows meaningful factors to be further resolved as compared to ACSM due to its increased apportionment specificity at the molecular level. Corresponding to two ACSM components, five APCI-MS factors are identified and linked to three distinct absorption profiles. Moreover, online ACSM measurements, monitored gas species, and meteorological data are analyzed to interpret factor sources. Online data is also used to evaluate the influence of atmospheric processing on organic aerosol absorption. Primary anthropogenic aerosols are found to exhibit higher absorbance in the visible range than that of secondary aerosols. In particular, one component associated with polycyclic aromatic hydrocarbon (PAH) contributes greatly to the overall absorbance. This work demonstrates the promising potential of soft ionisations in molecular level source apportionment of BrC absorption.

Early Career Scientist

YES, I am an early career scientist.

CCMI-10A

Ozone Production in U.S. Thunderstorm Convective Outflow Regions

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

Convective outflow plumes in the upper troposphere are a region where ozone (O_3) production can be prolific. Modeling studies from the 1990s estimated 4-15 ppbv O_3 produced per day for midlatitude convection, while analysis of Deep Convective Clouds and Chemistry (DC3) storms showed agreement with this estimate for a severe convection case, but even more O_3 production (20 ppbv over a 10-hour period) in the outflow of a mesoscale convective system. Photochemically, the ozone production depends on nitrogen oxides (NO_x), hydrogen oxides (HO_x) and their precursors (primarily formaldehyde, and peroxides).

Here, we use modeling tools (both box modeling and cloud-scale WRF-Chem simulations) in conjunction with DC3 and SEAC4RS observations to estimate the production of ozone in convective outflow regions. Preliminary analysis of box model calculations indicates that O_3 production increases with the severity of the thunderstorm, and this is strongly correlated with convective outflow NO_x concentrations. Because the primary source of NO_x in thunderstorms is from lightning, these correlations make sense. However, the correlation between the convective outflow NO_x concentrations and the severity of the storm is not strongly correlating, indicating that HO_x precursors influence the magnitude of O_3 production. We examine the O_3 production in the NO_x-NMVOC (non-methane volatile organic compound) regime for each of the storms and contrast O_3 production in regions with high biogenic VOCs to regions with high anthropogenic VOCs. Lastly, we examine the role of cloud physics in affecting O_3 production in convective outflow regions, because freezing of cloud drops during snow or graupel riming can modify the amount of scavenging of formaldehyde and peroxides. Preliminary results show only a small sensitivity of cloud physics on O_3 production, yet this may depend on the chemical and storm environments.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-11B

Investigating aerosol radiative adjustment mechanisms and magnitudes with model nudging

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IGAC Activities

CCMi: Chemistry Climate Model Initiative

Abstract

Many anthropogenic air pollutants are radiatively active and therefore affect climate. Consequently, future air quality control policies will influence climate change. To understand the effects of these policies on climate requires understanding of the radiative forcing associated with these pollutants. The total forcing depends on the instantaneous radiative forcing and further radiative forcing from complex 'radiative adjustments' in meteorological parameters, which together give the Effective Radiative Forcing (ERF). For example, research suggests that increased black carbon aerosol may enhance tropospheric temperature inversions, causing adjustment (specifically increase) of cloud fraction below the inversion, offsetting its positive forcing. We investigate a use of model nudging in isolating different aerosol adjustment mechanisms and constraining their magnitudes.

Global perturbation experiments were conducted for anthropogenic emissions of sulphate and black carbon aerosol using the UK Earth System Model 1 (UKESM1). Three pairs of simulations (each with one pre-industrial and one present day emissions simulation) for each species were conducted, each pair using either no nudging, nudging of horizontal winds, or nudging of horizontal winds and atmospheric temperature. By comparing ERFs and adjustments across the pairs, the magnitude and mechanisms of circulation and atmospheric temperature mediated adjustments can be determined. Replicates of each nudging pair were also conducted to test the optimum nudging setup.

For sulphate, the net adjustment forcing from atmospheric temperature mediated adjustments (~0.15 W m^{-2}) is larger in magnitude than that of circulation adjustments (~0.10 W m^{-2}). The same was found for black carbon, but with negative forcing (temperature mediated: ~-0.25 W m^{-2}; circulation: ~-0.05 W m^{-2}). For both species the majority of the temperature mediated adjustment arises from cloud responses, with some offset by other responses (e.g. humidity, surface temperature). The results depended significantly on the nudging setup used and a comparison of the different nudging setups is also given.

Early Career Scientist

YES, I am an early career scientist.

CCMI-12C

Ozone changes from past to future: characterising regional ozone sensitivity across the globe

Zhenze Liu[1], Ruth M. Doherty[1], Oliver Wild[2], Fiona M. O'Connor[3], Steven T. Turnock[3]
[1]School of Geoscience, University of Edinburgh, Edinburgh, United Kingdom. [2]Lancaster Environment Centre, Lancaster University, Lancaster, United Kingdom. [3]Met Office Hadley Centre, Exeter, United Kingdom

Abstract

Present-day (2004 – 2014) and future (2045 – 2055) ozone responses and ozone sensitivities to combined changing emissions and climate are quantified under different shared socio-economic pathways (SSPs). A more detailed chemistry scheme with more reactive VOCs implemented in the UKCA – a global chemistry-climate model demonstrates substantial increases in surface ozone concentrations in South Asia and East Asia compared with the standard UKCA chemistry scheme. In addition, the tropospheric ozone burden increases by 5 % but the ozone chemical lifetime remains stable. Surface ozone levels in North America and Europe decrease in future SSP scenarios because of reductions of emissions. However, surface ozone concentrations generally rise in South Asia and East Asia due to increases in ozone precursor emissions. While methane decreases lower O_3 concentrations, we find that reductions in ozone precursor emissions except methane are more efficient in reducing surface ozone levels than methane decreases alone. We quantify ozone sensitivity regimes for the first time across different world regions, and estimate the threshold of ratios between monthly mean NO_x to VOC concentrations to be 0.8, in order to determine NO_x and VOC limited regimes. We find that winter and summer ozone responses to emissions are varied due to seasonal changes of O_3 sensitivity. NO_x limited areas in North America, Europe, South Asia and East Asia occurred in summer would shift towards VOC limited in winter, indicating that reductions in NO_x emissions would likely to increase ozone levels in winter. This study also shows that daytime ozone responses in summer are larger than the seasonal-mean ozone changes in these regions. We highlight that the evolution of ozone sensitivity over time and by season is of key importance in determining the direction and magnitudes of ozone responses, that allow us to implement effective air quality policies in the future.

Early Career Scientist

YES, I am an early career scientist.

CCMI-13A

Insights from MOZAIC long-term routine in-situ measurements into vertical distribution, seasonal variability and tropospheric fingerprint of ice-supersaturated air masses in the northern mid-latitudes

Dr. Susanne Rohs[1], Dr. Andreas Petzold[1], Mihal Rütimann[1], Dr. Patrick Neis[1,2], Dr Florian Berkes[1], Dr Herman Smit[1], Dr Martina Krämer[3], Nicole Spelten[3], Prof. Dr. Peter Spichtinger[2], Philippe Nédélec[4], Prof. Dr. Andreas Wahner[1]
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IGAC Activities

CCMi: Chemistry Climate Model Initiative

Abstract

In the frame of the European research infrastructure MOZAIC and ist successor IAGOS long-term routine in-situ observations of atmospheric chemical composition, water vapour, and temperature are performed on a global scale by operating compact instruments on board of passenger aircraft.

In the present study, we use the full MOZAIC period from 1995 to 2010 to analyse the distribution properties of relative humidity with respect to ice (RH_{ice}) and of ice-supersaturated regions (ISSR) in the Ex-UTLS for a latitudinal band reaching from Eastern North America across the North Atlantic to Europe. The high amount of data and good resolution of MOZAIC makes it possible to analyse the structure of the vertical distribution of RH_{ice} relative to the thermal tropopause, its variability and seasonality, and potential trends. Due to the importance of ice-supersaturated regions (ISSR) in the uppermost troposphere and tropopause layers for the formation and life cycle of cirrus clouds, our study focus on ISSR occurencies. The determined seasonal cycles were compared with observations of ISSR occurrence from radio soundings and from satellite observations from AIRS and TOVs Path B instruments. Finally, for all three regions, we investigate the trends and the dependencies of ISSR occurrence on the North Atlantic Oscillation (NAO) index.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-14B

How detailed should a vegetation canopy be represented for ozone deposition impact assessments?

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Abstract

Dry deposition is an important sink of tropospheric ozone that controls surface concentrations, and impacts crop yields and the land carbon sink as a function of the ozone stomatal dose. Observational studies indicate that ozone deposition exhibits substantial temporal variability not reproduced by atmospheric chemistry and transport models (ACTMs) used for large-scale ozone deposition impact assessments. Misrepresentation of the observed temporal variability is due to a simplified or incomplete representation of vegetation uptake processes in these ACTMs. In this study, we evaluate the added value of a multi-layer formulation of ozone canopy exchange versus the commonly used 'big-leaf' parameterization in ACTMs.

We perform observation-driven simulations of ozone dry deposition fluxes and velocity ($V_d(O_3)$) with a big leaf parameterization and a Multi-Layer Canopy CHemistry Exchange Model (MLC-CHEM) representation of atmosphere-biosphere exchange, including in-canopy emissions, chemistry, turbulent mixing and dry deposition of chemical species. The simulated temporal variability, stomatal and non-stomatal components, and the seasonal ozone dose are evaluated against observations during 12 site-years at two European sites under contrasting climate and pollution conditions.

Our results highlight time-dependent mis-matches between the observed and simulated median $V_d(O_3)$ diurnal cycle for the big-leaf parameterization, ranging from 16-47%, associated with missing representation of (atmospheric) moisture controls on stomatal conductance, underestimated uptake by wet vegetation and overestimated in-canopy transport and uptake by soils. MLC-CHEM accurately simulates afternoon $V_d(O_3)$ (within 1.5% of the observations), but morning $V_d(O_3)$ is biased by -11% to 19%, mainly reflecting uncertainty associated with wet leaf ozone uptake. The big-leaf parameterization overestimates the seasonal ozone dose by 18-28% (versus -1-6% in MLC-CHEM), mainly reflecting the site-to-site differences in the representation of stomatal conductance. Our results highlight the need for an accurate description of stomatal and non-stomatal ozone uptake processes in ACTMs, benefitting surface ozone simulations and assessments of vegetation ozone damage.

Early Career Scientist

YES, I am an early career scientist.

CCMI-16A

One value of cloud pH to rule them all: The impact of an interactive cloud pH scheme on aerosols in UKESM1

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Met Office Hadley Centre, Exeter, Devon, United Kingdom

IGAC Activities

CCMi: Chemistry Climate Model Initiative

Abstract

Sulphate is a major component of particulate matter and can be formed via both gas-phase and aqueous phase oxidation. Oxidation of sulphur dioxide (SO_2) in cloud-water by reaction with ozone is an important formation mechanism for sulphate aerosol (~60% of sulphate globally) and is strongly dependent on the acidity of cloud-water. The value of cloud-water pH has previously been identified as one of the main causes in uncertainties in calculating cloud condensation nuclei concentrations in global aerosol models. The uncertainties in cloud-water pH have also been shown to have an impact on aerosol radiative forcing over recent decades. Despite the importance of this relationship, cloud water pH has tended to be represented in global composition climate models by a simplistic mechanism e.g. a single global value for all temporal and spatial locations. This assumption has potentially important consequences for the formation of aerosols and their impact on climate. Here, we present results from the implementation of a new scheme within the United Kingdom Earth System Model (UKESM), to interactively calculate the cloud-water pH. The inclusion of an interactive pH is shown to have regionally different impacts on sulphate aerosol formation. The effect of these changes on aerosol burden and aerosol radiative effects are calculated. These results show the importance of accounting for the spatial and temporal variance of cloud-water pH in global composition climate model for aerosol formation and radiative forcing.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-17B

Methane: At the Interface between Hydrology, Atmospheric Composition, Air Quality, and Climate

Dr Fiona M O'Connor, Dr Chris D Jones, Dr Gerd A Folberth, Dr Nicola Gedney, Dr Andrew J Wiltshire
Met Office Hadley Centre, Exeter, United Kingdom

Abstract

Methane is the second most important greenhouse gas in the forcing of climate after carbon dioxide and exerts indirect forcings via ozone, stratospheric water vapour, and potentially aerosols. As a result, methane emissions reductions will play an important role in a multi-gas strategy for mitigating near-term climate change and in global-scale air quality abatement. Methane has substantial natural emissions that are sensitive to climate and/or carbon dioxide, potentially resulting in the need for even larger anthropogenic emissions reductions to meet specified climate and/or air quality targets.

Despite methane's role in the Earth System, however, the current generation of Earth System Models contributing to the Coupled Model Intercomparison Project Phase 6 (CMIP6) typically prescribes surface methane concentrations - following either historical observations or specified future shared socioeconomic pathways. Here, we make use of a methane emissions-driven configuration of the UK's Earth System Model to explore the role of an interactive methane cycle, including a wetlands emissions scheme, on the model's equilibrium climate sensitivity and its transient climate response to changes in carbon dioxide concentration. We also evaluate the present-day climate forcing from changes in anthropogenic emissions of methane and other tropospheric ozone precursors since the pre-industrial era, using model simulations in which the response of methane is not constrained and interactions between methane, aerosols and clouds come into play. In addition, climate-driven feedbacks play a fundamental role in determining the climate response to external forcings and this work will investigate the impact of interactive methane on the assessment of relevant Earth System feedbacks.

This work demonstrates the need for including interactive methane in Earth System Models, thereby enabling decision makers to determine the consequences of methane emission reduction policies or potential methane removal techniques towards meeting global climate as well as global air quality targets.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-18C

Trends in global tropospheric hydroxyl radical and methane lifetime since 1850 from AerChemMIP

David S Stevenson[1], Alcide Zhao[1], Vaishali Naik[2], Fiona M O'Connor[3], Simone Tilmes[4], Guang Zeng[5], Lee T Murray[6], William J Collins[7], Paul Griffiths[8], Sungbo Shim[9], Larry W Horowitz[2], Lori Sentman[2], Louisa Emmons[4]
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Abstract

We analyse historical (1850–2014) atmospheric hydroxyl (OH) and methane lifetime data from Coupled Model Intercomparison Project Phase 6 (CMIP6)/Aerosols and Chemistry Model Intercomparison Project (AerChemMIP) simulations. Tropospheric OH changed little from 1850 up to around 1980, then increased by around 9 % up to 2014, with an associated reduction in methane lifetime. The model-derived OH trends from 1980 to 2005 are broadly consistent with trends estimated by several studies that infer OH from inversions of methyl chloroform and associated measurements; most inversion studies indicate decreases in OH since 2005. However, the model results fall within observational uncertainty ranges. The upward trend in modelled OH since 1980 was mainly driven by changes in anthropogenic near-term climate forcer emissions (increases in anthropogenic nitrogen oxides and decreases in CO). Increases in halocarbon emissions since 1950 have made a small contribution to the increase in OH, whilst increases in aerosol-related emissions have slightly reduced OH. Halocarbon emissions have dramatically reduced the stratospheric methane lifetime by about 15 %–40 %; most previous studies assumed a fixed stratospheric lifetime. Whilst the main driver of atmospheric methane increases since 1850 is emissions of methane itself, increased ozone precursor emissions have significantly modulated (in general reduced) methane trends. Halocarbon and aerosol emissions are found to have relatively small contributions to methane trends. These experiments do not isolate the effects of climate change on OH and methane evolution; however, we calculate residual terms that are due to the combined effects of climate change and non-linear interactions between drivers. These residual terms indicate that non-linear interactions are important and differ between the two methodologies we use for quantifying OH and methane drivers. All these factors need to be considered in order to fully explain OH and methane trends since 1850; these factors will also be important for future trends.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-19A

Graph Theory and Atmospheric Chemistry

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Abstract

Graph theoretical methods have revolutionized the exploration of complex systems across scientific disciplines. Here, we demonstrate their applicability to the investigation and comparison of three widely-used atmospheric chemical mechanisms of varying complexity: the Master Chemical Mechanism v3.3, GEOS-Chem v12.6, and the Super-Fast chemical mechanism. We investigate these mechanisms using a class of graphical models known as species-reaction graphs and find similarities between these chemical reaction systems and other systems arising in nature. Several graph theoretical properties are consistent across mechanisms, including strong dynamical system disequilibrium and clustering of chemically-related species. This formalism also reveals key differences between the mechanisms, some of which have characteristics inconsistent with domain knowledge; for example, isoprene and peroxy radical chemistry exhibit substantially different graph properties in each mechanism. Graph theoretical methods provide a promising set of tools for investigating atmospheric chemical mechanisms, complementing existing computational approaches, and potentially opening new avenues for scientific discovery.

Early Career Scientist

YES, I am an early career scientist.

CCMI-20B

Examining the Competition Between Oxidation and Deposition in the Fate of Reactive Organic Carbon

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Virginia Tech, Blacksburg, VA, USA

Abstract

Most of the reactive organic carbon in the atmosphere is emitted in the form of a small number of molecules and compound classes, which undergo photochemical oxidation processes in the atmosphere to form the dynamic and complex mixture of tens of thousands of compounds. To tackle this analytical challenge, a wide range of measurement techniques and modeling frameworks have been developed that classify compounds by their physicochemical properties and/or their molecular formulas. By estimating physicochemical properties of modeled and measured atmospheric oxidation products, we examine the predicted timescales for critical atmospheric transformations, particularly deposition and oxidation. To understand the potential impact of deposition on broader atmospheric chemistry, we place real-world smog chamber data into a framework of competition between loss processes and implement a simple description of deposition into a 0-d box model of photochemical oxidation. We further quantify the extent to which the molecular structure of each compounds impacts the transformations and fates of organic compounds in the atmosphere. A substantial fraction of atmospheric organic compounds is found to have competitive timescales for oxidation and deposition, particularly in the case of semi-volatile oxygenated gases that are likely to form aerosol upon further oxidation. Reactive organic carbon in these transition regimes account for a major fraction of both atmospheric reactivity and potential for secondary aerosol formation, suggesting the need for improved constraints on removal processes to reduce uncertainty in modeled aerosol formation.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-21C

Reactive nitrogen in global upper troposphere from NASA DC8 and MOZAIC aircraft campaigns

Miss Nana Wei[1], Dr. Eloise A. Marais[2], Dr. Robert Ryan[2], Mr. Gongda Lu[3], Dr. Paul O. Wennberg[4], Miss Hannah M. Allen[4], Dr. John D. Crounse[4], Dr. Donald R. Blake[5], Dr. Greg L. Huey[6], Dr. Andy J. Neuman[7], Dr. Patrick R. Veres[7], Dr. Chelsea R. Thompson[7], Dr. Ilann Bourgeois[7], Dr. Jeff Peischi[7], Dr. Bastien Sauvage[8]
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IGAC Activities

GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report

Abstract

Reactive nitrogen in the oft underappreciated upper troposphere (~8-12 km) impacts global climate, air quality and the oxidizing capacity of the whole troposphere. Here we use aircraft observations from instruments onboard the NASA DC8 aircraft for campaigns from 1997 (SONEX) to the recent ATom campaign (2016-2018) to address uncertainties in the dynamics of reactive nitrogen (NO_y = NO_x + NO_x reservoir compounds) in the global upper troposphere (UT). Our initial analysis of the DC8 aircraft observations is consistent with previous work in that PAN is the dominant NO_y component (average: 43%; range: 40-60%), followed by NO_x (on average 21%), and nitric acid (on average 12%), with smaller contributions (on average 5-7%) from pernitric acid, and organonitrates. We also find that seasonal mean DC8 NO_y is similar in spatial distribution and magnitude to seasonal multiyear means from the commercial MOZAIC aircraft campaign, supporting the use of DC8 to assess our best understanding of global NO_y and its components in the UT by comparison to the GEOS-Chem model.

Early Career Scientist

YES, I am an early career scientist.

CCMI-22A

A large source of formic acid from cloud droplets

Domenico Taraborrelli[1], Bruno Franco[2], Thomas Blumenstock[3], Changmin Cho[1], Lieven Clarisse[4], Cathy Clerbaux[2,5], Pierre-Francois Coheur[2], Martine De Mazière[6], Isabelle De Smedt[6], Hans-Peter Dorn[1], Tamara Emmerichs[1], Hendrik Fuchs[1], David Griffith[7], Sergey Gromov[8,9], James Hannigan[10], Frank Hase[3], Thorsten Hohaus[1], Nicholas Jones[7], Astrid Kerkweg[1], Erik Lutsch[11], Emmanuel Mahieu[12], Anna Novelli[1], David Reimer[1], Simon Rosanka[1], Ivan Ortega[10], Clare Paton-Walsh[7], Matthieu Pommier[13], Andrea Pozzer[8,14], Rolf Sander[8], Matthias Schneider[3], Kimberly Strong[11], Ralf Tillmann[1], Michel Van Roozendael[6], Luc Vereecken[1], Corinne Vigouroux[6], Andreas Wahner[1], Astrid Kiendler-Scharr[1]
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Abstract

Formic acid is a pervasive trace gas in the troposphere. It enhances cloud droplet activation and contributes to determining the acidity of clouds and rain. Despite many efforts, knowledge of its tropospheric budget is unsatisfactory as state-of-art models considerably underestimate its burden. Models inferring either photochemical sources or large emissions fail to reproduce the measured concentrations. This is an indication that relevant key processes still elude our understanding. In this study we present lab evidence and theoretical predictions of how formic acid is efficiently formed by oxidation of hydrated formaldehyde, methanediol, outgassing from cloud droplets. Explicit representation of these processes in a global atmospheric chemistry model allows us to estimate that this novel pathway could provide a source of formic acid 2-4 times the known sources combined. We show that this pathway can bring the model predictions close to remote-sensing measurements. The pathway we discovered leads to an increase of the acidity of cloud and rain especially over the continents. These results are an advancement towards consistent mechanisms for a more realistic representation of organic carbon oxidation in the atmosphere. The oxidation framework we present here is also valid for higher carbonyl compounds and can account for the large atmospheric source of more complex organic acids which influence aerosol growth and cloud formation.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-23B

The NOAA Baseline Balloon Stratospheric Aerosol Profiles (B2SAP) Project

Elizabeth Asher[1,2], Michael Todt[1,2], Emrys Hall[3,2], Allen Jordan[3,2], Patrick Cullis[3,2], Kensy Xiong[3,2], Dale Hurst[3,2], Troy Thornberry[4]
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Abstract

Given the increasing consideration of the potential for climate intervention using stratospheric aerosols, more intensive measurement efforts are needed to characterize stratospheric aerosol microphysics and establish a stratospheric baseline in regards to both the mean and geophysical variability. The baseline composition state includes concentrations of trace gases and the aerosol size distribution, chemical composition and radiative properties. These parameters generally vary with altitude, latitude, season and meteorological conditions in the stratosphere. Spaceborne measurements provide important global-scale observations of stratospheric aerosol, but unlike in situ measurements, cannot measure aerosol size distributions directly. Systematic in situ measurements from multiple locations will yield improved insight into stratospheric aerosol microphysical processes, including the temporal and spatial variability in aerosol burden and properties created by volcanic eruptions and pyrogenic aerosol injections or anthropogenic perturbations.

In this presentation we describe a balloon sonde program, the Baseline Balloon Stratospheric Aerosol Profiles (B^2SAP) Project, to obtain baseline information on stratospheric aerosol loading and properties. The sonde payload includes a light-weight optical particle spectrometer (POPS) to measure aerosol number concentrations and size distributions in the 140-2500 nm diameter range. To investigate variations in stratospheric aerosol properties, POPS instruments, along with frost point hygrometers (FPH) and ozonesondes, are being launched approximately twice per month from Boulder, CO and less frequently from Lauder, NZ. Vertical profiles of stratospheric aerosol number concentration and size distribution measured since 2019 as part of the B^2SAP project and SAGE III-ISS aerosol retrieval validation efforts will be shown, and observations of distinct layers in the lower stratosphere produced by pyrogenic injections and volcanic eruptions will be discussed in relation to their radiative impacts and influence on stratospheric ozone. In the near future, we plan to begin augmenting these profiles with regular soundings from other locations across a range of latitudes from tropical to polar.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-24C

Dynamical downscaling of a global chemistry-climate model to study the influence of climate change and variability on mid-21st century $PM_{2.5}$ in the continental US

Surendra Kunwar[1], Jared Bowden[2], George Milly[3], Michael Previdi[3], Arlene Fiore[3], Jason West[1]
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Abstract

Anthropogenically induced climate change and associated feedback from natural emissions (biogenic VOCs, wildfires) have the potential to alter air quality in the coming decades, but noise from climate variability can confound the climate change signal. Here, we aim to quantify the impacts of climate change and variability on US $PM_{2.5}$ levels at fine spatial resolution, by combining probability distributions from multi-year global model ensembles with downscaling over the continental US.

We use a 3-member ensemble of simulations varying only in initial conditions from the GFDL-CM3 global chemistry-climate model (at 2° spatial resolution) for the period 2006-2100 under the RCP8.5 scenario. To isolate the impact of climate change on air quality, the GFDL-CM3 simulations fix aerosol and O_3 precursor emissions at 2005 levels. Empirical Orthogonal Function (EOF) analysis of the simulations is used to identify eastern US regions that vary coherently, from which we carefully select four present (2006-2020) and four future (2050-2060) years that include several high and medium annual mean $PM_{2.5}$ levels.

We dynamically downscale the GFDL-CM3 meteorology and chemistry to 12-km with the regional models WRF and CMAQ, for the selected years. The 3-member GFDL-CM3 and another global model NCAR CESM (12-member ensemble, 1° spatial resolution) run under the same future scenario as GFDL-CM3, provide a broader context for the downscaled CMAQ simulations, and give an unprecedented set of statistics. Using the results of CMAQ downscaling, we then construct mean annual $PM_{2.5}$ probability distributions for the present and the future in individual 12 km grid cells.

By examining the differences in fine scale mean annual $PM_{2.5}$ distributions between the present and the future, we quantify the effects of climate change and variability on $PM_{2.5}$. We also analyze the meteorological drivers of future air quality changes in the global and regional model simulations.

Early Career Scientist

YES, I am an early career scientist.

CCMI-25A

Two proxies reflect OH variability on local scales in the remote atmosphere

Colleen Baublitz[1,2], Arlene M. Fiore[1,2], Lee T. Murray[3], Lukas Valin[4], Julie M. Nicely[5], Michael Prather[6], Glenn M. Wolfe[5], Róisín Commane[1,2], Gus Correa[2], Bryan Duncan[5], Melanie Follette-Cooke[5], William H. Brune[7], Samuel R. Hall[8], Kirk Ullmann[8], Glenn S. Diskin[9], Thomas F. Hanisco[5], Jason St. Clair[5], Thomas B. Ryerson[10], Chelsea Thompson[11], Jeff Peischl[10], Ilann Bourgeois[10], Bruce Daube[12], David Miller[7], Alexander Thames[7], Thaopaul V. Bui[13], Paul O. Wennberg[14], John D. Crounse[14], Hannah Allen[14], Michelle Kim[14], Steven C. Wofsy[12]
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Abstract

The hydroxyl radical (OH), the primary atmospheric oxidant, is a critical constituent of atmospheric chemistry as the main sink for methane and a precursor to tropospheric ozone. However, its lifetime is less than a second, precluding the development of a representative measurement network. Here we apply observations from the NASA Atmospheric Tomography (ATom) aircraft campaign to assess the skill of two proxies for OH variability in the remote atmosphere on the smallest scales yet considered for any method aimed at inferring OH. We first consider formaldehyde (HCHO), which is produced from the reaction of methane with OH and can reflect OH variability if the dominant loss process is by photolysis, rather than by reaction with OH. We use ATom measurements to demonstrate that these conditions hold throughout the remote atmosphere, in all four seasons, in ~1 km altitude, 10° latitude spatial bins. Second, we consider a convolved set of terms related to OH steady-state chemistry: the rate of ozone photolysis to produce $O(^1D)$ (J_{O3}), the concentrations of water vapor (H_2O) and carbon monoxide (CO), and the sum of nitric oxide and nitrogen dioxide, NO_x ($NO_x = NO + NO_2$). With the F0AM 0-D box model driven with ATom observations, we show that the terms integrated in our steady-state proxy capture most of the variance in OH production ($J_{O3}[H_2O][NO_x]$) or loss ([CO]), respectively. Through a correlation analysis, we find that both proxies are able to capture the majority of the tropospheric OH variability ($r^2 > 0.5$) measured during ATom across spatial bins and seasons. This work is a step towards developing new observational proxies for OH, such as from satellite products. Such proxies can provide stronger constraints on the global models that rely heavily on OH in projecting atmospheric composition and climate.

Early Career Scientist

YES, I am an early career scientist.

CCMI-26B

Viscosity of Secondary Organic Aerosol: Effects of Composition and Oxidation Method

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IGAC Activities

CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Forests emit large quantities of volatile organic compounds (VOC) into the troposphere. Upon oxidation, lower volatility products condense and form secondary organic aerosol (SOA). SOA constitutes a large mass fraction of submicron atmospheric aerosols. SOA is important for air quality and influences climate. Information on the viscosity of SOA is needed to predict their role in air quality and climate. For example, the viscosity of SOA can impact the growth and evaporation rate of SOA, their ability to act as ice nucleating particles, and their ability to transport pollutants over long distances. Nevertheless, the viscosity of SOA remains uncertain. Here we report viscosities as a function of relative humidity for SOA derived from terpene and sesquiterpene photooxidation and dark ozonolysis. From the measured viscosities and the Stokes-Einstein equation, we determined diffusion coefficients and mixing times of organic molecules within the SOA. We show that particle viscosity and mixing times within the SOA depends strongly on the oxidation method and the type of VOC used to generate the SOA. Photooxidation lead to higher viscosities compared to dark ozonolysis, and a complex mixture of VOCs resulted in a higher SOA viscosity compared to SOA generated from α-pinene alone.

Early Career Scientist

YES, I am an early career scientist.

CCMI-27C

Tropospheric Age-of-Air: Influence of SF_6 Emissions in Recent Surface Trends and Model Biases

Clara Orbe[1], Darryn W. Waugh[2], Stephen A. Montzka[3], Edward J. Dlugokencky[3], Susan Strahan[4,5], Stephen Steenrod[4,5], Sarah Strode[4,5]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative

Abstract

The mean time (or mean age) since air was last at the Northern Hemisphere (NH) midlatitude surface is a fundamental property of tropospheric transport. Here we present new observational estimates of the mean age, derived from a network of surface and in-situ aircraft measurements of SF_6 that is much broader in spatial scope and covers a longer time period (1997-2018) than considered in previous studies. In particular, we approximate the mean age in terms of an "SF_6 age" (Γ_{SF6}), or the time lag since the SF_6 mixing ratio over a northern midlatitude source region equaled the mixing ratio at that location. At the surface, we show that Γ_{SF6} increases from near-zero values north of 30^{o}N to ~1.5 years over the Southern Hemisphere (SH) extratropics. Furthermore, the surface meridional gradients in Γ_{SF6} are larger in the tropics and weaker in the extratropics; by comparison, vertical gradients in Γ_{SF6} are consistently weak over all latitudes, with only slight increases/decreases of age with height in the NH/SH.

An analysis of trends in Γ_{SF6} over the period 1997-2018 reveals that the SF_6 age has been decreasing nearly uniformly by ~0.12 yr/dec. Quite importantly, however, these decreases are not due to underlying changes in transport but, rather, are associated with a southward shift in SF_6 emissions from northern midlatitudes into the northern subtropics. This is demonstrated in simulations using the NASA Global Modeling Initiative chemistry transport model, which reproduce the SF_6 age trends but show no corresponding decreases in an age-of-air or "clock" tracer. Finally, consistent with previous studies, we show that the modeled SF_6 ages are older than observed, by ~0.3-0.4 years throughout the southern extratropics. We show that this bias is due partly -- but not entirely – to an overestimation in the simulated SF_6 mixing ratios in emissions regions, which result in larger overall SF_6 mixing ratios over northern midlatitudes (and, hence, older ages south of the source region).

Early Career Scientist

NO, I am not an early career scientist.

CCMI-28A

Observed and simulated effects of droughts and heatwaves on ozone concentration in Southern Europe

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[2]LMD/IPSL, Ecole Polytechnique, Institut Polytechnique de Paris, ENS, PSL Université, Sorbonne Université, CNRS, Palaiseau, France

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Extreme weather events significantly impact atmospheric chemistry and are often associated with severe pollution episodes. Among these extremes, the frequency and intensity of heatwaves and droughts have increased over the last decades in the Mediterranean area. Heatwaves influence atmospheric chemistry through atmospheric conditions (e.g. air stagnation, enhanced temperature and radiation) and biosphere-atmosphere interactions (e.g. increased biogenic emissions and reduced dry deposition). The effect of droughts is less known.

This study aims to quantify the impact of isolated and combined droughts and heatwaves on ozone in Southern Europe. These extreme conditions are identified using percentile limit anomalies of surface temperature and soil dryness simulated with the coupled meteorological (WRF) and land surface (ORCHIDEE) regional model (RegIPSL) for the 1979-2016 time period. Atmospheric chemistry has been simulated using the CHIMERE regional model over three selected summers (2012, 2013 and 2014) and analysed in conjunction with observations from the European surface network AQ e-Reporting (EEA).

The combined analysis of satellite observations and simulations shows that heatwaves and droughts significantly impact the biosphere through larger wildfires (observed burned area two times larger) and decreased leaf area index (LAI) during dry conditions (-10% of observed LAI). The analysis of both observations and simulations of surface O_3 shows a mean enhancement in surface of ~12µg/m^3 (10%) during heatwaves and ~5µg/m^3 (4.2%) during droughts. Heatwaves result in an increase of biogenic emissions of organic compounds (e.g. +31% isoprene), precursors of ozone formation. During droughts, biogenic emissions increase but to a lesser extent (e.g. +24% isoprene): biomass reduction is compensated by favourable weather. Two types of droughts have been identified: hot droughts combined with a heatwave and those isolated, fresh droughts, during which O_3 concentration is lower. The relative influence of biogenic and fire emissions to the observed and simulated signals will be discussed.

Early Career Scientist

YES, I am an early career scientist.

CCMI-29B

Climatological pattern of hydrocarbon in the UTLS region associated with the Australian Bushfires

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IGAC Activities

Abstract

In this study, we examined the long-term (FEB.2004 – FEB.2020) vertical distributions of six hydrocarbons (C_2H_2, C_2H_6, CH_3OH, HCOOH, and HCHO), including CO and HCN, in Upper Troposphere and Lower Stratosphere (UTLS) from the Australian bushfires. We analyzed hydrocarbons mixing ratio retrieved from Atmospheric Chemistry Experiment-Fourier Transform Spectrometer (ACE-FTS) version 4.1 and fire count as fire property retrieved from MODIS Collection 6 level 2 products (MOD14 and MYD14) over Australia. Since the trajectory from the HYSPLIT modeling reveals the eastward transport of air masses from the Australian bushfire region, we investigated the hydrocarbon pattern over the Pacific located in the east of Australia. We found the general enhancement of hydrocarbons in austral spring (SON) when the bushfire usually occurs dominantly. Correlation coefficients (R) between the hydrocarbon mixing ratio and fire counts are moderately high (R = ~0.5 to 0.7) in the upper troposphere, but low in the lower stratosphere, showing that the regional bushfire events can contribute to the increase of tropospheric hydrocarbon amounts. HCHO, however, shows the exception: no enhancement during the fire season and no correlation with the fire count. It might be possible that the amount of HCHO is more controlled by other sources such as the biogenic emission, or attributed to relatively short lifetime (~ several hours). Further research will be required for the better understanding about the relationship between the quantity of hydrocarbons and the activity of bushfires.

Early Career Scientist

YES, I am an early career scientist.

CCMI-30C

Intercomparison of Ground- and Satellite-Based Total Ozone Column Data at Three stations, Antarctic Region

SONGKANG KIM[1], Sang-Jong Park[2], Hana Lee[1], Dha Hyun Ahn[1], Yeonjin Jung[3], Taejin Choi[2], Bang Yong Lee[2], Seongjoong Kim[2], Ja-Ho Koo[1]
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Abstract

In orger to monitor the Total Ozone Column (TOC) over Antarctica Brewer spectrophotometers (Brewer) have been installed in many ground-based stations. As a result, long-term record of TOC measurement by the Brewer is now available, which is very useful data to apply the validation of satellite TOC measurement. Using the TOC data at three Brewer stations (King Sejong, Jang Bogo, and Zhongshan station), this study performed intercomparison with TOC measurements by multiple polar-orbit satellite instruments: Ozone Monitoring Instrument (OMI) and Atmospheric Infrared Sounder (AIRS) of Aqua satellite, TROPOspheric Monitoring Instrument (TROPOMI) of Sentinel-5 Precursor satellite, Global Ozone Monitoring Experiment (GOME-2) of MetOp satellite, Ozone Mapping and Profiler Suite (OMPS) of Suomi-NPP satellite. Generally we found a good correlation between Brewer and satellite TOCs. The lowest correlation was found with the AIRS TOCs, which looks resulted from the poor performance in austral spring. Also we used both Level 2 and 3 data for the analysis because the difference among satellite products are usually attributed to the spatial resolution. Our analyses about the correlation between the Brewer and satellite TOCs, however, did not show large difference between level 2 and level 3, implying that 'which satellite is used' induces large difference than 'which spatial resolution is considered'. Therefore, it seems necessary to use the multiple satellite product simultaneously for the diagnosis of Antarctic TOC pattern.

Early Career Scientist

YES, I am an early career scientist.

CCMI-31A

Direct Comparison of the Submicron Aerosol Hygroscopicity of Water-Soluble Sugars

Kotiba Malek[1], Joseph Dawson[2], Patricia Razafindrambinina[1], Dr. Akua Asa-Awuku[1], Dr. Timothy Raymond[3], Dr. Darbina Dutcher[3], Dr. Miriam Freedman[2]
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Abstract

Water-soluble organic compounds (WSOCs) are ubiquitous in the atmosphere and play a major role on climate by readily absorbing water and forming cloud droplets. Hence, exploring the water uptake extent of WSOCs can improve our understanding of their impact on cloud formation, and consequently, their impact on climate. In this study, the subsaturated and supersaturated droplet growth of four atmospherically relevant WSOCs: levoglucosan, sucrose, raffinose, and trehalose were measured using three droplet growth analytical methods. Specifically, Cavity ring-down spectroscopy (CRDS), hygroscopic tandem differential mobility analysis (H-TDMA), and cloud condensation nuclei (CCN) counting were used to retrieve the optical growth factors (fRH), geometric growth factors (G_f), and critical activation diameters (d_p50) per aerosol system. For each technique, the hygroscopicity parameter (κ) was deduced using köhler theory and reported for the four WSOCs measured. The κ values obtained from all three techniques were comparable in precision, and consistent with known values. In addition, across all experimental methods, molecular weight showed to be inversely correlated with hygroscopicity.

Early Career Scientist

YES, I am an early career scientist.

CCMI-32B

Hemispheric Lightning NOx Emissions and the Impact on Ground-Level Ozone

Mike Madden[1], Daiwen Kang[2], Golam Sarwar[2], Christian Hogrefe[2], Rohit Mathur[2], Barron H Henderson[2]
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IGAC Activities

GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

As anthropogenic emissions decrease in parts of the world, the roles of natural emissions in modulating ground-level ozone (O3) become more pertinent to atmospheric chemistry and regulatory applications. Research shows that lightning is a candidate for natural emissions studies because it produces nitrogen oxides (NOx), which significantly impact the upper-tropospheric O3 budget and subsequently the oxidative capacity of the atmosphere. Additional studies must occur to better understand the fate of lightning-generated NOx (LNOx) because its impacts on surface O3 levels are not well quantified.

Coupled models, such as WRF-CMAQ (Weather Research and Forecasting Model / Community Multiscale Air Quality Modeling System), can quantify the effects of LNOx upon surface O3. Specifically, WRF-CMAQ can simulate LNOx using high-detection efficiency flash data from the National Lightning Detection Network (NLDN); however, this dataset is expensive and restricted to studies inside the contiguous United States (CONUS). For modeling domains outside the CONUS and hemispheric studies, researchers must use low-cost, low-detection efficiency flash datasets, such as the World Wide Lightning Location Network (WWLLN). While WWLLN is valuable for global applications, its low-detection efficiency introduces uncertainty, especially with regions and periods of active convection.

To address this issue and gain additional understanding of LNOx, multiple annual hemispheric WRF-CMAQ simulations were conducted with varying configurations. A control simulation is conducted with no LNOx. Then, two simulations are conducted using WWLLN data - one with hourly flash data, and the other with static flash parameters. Two additional simulations are performed using adjusted WWLLN data and adjusted static flash parameters to reflect NLDN climatology. We analyze results by comparing predictions with observed data and against another simulation that was prepared with Global Emissions InitiAtive (GEIA) climatological lightning emissions data. If the adjusted WWLLN simulations perform well, then future studies can incorporate these adjustments until a global, high-detection efficiency flash dataset materializes.

Disclaimer. The views expressed in this abstract are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency (EPA)

Early Career Scientist

YES, I am an early career scientist.

CCMI-33C

Observational Metrics that Relate to the Answers we seek from Chemistry-Climate Models

Michael J. Prather
UC Irvine, Irvine CA, USA

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Global atmospheric chemistry models have become more complex in terms of running coupled historical simulations within an Earth system model, and thus far more difficult to evaluate in terms of skill in simulating the chemistry of the atmosphere. The use of chemistry-climate models in policy-relevant assessments like the IPCC, however, require chemistry models that are reliable and tested, i.e., skillful in simulating the current atmosphere. Collectively, we have developed model-measurement tests (i.e., metrics of model performance) over the past three decades. Unfortunately, these metrics usually change from assessment to assessment. Unlike the climate community, we mostly do not to grade individual model performance, thus we lose a traceable confidence level in assessment projections, and fail to document model development. In this talk, we propose a number of "relational" model metrics based on solid observations of quantities that are closely related to the answers we seek from the CCMs. Primarily, these focus on the tropospheric budgets of ozone and methane and can be readily graded. The goal is to have a standard set of model simulations, diagnostics, and related metrics that the modeling community and centers can support, and that only improve and become more rigorous with better observations.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-34A

Impacts of future land use and land cover change on mid-21st-century dust air quality

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group, Southern Hemisphere Working Group, Americas Working Group, China Working Group

Abstract

Mineral dust plays an important role in global air quality and climate. Land use and land cover is one of the critical factors influencing dust concentration. Land use and land cover change (LULCC) can affect dust concentration “biogeochemically”, i.e., via dust emission and dry deposition. LULCC can also alter regional- to large-scale climate through modifying underlying surface of the atmosphere, which can lead to meteorological changes in such as surface wind and precipitation and ultimately affect dust “biogeophysically”. However, such biogeophysical effects of LULCC on dust are largely understudied.

The projected global LULCC scenarios of the mid-21st century were adopted to examine the dust concentration change through the two above mentioned pathways. In particular we qualified the impacts of future LULCC on springtime dust concentration, by integrating the CESM CAM-chem with LULCC according to RCP8.5. Significant increase of dust concentration is found in the East Asia desert domain such as Teklimakan Desert and Gobi Desert and its downstream regions due to LULCC of RCP8.5. The dust concentration increase is around 20% in these regions, which is driven by both stronger local surface wind speed (biogeophyscial) and more dust emission (biogeochemical). In RCP8.5 LULCC, there consistent reduction in forest is found in tropical areas, with the result of reduced roughness length; at the same time there is stronger equatorial surface wind. The northern Hemisphere Hadley Cell is found shifted to the north, together with a systematically northward shifting subtropical jet. The change of circulation eventually leads to stronger surface westerly winds in Teklimakan Desert and Gobi Desert regions, resulting in the dust concentration increase. Overall, the future LULCC of globe can affect East Asian dust concentration simultaneous through biogeophysical way. The rapid desertification in tropical regions could have significant remote effects on dust concentration in the East Asia desert regions.

Early Career Scientist

YES, I am an early career scientist.

CCMI-35B

A Simplified Chemistry-Dynamical Model

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IGAC Activities

CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

Japan National Committee

Abstract

Recent observational and modeling studies show that variations of stratospheric ozone and the resulting interaction between ozone and the stratospheric circulation play an important role for surface weather and climate. However, in many cases computationally expensive coupled chemistry models have been used so far to study these effects. Here, we demonstrate how a much simpler idealized general circulation model (GCM) can be used for studying the impact of interactive ozone on the circulation. The model, named simplified chemistry-dynamical model (SCDM), is constructed from a preexisting idealized GCM, into which a simplified linear ozone scheme and a parameterization for the shortwave radiative effects of ozone are implemented. The distribution and variability of stratospheric ozone simulated by the new model are in good agreement with the MERRA2 reanalysis, even for extreme circulation events such as Arctic stratospheric sudden warmings. The model thus represents an economical new tool for the study of ozone-circulation interaction in the stratosphere and the associated effects on tropospheric weather and climate.

Early Career Scientist

YES, I am an early career scientist.

CCMI-36C

Study of Different Carbon Bond 6 (CB6) Mechanisms by Using a Concentration Sensitivity Analysis

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Nanjing University of Information Science and Technology, Nanjing, Jiangsu Province, China

Abstract

Different versions of the Carbon Bond 6 (CB6) mechanism have been developed. However, the discrepancies in simulation results brought about by the modifications between different versions of the CB6 mechanism are still not fully understood. Therefore, we investigated the behavior of three different CB6 mechanisms (CB6r1, CB6r2 and CB6r3) in simulating ozone (O_3), nitrogen oxides (NO_x) and formaldehyde (HCHO) under an urban condition, by applying a concentration sensitivity analysis in a box model. The results show that when the surface emission is excluded, the O_3 level predicted by CB6r1 is approximately 6 % and 8 % higher than that predicted by CB6r2 and CB6r3, specifically due to the change in the sink of CXO3 in the mechanism. In contrast, the levels of NO_x and HCHO estimated by these three CB6 mechanisms are mostly similar, when the surface emission is turned off. After adding the surface emission, the simulated profiles of O_3, NO_x and HCHO obtained by CB6r2 and CB6r3 are similar. However, the deviation between the O_3 levels provided by CB6r1 and the other two CB6 mechanisms (i.e. CB6r2 and CB6r3) is enlarged, because of the weakening of the ozone dependence on the emission of isoprene in CB6r1. Moreover, HCHO predicted by CB6r1 is found larger than that predicted by CB6r2 and CB6r3, which is caused by an enhanced dependence of HCHO on the emission of isoprene in CB6r1. Regarding to NO_x, it was found that CB6r1 gives a higher value during the daytime and a lower value during the nighttime than the other two mechanisms, which is caused by the relatively stronger connection between the NO_x prediction and the local chemistry in CB6r1, so that more NO_x is consumed and converted to PANX (peroxyacyl nitrate with three and higher carbons) in the nighttime and more NO_x is reformed by the photolysis of PANX in the daytime.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-37A

Observationally constrained analysis of sulfur species in the marine atmosphere

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

The NASA Earth Venture (EV2) Atmospheric Tomography Mission (ATom) provided rich gas and aerosol measurements over the global oceans. In this study, we investigate the sulfur species of dimethyl sulfide (DMS), sulfur dioxide (SO2), methane sulfonic acid (MSA), and sulfate (SO4) that were measured during the ATom aircraft campaigns and simulated by the NASA GEOS model. This study covers remote regions over the Pacific, Atlantic, and Southern Oceans from near the surface to ~12 km altitude and covers all four seasons. We examine the vertical and seasonal variations of these sulfur species over tropical, mid-, and high latitude regions in both hemispheres. We reveal their origins from land versus ocean and from anthropogenic versus natural sources. We discuss current potential problems in the GEOS model sulfur simulation revealed by the ATom measurements from process levels, such as emission, chemistry, and dry/wet deposition.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-38B

Revising the Ozone Depletion Potentials Metric for Short-Lived Chemicals Such as CF3I and CH3I

Dr. Jun Zhang[1], Professor Donald Wuebbles[1], Dr. Douglas Kinnison[2], Dr. Alfonso Saiz-Lopez[3]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group, MANGO: Monsoon Asia and Oceania Networking Group, China Working Group

Abstract

Ozone depletion potentials (ODPs) are an important metric in national and internationalpolicy for evaluating the relative importance of different gases to affecting stratospheric ozone. Inevaluating the ODPs of iodotrifluoromethane (CF3I) and methyl iodide (CH3I) using the recently updatedunderstanding of atmospheric iodine chemistry, only minor ozone loss would be expected to occur in thestratosphere from the very short-lived (~6 days) CF3I, with slightly larger destruction of stratosphericozone from CH3I (~12 days). In addition, most of the ozone destruction would likely occur in the lowertroposphere over continental surfaces, reducing anthropogenic ozone pollution. The traditional ODPconcept uses total column ozone change, but this is not an accurate representation of potential future use ofvery short-lived substances (VSLSs) on the abundance of stratospheric ozone. A new metric, StratosphericODP (or SODP), is defined that only accounts for stratospheric ozone loss, providing a useful additional toolfor policy considerations of VSLSs on stratospheric ozone.

Early Career Scientist

YES, I am an early career scientist.

CCMI-40A

Evaluation of CMIP6 model simulations of PM2.5 components in China

Fangxuan Ren
Peking University, Beijing, China

Abstract

The direct and indirect climate effects of $PM_{2.5}$ components play an important role in climate change. Due to the late large-scale $PM_{2.5}$ monitoring in China, the observation data is lacking. Therefore, there are few evaluations on $PM_{2.5}$ components simulations. Our research use $PM_{2.5}$ satellite data and observed surface $PM_{2.5}$ components(OC, BC, SO_4^{2-}, NO_3^-, NH_4^+) concentrations collected from the literature to evaluate the simulation results of 14 models from the Sixth Coupled Mode Interomparison Project(CMIP6) from 2000 to 2014. The analysis shows that the self-defined $PM_{2.5}$ of each model has a high concentration in eastern China, which is consistent with the satellite data. However, six models' self-defined $PM_{2.5}$ concentrations have false high values in western China. The self-output $PM_{2.5}$ concentrations of eight models are generally underestimated but increase year by year in high anthropogenic emission areas such as eastern and central China. The variation is also greater than satellite data. The simulation concentrations of OC, BC, SO_4^{2-}, NO_3^- and NH_4^+ are higher in the southeast China and lower in the northwest China. Compared with observation data, the OC concentration of each model is underestimated and the OC simulation results of HadGEM3-GC31-LL and UKESM1-0-LL are closer to observation data. The simulation results of BC are less underestimated in eastern and central China and the SO_4^{2-} simulation results show the largest difference among the models. However, the summer simulated concentrations of NO_3^- in all models are underestimated. The NO_3^- simulation result of EC-Earth3-AerChem is closer to observed data. The simulation results of NH_4^+ in other four models are pretty close except CESM2-WACCM.

Early Career Scientist

YES, I am an early career scientist.

CCMI-41B

Modeling atmospheric brown carbon in the GISS ModelE Earth system model

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IGAC Activities

CCMi: Chemistry Climate Model Initiative

Abstract

Brown carbon (BrC) is an absorbing organic aerosol primarily emitted by the combustion of biomass and biofuel. While field and laboratory studies have shown that BrC exhibits light absorption unique from black carbon (BC) and organic carbon (OC) aerosols, the climate forcing of BrC is still poorly understood as it is not well represented in most Earth system models (ESMs). BrC undergoes photochemical transformation, or aging, in the atmosphere, resulting in changing absorption. This makes it particularly difficult to incorporate into ESMs, as most are limited to tracers with invariant optical properties. BrC was introduced in the GISS ModelE One-Moment Aerosol (OMA) module by creating three BrC tracers emitted from biomass burning, each with different refractive indices and absorbance. Aging of BrC was simulated through mass exchange between lighter (less absorbing) and darker (more absorbing) BrC tracers. Through this modeling approach, we were able to successfully incorporate primary brown carbon with a hydroxyl dependent aging scheme into the GISS climate model. Sensitivity tests of BrC and OC refractive indices can be used to determine the radiative effect of including dynamic BrC tracers, rather than just attributing some absorbance to OC as previously modeled.

Early Career Scientist

YES, I am an early career scientist.

CCMI-42C

Enhancing chemical schemes accounted in the FLEXPART v10.4 transport model using a kinetic preprocessor

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IGAC Activities

Abstract

Two developments have been performed on the FLEXible PARTicle 10.4 (FLEXPART v10.4) atmospheric transport model in order to enhance its chemical scheme.

Firstly, OH fields from the Massively Parallel version of the Tracer Model 5 (TM5-MP) have been made available as input for FLEXPART, replacing its default GEOS-Chem OH fields. Secondly, a box model generated using the kinetic preprocessor KPP has been coupled to FLEXPART as its chemical solver, based on a Rosenbrock Rodas-3 numerical integration scheme.

These developments have been validated in two sets of experiments: 1) a set of global simulations of a single release for each FLEXPART's OH-reacting species (methane, ethane, PCB28 and lindane (γ-HCH)), and 2) a two-month experiment emulating CMIP6 ethane emissions at European level, evaluated against ground-based observational data. Finally, a sensitivity study of the effect of each development stage on the results is performed.

The results of the first set of experiments show an overall slight increase of the OH sink rate for all the species. The spatial distribution evaluation shows that most of the differences between development stages are region-independent, indicating that they are caused mainly by the TM5-MP OH fields implementation rather than by the chemical solver change. From the second set of experiments, no relevant conclusions could be obtained due to computational limitations. However, a strong reproducibility of the results obtained with the default FLEXPART v10.4 is obtained. This seems to indicate that the new implementations do not affect significantly on simulations' results.

The availability of TM5-MP concentration fields as input to FLEXPART together with the coupling of KPP-produced box model signify an increase in adaptability and flexibility of the FLEXPART chemical mechanism to virtually any set of reactions, setting the path for an enhancement in FLEXPART simulations' quality and possibility to simulate different atmospheric chemistry scenarios.

Early Career Scientist

YES, I am an early career scientist.

CCMI-43A

In- and out-of-cloud measurements at SMEAR IV for pristine conditions and an aged forest fire plume event

Angela Buchholz[1], Iida Pullinen[1], Liqing Hao[1], Lejish Vettikkat[1], Arttu Ylisirniö[1], Jian Xu[2], Thomas Mentel[2], Sami Romakkaniemi[3], Ari Leskinen[3], Siegfried Schobesberger[1], Annele Virtanen[1]
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Abstract

Understanding aerosol-cloud interactions is crucial for improving the representation of cloud, precipitation, and aerosol processes in earth system models. Chemical processes inside cloud droplets have the potential to impact the properties of the cloud droplets and the aerosol particles re-emerging after the cloud dissipates.As part of the FORCeS project, we studied these processes at the Puijo SMEAR IV station, a semi-urban/rural measurement station in central Finland, which is frequently "in-cloud" due to its elevation. Its dual inlet system enables the parallel sampling of the dried total particle distribution and the interstitial particles (i.e., remaining particles after removal of cloud droplets). A similar suite of instruments was situated at a lower level "out-of-cloud" station for further comparison.

We measured the Cloud Condensation Nuclei (CCN) activity and compare the results before, during, and after a cloud event (i.e., when the in-cloud station is inside a cloud). As expected, the remaining interstitial particles exhibit lower CCN activity during a cloud event. The CCN activity can be related to the chemical composition information obtained from aerosol mass spectrometers (an ACSM and an HR-AMS). FIGAERO-CIMS instruments provide more detailed composition and particle volatility information. The measurements of the out-of-cloud station give more insights into the possible chemical and physical changes induced by in-cloud processes.

During an observed (south-)eastern Europe forest fire plume, which lasted for 15 days, the total particle concentration increased from 0.56 µg m^{-3} to 4.5 µg m^{-3}. The fire plume particles exhibited a higher CCN activity. The forest fire plume event opens the opportunity to compare cloud events occurring in a semi-urban/rural atmosphere typical for the SMEAR IV station with clouds formed under the influence of aged forest fire emissions.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-44B

Observations of Lightning NOx Production from TROPOMI Case Studies over the United States

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Abstract

Lightning produces nitrogen oxides (NO_x) as the extreme temperatures within lightning channels break apart molecular nitrogen (N_2) and oxygen (O_2). NO_x produced by lightning (LNO_x) plays an important role in determining mid- and upper-tropospheric concentrations of the hydroxyl radical (OH), the atmosphere's cleanser; methane (CH_4), an especially potent greenhouse gas; and ozone (O_3), a greenhouse gas and pollutant. In this study, NO_x production per lightning flash was examined for 29 convective systems over the eastern- and central- United States that occurred during the warm seasons of 2018 and 2019 using nitrogen dioxide (NO_2) retrievals and cloud properties from the Tropospheric Monitoring Instrument (TROPOMI) aboard the Copernicus Sentinel-5 Precursor satellite and lightning flash counts from a satellite-based Geostationary Lightning Mapper (GLM) and the ground-based Earth Networks Total Lightning Network (ENTLN). The mean moles of NO_x produced per flash was found to equal approximately 180 moles per flash for optically-detected flashes from GLM and approximately 120 moles per flash for radio-signal-detected flashes from ENTLN. These values are on the lower end of the commonly cited range of 100 to 500 moles per flash for midlatitude flashes.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-45C

The fingerprint of Biomass Burning on CO in the remote atmosphere

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IGAC Activities

CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Carbon monoxide (CO) is an important ozone precursor, together with nitrogen oxides and volatile organic compounds, and in parallel among the main sinks of hydroxyl radical in the troposphere. It is chemically produced during oxidation of volatile organic compounds in the atmosphere but has also primary sources as product of incomplete combustion of organics. Therefore, wildfires known to significantly affect atmospheric composition emitting numerous gaseous and particulate pollutants, are a major source of atmospheric CO. In turn, CO with an atmospheric lifetime of about one month, can be transported far from source regions and therefore can be used to investigate atmospheric transport paths of wildfires impact in remote atmosphere through long range transport.

In order to follow the main pathways of biomass burning transport in the global atmosphere and their impact on CO levels in the remote atmosphere, the global chemistry and transport model TM4-ECPL was used to simulate atmospheric composition changes during two decades (1994-2014). Uncertainties in the simulations were evaluated by comparison with satellite data from MOPITT, and in situ observations from WDCGG and NOAA. Biomass burning sources were distinguished based on the 13 different land source regions as defined by HTAP and tagged CO tracers were attached to each one, enabling to monitor the fate of CO emissions from each source region. The contribution of each one of the biomass burning source regions to each of the HTAP receptor regions is investigated. The results show that even the most remote regions of the world like the south Pacific are significantly impacted by long-range transport of biomass burning emissions.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-46A

Assessing global chemistry-climate simulations on the long term in the UTLS with the IAGOS database

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, CCMi: Chemistry Climate Model Initiative

Abstract

A wide variety of observation data sets are used to assess long-term simulations provided by chemistry-climate models (CCMs) and chemistry-transport models (CTMs). However, the upper troposphere – lower stratosphere (UTLS) is hardly assessed in the models because of uncertainties in remote measurements, a limited area for balloon-borne observations and a limited period for aircraft campaigns. Observations performed in the framework of the IAGOS program (In-service Aircraft for a Global Observing System) combine the advantages of *in situ* measurements in the UTLS with an almost global-scale area, a ~20-year monitoring period and a high sampling frequency. Few model assessments have been made using the IAGOS database, and none of them involved the whole cruise data set.

Cohen et al. (2021, GMD) proposed a method to project all the IAGOS data onto a model monthly grid, in order to make them ready for assessing global climatologies and seasonal cycles above several well-sampled regions in the North Hemisphere. The present study extends this work to a daily resolution for an accurate separation between the upper troposphere and the lower stratosphere, and to other chemical species. As one of the first applications, a simulation generated by the LMDz-ORCHIDEE-INCA CCM has been evaluated during the 1994 – 2017 period, regarding its ozone, carbon monoxide, water vapour and reactive nitrogen (NO_y) fields.

Early Career Scientist

YES, I am an early career scientist.

CCMI-47B

Continuity of the Arosa ozone column series after Dobson automation and the displacement of the LKO instruments to Davos

Dr René Stübi[1], Dr Julian Gröbner[2], Herbert Schill[2], Franz Zeilinger[2], Dr Jörg Klausen[3], Dr Eliane Maillard Barras[1], Dr Alexander Haefele[1], Dr Luca Egli[2]
[1]MeteoSwiss, Payerne, Switzerland. [2]PMOD/WRC, Davos, Switzerland. [3]MeteoSwiss, Zürich, Switzerland

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, TOAR: Tropospheric Ozone Assessment Report

Abstract

Long time series of atmospheric composition represent crucial information to document the entry into the so-called Anthropocene.

One of these long records of observations started in 1926 in Arosa / Switzerland with the LKO (Licht Klimatisches Observatorium) ozone column measurements series. It is today the world's longest continuous record containing the fingerprint of the state of the ozone layer in the stratosphere spanning the last 95 years.

The historical LKO ozone column series have been based on the Dobson sun spectro-photometer since the beginning. The introduction of parallel measurements with the Brewer sun spectro-photometers at the end of the 1980s has reinforced the LKO series with data based on an independent instrument type.

Recently, MeteoSwiss has completed the development of a fully automated Dobson data acquisition and control system that was implemented on the three instruments located at Arosa. The present configuration of two triads of instruments, one of Dobson and one of Brewer instruments, allows a thorough comparison of coincident measurements from automated instruments. Furthermore, to assure the long-term sustainability of the time series in a more favorable technical and scientific environment, all the instruments were recently moved from LKO, Arosa to the PMOD/WRC, Davos.

Following the GCOS recommendation for instrumental changes affecting a historical record, comparisons between manual and automated measurements have been recorded during the development of the Dobson automation phase. Moreover, multiple years of parallel measurements between the two sites Arosa and Davos with both Brewer and Dobson instruments were recorded.

In the present contribution, we firstly present the automated data acquisition and control of the Dobson instrument. Then, we illustrate selected results of the analysis of coincident manual and automated Dobson-Dobson and Dobson-Brewer observations. Finally, we discuss the results of coincident measurements at the two sites.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-48C

An overview of iodine chemistry over the Indian and Southern Ocean waters using ship-based observations and modelling

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

This study presents an overview of observations and modelling of reactive iodine chemistry in the marine boundary layer (MBL) of the Indian and Southern Ocean. Ship observations of iodine oxide (IO) from 2015 to 2017 show its ubiquitous presence with values up to 1 pptv in this region. The estimated fluxes of HOI and I_2 did not adequately explain the observed IO levels in the Indian and Southern Ocean region. However, a significant correlation of IO with chlorophyll-a indicates a possible biogenic control on iodine chemistry in the Indian Ocean MBL. To understand the role of organic and inorganic precursors in MBL iodine chemistry, we used WRF-Chem incorporating halogen chemistry. The modelling study shows that including only organic sources of iodine underestimate the detected IO in the northern Indian Ocean MBL. However, the inorganic flux emissions in the model had to be reduced by 40% to match the detected IO levels in this region. The reduced emission produces an overall good match between the observed and modelled IO levels. This discrepancy with flux emissions and IO levels in both the modelled IO simulation and observation highlights that there may be uncertainties in estimating the fluxes or that the flux parameterisation does not perform well for the Indian and Southern Ocean region. The model results show that the inclusion of iodine chemistry causes significant regional changes to O_3 (up to 25%), nitrogen oxides (up to 50%), and hydroxyl radicals (up to 15%) affecting the chemical composition of open ocean MBL and coastal regions of the Indian sub-continent. Accurate estimation of iodine precursors in the MBL calls for an urgent need to improve the existing parameterisation of inorganic fluxes. Direct measurements of the HOI and I_2 may prove useful in the accurate quantification of iodine precursors in the marine atmosphere.

Early Career Scientist

YES, I am an early career scientist.

CCMI-49A

Arctic warming and associated sea ice reduction in the early 20th century induced by natural forcings in MRI-ESM2.0 climate simulations and multimodel analyse

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Japan National Committee

Abstract

The Arctic has experienced a substantial warming over the first half of 20th century, which is often called the early 20th century warming (ETCW). It is widely believed that various external forcings and internally generated variations have played an important role on ETCW. However, quantification of the response to external climate forcings and internal variability on ETCW is not still enough. Climate simulations using a state-of-the-art climate model of Meteorological Research Institute (MRI-ESM2.0) and multimodel analyses were conducted to better understand ETCW. The MRI-ESM2.0 historical simulations successfully reproduced the observed ETCW and the corresponding decreases in sea ice extent. Detection and attribution experiments using MRI-ESM2.0 suggest that internal climate variability and external natural forcings by solar and volcanic activities had major influences on the model-simulated ETCW, rather than external anthropogenic forcings. Multimodel analyses indicate that the Arctic warming trend during 1911–1940 induced by natural forcings is comparable to the unforced multidecadal internal variability, suggesting major contributions of the internal dynamics and natural forcings to ETCW.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-50B

A Core-Shell kinetic model for simulating Viscosity dependent secondary organic Aerosol (CSVA) and its applications

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

Secondary organic aerosol (SOA) plays a key role in air pollution and global climate change. However, the understanding and modeling of SOA properties and evolution are still limited. We developed a novel kinetic Core-Shell box model for Viscosity dependent SOA simulation (CSVA), which includes explicit gas-phase reactions (MCM), homogeneous nucleation by H_2SO_4-NH_3-H_2O, viscosity dependent mass transfer between gas and particle phases (organic and aqueous phases) and particle-phase reactions. The gas-particle mass transfer is represented by chainlike reactions analogizing to electrical resistance. The CSVA model is verified and applied to chamber experiments of toluene oxidation systems. The monomers and dimers of SOA are determined by coupling the high-resolution Orbitrap mass spectra and the MCM mechanism. The majority of dimers are confirmed to be peroxyhemiacetals formed by reactions of hydroperoxides with aldehydes in the particle phase. The CSVA model can well capture the following processes: (1) relative humidity (RH) dependent nucleation of the H_2SO_4-NH_3-H_2O system, (2) particle size-dependent hygroscopic growth of inorganics (e.g., NaCl and $(NH_4)_2SO_4$) and SOA, (3) NOx dependent SOA formation, (4) viscosity-induced evolution of particle size distribution, and (5) effect of RH on SOA formation.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-51C

The impact of changes in anthropogenic emissions on future summer ozone concentrations over China based on CMIP6

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

In this study, Weather Research and Forecasting (WRF) model version 3.8.1 coupled with Community Multiscale Air Quality (CMAQ) model version 5.2 was used to assess the changes of summer ozone air quality in the 2050s over China owing to future changes of anthropogenic emissions under four Shared Socioeconomic Pathways (SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5). Changes of the maximum daily 8-hr ozone (MDA8) ozone concentrations are investigated over China and four polluted regions in China, including Beijing-Tinjing-Hebei (BTH), The junction of Jiangsu, Anhui, Shandong and Henan (SWLY), Yangtze River Delta (YRD) and Sichuan Basin (SCB). The average changes of summer mean MDA8 ozone concentrations in China are found to be -9.0 ppbv, -6.0 ppbv, 2.3 ppbv and -1.2 ppbv relative to present years(2017-2019) under SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5 respectively. Among the four selected regions, the largest drop of summer mean MDA8 ozone concentrations was shown in SCB under SSP1-2.6, with the value of -23.3 ppbv, and the largest increase occurred in SCB under SSP3-7.0, with the value of 4.9 ppbv. These results indicate that the scenario of SSP1-2.6 with the largest emission reduction yields the highest improvement in relieving the summer ozone pollution in China whereas the scenario of SSP3-7.0 with concomitant warming and emission increase substantially aggravate the ozone pollution, underlying the critical role of continuous stringent emission reductions in improve the air quality in particular of the ozone pollution.

Early Career Scientist

YES, I am an early career scientist.

CCMI-52A

Dust minerals in the atmosphere as precursors of Ice Nuclei Particles

Mr Marios Chatziparaschos[1], Dr Nikos Daskalakis[2], Dr Nikos Kalivitis[3], Dr Stelios Myriokefalitakis[4], Prof Maria Kanakidou[3,2,5]
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IGAC Activities

CCMi: Chemistry Climate Model Initiative

Abstract

Aerosol-cloud interactions consist one of the major sources of uncertainty in climate projections. The radiative properties and lifetime of clouds as well as precipitation rates are affected by the presence of particles known as Ice Nucleating Particles (INP) that enable ice formation in mixed-phase clouds at temperatures higher than needed for homogeneous ice nucleation. Mineral dust is thought to be the most important type of INP in the mixed-phase cloud regime around the globe. For a decade, research on INP has mostly focused on K- feldspar rich mineral dust, that accounts on average only for about 13% of the total mass of dust in the atmosphere compared to other minerals.

In the present study, however, we use the global 3-D chemistry transport model TM4-ECPL to investigate quartz's contribution to INP concentration. Quartz is a more abundant component of atmospheric desert dust, accounting for about 35% of the total mass of airborne dust, but has a lower ice nuclei activity than K-feldspar. For this, the model has been further developed to account for INP concentrations from both K-feldspar and quartz mineral dust particles using updated parameterizations of ice active sites density. The model simulations show dominant desert dust contribution to the INP globally and a significant contribution of quartz to INP concentrations over the Southern Hemisphere. Despite the fact that K-feldspar is the main contributor to the INP concentrations (0.1- 1 L^{-1}), our results suggest that quartz may also significantly contribute to INPs at temperatures between about −12.5◦C and−20◦C. The simulated INP concentrations are found to agree well with INP measurements from different campaigns worldwide.

Early Career Scientist

YES, I am an early career scientist.

CCMI-53B

Global $PM_{2.5}$ prediction and estimated mortality to 2050 under different climate change scenarios

Wanying CHEN, Xingcheng Lu, Jimmy C.H. FUNG
Hong Kong University of Science and Technology, Hong Kong, Hong Kong

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

China Working Group

Abstract

Fine particulate matter ($PM_{2.5}$) is a significant threat to human health and leads to premature death, especially for the elderly. However, in future climate scenarios, the disease burden changes related to $PM_{2.5}$ are required to be constantly grasped and explored. In this work, the concentration and mortality density (deaths/100 km^2) associated with $PM_{2.5}$ were estimated by 2050 to guide public health to mitigate climate change risks. We constructed a deep learning model (U-net convolutional neural network) to reveal the critical meteorological variables and $PM_{2.5}$ concentration using Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2) and global emission from 1998 to 2014. The 10-fold validation showed that the model performs well in estimating the global $PM_{2.5}$ with a correlation coefficient of 0.95. The high-resolution and bias-corrected Coupled Model Intercomparison Project Phase 6 (CMIP6) future climates adjusted by delta downscaling method were combined with demographic projections in the Shared Socioeconomic Pathway (SSP) scenarios to estimate the $PM_{2.5}$ exposure. Then the mortality density is predicted based on the Global Exposure Mortality Model (GEMM) hazard ratios for chronic obstructive pulmonary disease (COPD), stroke, ischaemic heart disease (IHD), lung cancer (LC), and lower respiratory infection (LRI), which are closely related to $PM_{2.5}$ exposure. We found that the global $PM_{2.5}$ exposure reaches the maximum concentration in 2028 under the SSP1-2.6 scenario with the most apparent impact on India and China. Under the SSP1-2.6 scenario, the $PM_{2.5}$-caused mortality density for China is expected to increase by 5% in 2030 and decrease by 8% in 2050. Our results show that it is essential and urgent to understand the driving forces behind climate change. On this basis, our work will be a benefit to propose appropriate climate mitigation measures.

Early Career Scientist

YES, I am an early career scientist.

CCMI-54C

Co-benefits of changing diet. A modelling assessment at the regional scale integrating social acceptability, environmental and health impacts

prof. Marialuisa Volta[1], Dr Enrico Turrini[1], prof Claudio Carnevale[1], Dr Eva Valeri[2], prof Valerio Gatta[3], prof Michela Maione[4]
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Abstract

Several commentaries have suggested that the overconsumption of animal foods exerts several detrimental effects on human and environmental health. However, no studies have accurately estimated the impact of a reduction in animal food consumption on mortality due to the direct effects on metabolic health (i.e. animal protein and saturated fat intake as modulators of pathways leading to cardiovascular disease, cancer and accelerated ageing), and indirect effects on health due to excessive exposure to pollutants (i.e. PM concentrations originated by livestock ammonia emissions). The proposed modelling approach is innovative since it integrates social acceptability, environmental and health impacts. It is adopted to investigate different scenarios at a regional scale presenting the Lombardy region (Italy) case study.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-55A

Size-resolved aerosol pH over Europe during summer

Stylianos Kakavas, Athanasios Nenes, Spyros N Pandis
ICE/FORTH, Patras, Greece

Abstract

The dependence of aerosol acidity on particle size, location, and altitude over Europe during a summertime period is investigated using the hybrid version of aerosol dynamics in the chemical transport model PMCAMx. The pH changes more with particle size in northern and southern Europe owing to the enhanced presence of non-volatile cations (Na, Ca, K, Mg) in the larger particles. Differences of up to 1–4 pH units are predicted between sub- and supermicron particles, while the average pH of $PM_{1\text{-}2.5}$ can be as much as 1 unit higher than that of PM_1. Most aerosol water over continental Europe is associated with PM_1, while coarse particles dominate the water content in the marine and coastal areas due to the relatively higher levels of hygroscopic sea salt. Particles of all sizes become increasingly acidic with altitude primarily because of the decrease in aerosol liquid water content (driven by humidity changes) with height. Inorganic nitrate is strongly affected by aerosol pH with the highest average nitrate levels predicted for the $PM_{1\text{-}5}$ range and over locations where the pH exceeds 3. Dust tends to increase aerosol pH and nitrate concentrations for supermicron range particles. This effect of dust is quite sensitive to its calcium content.

Early Career Scientist

YES, I am an early career scientist.

CCMI-56B

Estimation of radiative forcing and heating rate based on vertical observation of black carbon in Nanjing, China

Shuangshuang Shi
Nanjing University of Information Science & Technology, Nanjing, China

IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

China Working Group

Abstract

Owing to a lack of vertical observations, the impacts of black carbon (BC) on radiative forcing (RF) have typically been analyzed using ground observations and assumed profiles. In this study, a UAV platform was used to measure high resolution in-situ vertical profiles of BC, fine particles (PM2.5), and relevant meteorological parameters in the boundary layer (BL). Further, a series of calculations using actual vertical profiles of BC were conducted to determine its impact on RF and heating rate (HR). The results show that the vertical distributions of BC were strongly affected by atmospheric thermodynamics and transport. Moreover. Three main types of profiles were revealed: Type I, Type II, Type III, which correspond to homogenous profiles (HO), negative gradient profiles (NG), and positive gradient profiles (PG), respectively. Types I and II were related to the diurnal evolution of the BL, and Type III was caused by surrounding emissions from high stacks and regional transport. There were no obvious differences in RF calculated for HO profiles and corresponding surface BC concentrations, unlike for NG and PG profiles. RF values calculated using surface BC concentrations led to an overestimate of 13.2 W m-2 (27.5%, surface) and 18.2 W m-2 (33.4%, atmosphere) compared to those calculated using actual NG profiles, and an underestimate of approximately 15.4 W m-2 (35.0%, surface) and 16.1 W m-2 (29.9%, atmosphere) compared to those calculated using actual PG profiles. In addition, the vertical distributions of BC HR exhibited clear sensitivity to BC profile types. Daytime PG profiles resulted in a positive vertical gradient of HR, which may strengthen temperature inversion at high altitudes. These findings indicate that calculations that use BC surface concentrations and ignore the vertical distribution of BC will lead to substantial uncertainties in the effects of BC on RF and HR.

Early Career Scientist

YES, I am an early career scientist.

CCMI-57C

On the formation of formic acid from formaldehyde processing in liquid clouds

Jean-Francois Muller[1], Jenny Stavrakou[1], Jozef Peeters[2]
[1]Royal Belgian Institute for Space Aeronomy, Brussels, Belgium. [2]Department of Chemistry, KU Leuven, Leuven, Belgium

Abstract

It has been recently proposed (Franco et al., Nature, 2021) that methanediol (OHCH2OH) formed by hydration of formaldehyde in clouds is outgassed to a larger extent than previously estimated, and reacts in the gas phase with the hydroxyl radical, leading to formic acid (HCOOH). Whereas the global production of formic acid is greatly dependent on poorly-known parameters, such as the Henry's law constant (HLC) of methanediol and the rate constant of its reaction with OH, Franco et al. suggest, based on global model calculations and on newly conducted chamber experiments (for the rate constant) and on statistical prediction methods (for the HLC), that this mechanism explains the well-known missing source of HCOOH in the atmosphere. If verified, this finding would be of tremendous importance for our understanding of the biogeochemical cycling of oxygenated organic compounds. For this reason, it is of utmost importance to double-check the validity of the hypotheses and parameterizations behind this assessment. We examine several aspects of this determination, including the HLC, the reactions of methanediol, and the representation of chemical processing in liquid clouds in global models. Plausible ranges for critical parameters will be proposed, and various causes of uncertainty will be discussed. The potential consequences for the budget and distributions of formic acid will be briefly explored.

Early Career Scientist

NO, I am not an early career scientist.

CCMI-58A

Assessment of the impact of OH's temporal resolution on the global atmosphere

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Assessment of the impact of OH's temporal resolution on the global atmosphere

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Focus: Atmospheric modeling/ air quality

ABSTRACT

Hydroxyl radicals (OH) concentration accuracy is crucial for the overall description and prediction of atmospheric chemicals. OH is widely known as the main oxidant or the "detergent" of the lower atmosphere, emphasizing its utmost importance. Since 1990, in the atmospheric chemistry modeling community, one set of OH concentrations with coarse temporal (monthly means) and spatial (10^{o}x8^{o}; long x lat) resolution, known as "climatological" data, has been widely used in the simulations. However, now, more accurate models that calculate OH concentrations are available.

The presented study utilizes one of those finer scale calculations, the OH mixing ratios obtained with the TM5-MP model on an hourly step and at 1^{o}x1^{o} resolution. Herewith, we assess the impact of using coarse and fine temporal and spatial resolution on the computed lifetimes of several atmospheric species.

Early Career Scientist

YES, I am an early career scientist.

COVID-1A

First year of real-time VOC measurements at the SIRTA facility (Paris region, France): diurnal and seasonal variabilities, impact of COVID-19 lockdown on air quality

Leïla Simon[1,2], Valérie Gros[3], Jean-Eudes Petit[3], François Truong[3], Roland Sarda-Esteve[3], Dominique Baisnée[3], Nicolas Bonnaire[3], Jean-Charles Dupont[4], Martial Haeffelin[4], Caroline Marchand[2], Olivier Favez[2]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

Long-term datasets of in-situ air pollutant measurements are crucial to characterize the variability of the atmospheric chemical composition, and therefore to investigate their impacts on air quality and climate. On-going establishment of the Aerosol, Cloud and Trace gases Research InfraStructure (ACTRIS) allows implementing the collection and provision of such high-quality datasets. In this context, online and continuous measurements of O_3, NO_x and aerosols have been carried out since 2012 at the SIRTA observatory, located within the Paris region, France. Volatile Organic Compounds (VOCs) are also key atmospheric components notably because they are precursors of secondary pollutants, such as ozone (O_3) and secondary organic aerosols (SOA). In the last decade, some VOC measurements have been conducted offline at SIRTA, until the implementation of an online monitoring which has started in January 2020, using a Proton-Transfer-Reaction Quadrupole Mass-Spectrometer (PTR-Q-MS).

The dataset acquired during the first year of online VOC measurements provides insights on their seasonal variability. The additional long-term datasets obtained from co-located measurements (O_3, NO_x, aerosol physical and chemical properties, meteorological parameters) are used to better characterize the atmospheric conditions and to complement the analysis.

Due to COVID-19 pandemic, France, as many other countries, experienced a quasi-total lockdown in Spring 2020, which significantly reduced some of the usual human activities. A focus can then be made on the effect of such lockdown measures on the VOC variability and sources. To this end, the diurnal cycles of VOCs considered markers for anthropogenic sources are carefully investigated. Results notably indicate that markers for traffic and wood burning sources show a change in their diel variability during the Spring lockdown in comparison to other periods. A source apportionment analysis using positive matrix factorization allows to further document the seasonal variability of VOC sources and the impacts on air quality associated with the lockdown measures.

Early Career Scientist

YES, I am an early career scientist.

COVID-2B

Global tropospheric ozone responses to reduced NOx emissions linked to the COVID-19 world-wide lockdowns

Kazuyuki Miyazaki[1], Kevin Bowman[1], Takashi Sekiya[2], Masayuki Takigawa[3], Jessica Neu[1], Henk Eskes[4], Kengo Sudo[5], Greg Osterman[6]
[1]Jet Propulsion Laboratory, CA, USA. [2]JAMSTEC, Yokohama, Japan. [3]JAMSTEC, Yokohama, USA. [4]KNMI, De Bilt, Netherlands. [5]Nagoya University, Nagoya, Japan. [6]JPL, Pasadena, USA

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, TOAR: Tropospheric Ozone Assessment Report, GEIA: Global Emissions Initiative

Abstract

Efforts to slow the transmission of COVID-19 led to rapid, global ancillary reductions in air pollutant emissions. Here, we quantify the impact of these reductions on tropospheric ozone using a multi-constituent data assimilation system. Total anthropogenic NOx emissions dropped by at least 15% globally and 18-25% regionally in April and May 2020, which led to up to a 5 ppb decrease in free tropospheric ozone, consistent with independent satellite observations. The tropospheric ozone response to the NOx emission reductions exhibited strong spatial and temporal gradients as a consequence of differences in ozone production efficiency (OPE). A decline in the global total tropospheric ozone burden of 6 TgO3 (2 %) in May-June 2020 was largely due to emission reductions in Asia and the Americas, the effects of which were amplified by regional ozone production efficiencies up to 4 TgO3/TgN. Even the most aggressive emissions controls considered by the IPCC report would lead to only a 4% reduction by 2030. So the COVID-related reductions in ozone were about 15 times more rapid than what is viewed as achievable through “normal” policies to reduce emissions. These reductions correspond to a tropospheric ozone radiative forcing of 233-350 mW m-2. Decreased concentrations of PAN and OH suggest highly non-local impacts of the lockdowns and substantial changes in the tropospheric chemistry system. Our results show that COVID-19 mitigation led to a clear and global atmospheric signature that altered atmospheric oxidative capacity and climate radiative forcing and can be used to inform policies that co-benefit air quality and climate.

Early Career Scientist

NO, I am not an early career scientist.

COVID-3C

Impact of Singapore's COVID-19 lockdown on atmospheric CO_2 fluxes at neighborhood scale

Dr. Erik Velasco
Independent, Singapore, Singapore

IGAC Activities

GEIA: Global Emissions Initiative, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Singapore entered a two-month partial lockdown in April 2020 to curb the spread of COVID-19. The imposed measures in addition to contain the virus spread, cut the emissions of greenhouse gases as many economic activities stopped across the city. The advice of stay-at-home changed the pattern of carbon dioxide (CO_2) emissions within the community. To examine how CO_2 emissions responded to the COVID-19 measures at neighborhood scale, anonymized mobility data released by Google and Apple, and traffic congestion data from TomTom were used to track daily and diurnal changes in emissions related to driving, cooking and metabolic breathing in a residential neighborhood of Singapore, in which the anthropogenic and biogenic fluxes of CO_2 have been widely characterized. During the lockdown, traffic emissions dropped 41%, but emissions from cooking and metabolic breathing increased 21% and 20%, respectively. The uptake of CO_2 by vegetation was not able to offset these emissions, and after adding the biogenic contribution from soil and plants, a net reduction of 24% was found. During the following six months the city got its pace back, with the rate of CO_2 emissions reaching similar or slightly higher levels than those predicted before the pandemic crisis. Unfortunately, the stark drop in emissions was just a temporary relief, which reduced only 3.5% the annual CO_2 flux over the studied neighborhood.

Early Career Scientist

NO, I am not an early career scientist.

COVID-4A

Quantification of the Emission Changes in Europe During 2020 Due to the COVID-19 Mobility Restrictions

Dr. Marc Guevara[1], Dr. Oriol Jorba[1], Dr. Hervé Petetin[1], Dr. Hugo A.C. Denier van der Gon[2], Jeroen J.P. Kuenen[2], Dr. Ingrid Super[2], Dr. Vincent-Henri Peuch[3], Dr. Carlos Pérez García-Pando[1,4]
[1]Barcelona Supercomputing Center, Barcelona, Spain. [2]Netherlands Organization for Applied Scientic Research (TNO), Utrecht, Netherlands. [3]European Centre for Medium-Range Weather Forecasts, Reading, United Kingdom. [4]Catalan Institution for Research and Advanced Studies (ICREA), Barcelona, Spain

IGAC Activities

GEIA: Global Emissions Initiative

Abstract

To hinder the circulation of the COVID-19 virus, European governments implemented emergency measures going from light social distancing to strict lockdowns, depending on the country. As a consequence, many industries, businesses and transport networks were forced to either close down or drastically reduce their activity, which resulted in an unprecedented drop of anthropogenic emissions. This work presents the Copernicus Atmosphere Monitoring Service (CAMS) European regional emission adjustment factors associated to the COVID-19 mobility restrictions, an open source dataset of daily-, sector-, pollutant- and country-dependent emission adjustment factors for Europe linked to the COVID-19 pandemic. The resulting dataset covers a total of six emission sectors, including: road transport, energy industry, manufacturing industry, residential and commercial combustion, aviation and shipping. The time period covered by the dataset includes the first and second waves of the disease ocurred during 2020, starting from 21 February, when the first European localised lockdown was implemented in the region of Lombardy (Italy), until 31 December, when COVID-19 transmission remained widespread and several countries had nationwide restrictions still in place. The adjustment factor dataset is based on a wide range of information sources and approaches, including open access and measured activity data and meteorological data, as well as the use of machine learning techniques. We combined the computed emission adjustment factors with the CAMS European gridded emission inventory to spatially (0.1x0.05 degrees) and temporally (daily) quantify reductions in 2020 emissions from both criteria pollutants (NO_x, SO_2, NMVOC, NH_3, CO, PM10 and PM2.5) and greenhouse gases (CO_2 fossil fuel, CO_2 biofuel and CH_4) as compared to a business-as-usual scenario, as well as to assess the contribution of each sector and country to the overall reductions. The resulting gridded and time-resolved emission reductions suggest an heterogeneous impact of the COVID-19 restrictions across pollutants, sectors and countries.

Early Career Scientist

NO, I am not an early career scientist.

COVID-5B

US COVID-19 shutdown demonstrates importance of background NO2 in inferring NOx emissions from satellite NO2 observations

Zhen Qu[1], Daniel J. Jacob[1], Rachel F. Silvern[1,2], Viral Shah[1], Patrick Campbell[3,4], Lukas C. Valin[5], Lee T. Murray[6]
[1]Harvard University, Cambridge, MA, USA. [2]National Academies of Sciences, Engineering, and Medicine, Washington, DC, USA. [3]Geroge Mason University, Fairfax, VA, USA. [4]National Oceanic and Atmospheric Administration, College Park, MD, USA. [5]US EPA, Triangle Research Park, NC, USA. [6]University of Rochester, Rochester, NY, USA

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group

Abstract

Satellite NO_2 measurements are used extensively to infer nitrogen oxide (NO_x) emissions and their trends, but interpretation can be complicated by background contributions to the NO_2 column sensed from space. We use the step decrease of US anthropogenic emissions from the COVID-19 shutdown to compare the responses of NO_2 concentrations observed at surface network sites and from satellites (OMI, TROPOMI). After correcting for differences in meteorology, surface NO_2 measurements for 2020 show decreases of 20% in March-April and 10% in May-August compared to 2019. The satellites show much weaker responses in March-June and no decrease in July-August, consistent with a large background contribution to the NO_2 column. Inspection of the long-term OMI trend over remote US regions shows a rising summertime NO_2 background from 2010 to 2019 potentially attributable to wildfires.

Early Career Scientist

YES, I am an early career scientist.

COVID-6C

The impact of COVID-19 on projections, and the use of scenario analysis tools for modelling impacts of mitigation strategies on air pollutant emissions and concentrations.

Mr Ben J Pearson[1], Mr Marco Pizzolato[1], Mr Ioannis Tsagatakis[1], Mrs Anne Misra[1], Mr Neil Passant[2]
[1]Ricardo Energy & Environment, London, United Kingdom. [2]Ricardo Energy & Environment, Lancashire, United Kingdom

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative

Abstract

The Covid-19 pandemic has, since February 2020, had an impact on the UK, along with the rest of the world. As well as the human toll, there have been consequences for the economy and for the way that people have had to live their lives, with social distancing and restrictions on travel. While some emission sources, such as aviation, have been especially impacted by the pandemic, there are likely to be very few activities that haven't been affected to some extent. The UK has carried out additional modelling which aims to generate more realistic projections for 2020.

This presentation will cover the standard approach to estimating emission projections and the reasons why this approach was not appropriate for estimating 2020 emissions. We will discuss our data sources and assumptions, and methodology used to estimate revised projections for 2020, for each sector. The talk will highlight sectors which were particularly affected and compare Business as Usual and revised 2020 projections.

Ricardo's interactive, web based scenario analysis tools for policy makers and scientists use local or national historic emission estimates and projections as a baseline, and allow users to investigate the likely impacts of different measures by building alternative policy scenarios for a wide range of pollutants, including NH3, NOx, PM, SO2, VOCs and GHGs.

Scenario analysis can be used to identify specific groups of emitters and analyse by sector including transport, power generation, domestic combustions, agriculture and waste. Where detailed baseline data are available the tools can provide a high transparency level for drill down of data via high resolution maps, and swipe comparisons between baseline and scenario projections. The outputs are designed to feed into existing climate or air quality models to investigate how changing emissions in particular locations or sectors would impact on ambient concentrations and exposure.

Early Career Scientist

NO, I am not an early career scientist.

COVID-7A

Do satellite-based HCHO and NO2 observations help with the quantitative prediction of surface ozone during the pandemic?

Amir Souri[1], Kelly Chance[1], Juseon Bak[2], Caroline Nowlan[1], Gonzalo González Abad[1], Yeonjin Jung[1], David Wong[3], Jingqiu Mao[4], Xiong Liu[1]
[1]Harvard-Smithsonian, Cambridge, MA, USA. [2]Pusan National University, Busan, Korea, Republic of. [3]U.S. Environmental Protection Agency, Research Triangle Park, NC, USA. [4]University of Alaska Fairbanks, Fairbanks, AK, USA

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

The slowdown in anthropogenic activities due to the COVID-19 pandemic had an impulsive and sweeping impact on air pollution. Several scientific studies have shown the extent of changes in relevant air pollutants using diverse monitoring systems such as satellite remote sensing and surface monitoring observations; however the ambient concentrations of pollutants (e.g, NO2) are driven by a large number of factors such as energy consumption patterns (expected changes), meteorology, photochemistry, and chemical feedback; thus, disentangling the impact of the pandemic on air pollution requires advanced observation systems, capable of carefully integrating well-characterized observations, chemical transport modeling, and inversion techniques. To properly account for these effects, we applied a joint non-linear inversion of ozone major precursors using satellite measurements of NO2 and HCHO over Europe, which in turn, improved our understanding of the lockdown-induced emission changes, illuminating the complexities associated with non-linear chemistry, and improving confidence in the high-resolution map of anthropogenic and biogenic emissions during the pandemic.

Early Career Scientist

YES, I am an early career scientist.

COVID-8B

Mapping Urban CO with $BEACO_2N$ and Bayesian Inversions

Naomi Asimow[1], Alexander Turner[2], Jinsol Kim[1], Helen Fitzmaurice[1], Catherine Newman[1], Pietro Vannucci[1], Kevin Worthington[1], Paul J Wooldridge[1], Ronald C Cohen[1]
[1]University of California, Berkeley, Berkeley, CA, USA. [2]University of Washington, Seattle, WA, USA

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

The Bay area Environmental Air-quality & CO2 Network (BEACO2N) features a suite of gas and particulate sensors in shoebox-sized nodes located at ~2km resolution. There are ~70 nodes in the San Francisco Bay Area (Shusterman et al., 2016) and are or will soon be deployments of 12-25 nodes in three other U.S. and two UK cities. Previous work has focused largely on the CO2 with analyses that describe network scale strategies for calibration and inverse models to map emissions at ~1km with hourly time resolution. Here we describe initial analyses of the concurrent CO observations. The observations resolve diurnal, seasonal, and annual changes to CO, numerous wildfires, and, most recently, the impacts of the COVID-19 “shelter-in-place” order, during which the BEACO2N network observed a 27.9% decrease in CO concentration. Inverse modeling of the CO dataset provides a map of emissions and insights into trends.

Early Career Scientist

YES, I am an early career scientist.

COVID-9C

Impact of COVID-19 on NOx and VOC levels over China based on multi-species satellite data and modeling

Dr. Jenny Stavrakou[1], Dr Jean-François Müller[1], Dr Maite Bauwens[1], Dr Thierno Doumbia[2], Dr Nellie Elguindi[3], Dr Sabine Darras[3], Dr Claire Granier[4,5], Dr Isabelle De Smedt[1], Dr Christophe Lerot[1], Dr Michel Van Roozendael[1], Dr Lieven Clarisse[6], Prof Cathy Clerbaux[7], Prof Pierre-François Coheur[6], Dr Yiming Liu[8], Prof Tao Wang[8], Dr Idir Bouarar[9], Dr Xiaoqin Shi[9], Dr Benjamin Gaubert[10], Dr Simone Tilmes[10], Prof. Guy Brasseur[8,9,10]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

China was the first country to undergo large-scale lockdowns in response to the pandemic in early 2020 and a progressive return to normalization after April 2020. Substantial decreases in pollutants levels and their subsequent recovery were revealed by spaceborne observations and in situ measurements of nitrogen dioxide (NO_2), a predominantly anthropogenic compound and an important precursor for ozone and aerosol formation. This study adds to this picture with the analysis of satellite data of oxygenated volatile organic compounds (OVOCs), namely formaldehyde (HCHO), glyoxal (CHOCHO) and peroxyacetylnitrate (PAN). The observations reveal important changes in pollutants levels in response to the pandemic-induced shutdowns and subsequent drop in pollutant emissions. In February 2020, when the shutdowns were at their peak, the observed declines in the OVOC levels were generally weaker (less than 20%) than the substantial NO_2 reductions (-40%). In May 2020, the observations reveal moderate decreases for NO_2 (-15%) and PAN (-21%), and small changes for CHOCHO (-3%) and HCHO (6%). Simulations with a regional atmospheric model using anthropogenic emissions taking into account the reductions during the shutdowns based on activity data, explain to a large extent the observed decreases between 2020 and 2019 in regions affected by the lockdowns. In areas where biomass burning and biogenic sources are dominant, the observed changes reflect the interannual variability of these sources, and are well captured by the model simulations.

Early Career Scientist

NO, I am not an early career scientist.

COVID-10A

The Impact of COVID-19 Lockdowns and Car Free- day Policy on Levels of Air Pollution in Kigali, Rwanda

Dr Egide Kalisa
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Air pollution is the largest environmental cause of premature human mortality worldwide. This is a particular concern in Africa where emissions are high and exposure data are lacking. Rwanda established an innovative policy of 'Car-Free' days where major streets are closed for 48 hours per month to vehicles and motorcycles and open them for collective exercise sessions. In March 2020, Rwanda also imposes Africa's first lockdown because of the COVID-19. This study uses the natural experiment of the COVID-19 lockdown and car-free days policy to investigate the role of transport as a source of particulate matter ($PM_{2.5}$) air pollution in Kigali, Rwanda. The results indicated that PM2.5 was significantly reduced during car-free days and COVID-19 lockdown by 15% and 20%, respectively. These findings suggest the contribution of transport emission to urban air pollution in Kigali. As lockdown restrictions loosen and regular activity resumes, air pollution levels continued to increase and the mean of 24- hours $PM_{2.5}$ level exceed the WHO air quality guideline more than three times, emphasising the need for further action such as investing in green transportation.

Early Career Scientist

YES, I am an early career scientist.

COVID-11B

Fast Climate Responses to Aerosol Emission Reductions During the COVID-19 Pandemic

Prof. Yang Yang
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IGAC Activities

CCMi: Chemistry Climate Model Initiative, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report, ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

The reduced human activities and associated decreases in aerosol emissions during the COVID-19 pandemic are expected to affect climate. Assuming emission changes during lockdown, back-to-work and post-lockdown stages of COVID-19, climate model simulations show a surface warming over continental regions of the Northern Hemisphere. In January–March, there was an anomalous warming of 0.05–0.15 K in eastern China, and the surface temperature increase was 0.04–0.07 K in Europe, eastern U.S. and South Asia in March–May. The longer the emission reductions undergo, the warmer the climate would become. The emission reductions explain the observed temperature increases of 10–40% over eastern China relative to 2019. A southward shift of the ITCZ is also seen in the simulations. This study provides an insight into the impact of COVID-19 pandemic on global and regional climate and implications for immediate actions to mitigate fast global warming.

Early Career Scientist

NO, I am not an early career scientist.

COVID-12C

The effects of the COVID-19 lockdowns on air-quality throughout the troposphere as seen by IAGOS in-situ data

Dr. Hannah L Clark
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

The European Research Infrastructure IAGOS (In-service Aircraft for a Global Observing System) equips commercial aircraft with a system for measuring atmospheric composition. A range of essential climate variables and air quality parameters are measured throughout the flight, from take-off to landing, giving high resolution information in the vertical in the vicinity of international airports, and in the upper-troposphere/lower-stratosphere during the cruise phase of the flight. Six airlines are currently involved in the programme, achieving a quasi-global coverage under normal circumstances. During the COVID-19 crisis, many airlines were forced to ground their fleets due to a fall in passenger numbers and imposed travel restrictions. Deutsche Lufthansa, a partner in IAGOS since 1994 was able to operate a IAGOS-equipped aircraft during the COVID-19 lockdown, providing regular measurements of ozone and carbon monoxide at Frankfurt airport. The data form a snapshot of an unprecedented time in the 26 year time-series. We see increases in ozone near the surface with respect to the 26 year climatology, a magnitude similar to that of the 2003 heatwave. The anomaly diminishes with altitude becoming a slightly negative anomaly in the free troposphere. The ozone precursor carbon monoxide shows a reduction near the surface. There is only a small reduction to the free tropospheric background levels of CO due to the impact of long-range transport on the CO from emissions in regions outside Europe.

Early Career Scientist

NO, I am not an early career scientist.

COVID-13A

Impacts of COVID-19 on Black Carbon in Two Representative Regions in China Based on Online Measurement in Beijing and Tibet

Mei Zheng[1], Yue Liu[1], Yinan Wang[2], Yang Cao[3], Xi Yang[1], Tianle Zhang[1], Mengxiao Luan[1], Anthony D. A. Hansen[4], Baoxian Liu[3,5], Daren Lyu[2]
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IGAC Regional Working Groups

China Working Group

Abstract

From January 2020, China has been fighting Coronavirus Disease 2019 (COVID-19) and the nationwide lockdown was implemented which significantly reduced primary emissions from human activities. A few studies have investigated response of $PM_{2.5}$ in megacities of China, but there still lack of study about the response of black carbon (BC). We managed to conduct one-year continuous online measurement of BC simultaneously in Beijing and Tibet from November 2019 to October 2020 and analyze different impacts of COVID-19 on BC in these two representative regions in China.

To investigate the temporal variation of BC concentration and sources, the aethalometer model was used for two sites. With more chemical composition data available in Beijing, the receptor model (PMF) was applied in Beijing. We found that the influence of COVID-19 on BC was significantly different in Beijing and Tibet. The average concentration in the lockdown period was 20% higher than that in pre-lockdown period in Beijing, which could be attributed to the increase of aged BC and transport from southwestern neighboring areas. In contrast to megacity, the average concentration of BC in Tibet decreased over 70% in the lockdown period, which was significantly different from the temporal variation in previous years. However, BC in Tibet during the lockdown period exhibited a strong influence of biomass burning, suggesting the site in Tibet was still impacted by long-range transport from South Asia where the overall biomass burning activities were much lower in 2020. Such abnormal decrease of BC in Spring 2020 in Tibet suggested the plateau background site was very sensitive to the anthropogenic emission reduction in South Asia.

This study clearly showed the different response of BC in megacity and background areas in China to the change of anthropogenic emission under the lockdown intervention. Such change includes both BC concentration and its source contributions.

Early Career Scientist

NO, I am not an early career scientist.

COVID-14B

Analysis of the effect of the COVID-19 lockdown on Aerosol Optical Properties over Bangladesh

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The COVID-19 pandemic has been established as one of the most challenging times for humanity in the 21st century, claiming the lives of millions and possessing huge economic losses across the world. However, it was considered that the mandatory nationwide lockdown in Bangladesh has decreased the Aerosol Optical Depth (AOD). In this investigation, the change in AOD level for six major cities in Bangladesh, during the lockdown, as compared to the long-term mean AOD level (2012-2019) using AOD product from NASA's MODIS (Aqua) satellite. Furthermore, to study overall air pollution during 2020, the AOD levels were investigated for January-June (overall period). The study's key findings reveal a substantial drop in AOD levels for all the cities under investigation (~16.6 to 24.6%) with the entire country observing a decline of 20.6%. However, the drop in AOD was not very substantial (~4.7%) when considering the overall period during 2020. In an extended study, the size of aerosols during the lockdown was characterized by the Ångström Wavelength Exponent (α) for the island of Bhola in Bangladesh (+9.1%) using NASA's ground-based Aerosol Robotic Network (AERONET). The Ångström Wavelength Exponent study over Bangladesh is only restricted to Bhola due to limitations in the number of AERONET sites. All in all, the entire country witnessed a huge drop in air pollution during the lockdown, owing to the reduction of anthropogenic-based emissions. The unique situation of the COVID-19 pandemic has allowed for this kind of investigation of air pollution levels.

Keywords: AOD, Ångström Exponent, COVID-19, lockdown, Bangladesh

Early Career Scientist

YES, I am an early career scientist.

COVID-15C

From COVID-19 to Future Electrification: Assessing Traffic Impacts on Air Quality by a Machine Learning Model

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IGAC Activities

CCMi: Chemistry Climate Model Initiative, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative, ACAM: Atmospheric Chemistry and the Asian Monsoon, CATCH: the Cryosphere and Atmospheric Chemistry, AMIGO: Analysis of eMIssions usinG Observations, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

China Working Group, Americas Working Group

Abstract

The large fluctuations in traffic during the COVID-19 pandemic provide an unparalleled opportunity to assess vehicle emission control efficacy. Here we develop a random forest regression model, based on the large volume of real-time observational data during COVID-19, to predict surface-level NO_2, O_3, and fine particle concentration in the Los Angeles megacity. Our model exhibits high fidelity in reproducing pollutant concentrations in the Los Angeles basin and identifies major factors controlling each species. During the strictest lockdown period, the traffic reduction led to decreases in NO_2 and $PM_{2.5}$ by –30.1% and –17.5%, respectively, but a 5.7% increase in O_3. Heavy-duty truck emissions contribute primarily to these variations. Future traffic-emission controls are estimated to impose similar effects as observed during the COVID-19 lockdown, but with a smaller magnitude. Vehicular electrification will achieve further alleviation of NO_2 levels.

Early Career Scientist

YES, I am an early career scientist.

COVID-16A

Knowns and unknowns on the impacts of COVID-19 lockdowns on urban air quality

Dr. Georgios I. Gkatzelis[1], Dr. Jessica B. Gilman[2], Prof. Steven S. Brown[2], Michael Decker[1], Prof. Henk Eskes[3], Ana R. Gomes[1], Dr. Anne C. Lange[1], Dr. Brian McDonald[2], Jeff Peischl[2,4], Dr. Andreas Petzold[1], Dr. Chelsea Thompson[2,4], Prof. Astrid Kiendler-Scharr[1]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

The coronavirus-19 pandemic led to government interventions to limit the spread of the disease that are unprecedented in the last decades. Stay at home orders led to sudden decreases in atmospheric emissions, most visibly from the transportation sector. Here we highlight findings from Gkatzelis et al. (2021) that summarize the current knowledge of the influence of these emission reductions on atmospheric composition and air quality. The review covers literature until September 30th, 2020 on NO_2, $PM_{2.5}$, O_3, NH_3, SO_2, black carbon, volatile organic compounds, and CO. Of the more than 200 papers covered, only about one third incorporates a specific method for meteorological correction or normalization for comparing the lockdown periods with prior reference observations despite the importance of doing so. We use the government stringency index as an indicator for the severity of lockdown measures and show how key air pollutants change as the stringency index increases. At most sites, we found O_3 increased, whereas $PM_{2.5}$ decreased with increasing stringency index. NO_2 also decreased with increasing stringency index in agreement with emission inventories that account for the lockdown effects. On the contrary, no such agreement to the inventories is found for changes in SO_2, an important aerosol precursor. While NO_2, $PM_{2.5}$, and O_3 are broadly covered, data for all other pollutants are sparse. We highlight the need for future studies to expand the available analysis, including chemically speciated $PM_{2.5}$ observations and summertime measurements. Finally, the data used in this review are available online at https://covid-aqs.fz-juelich.de. This website is designed as a living version of this review and as new literature emerges authors of published papers are encouraged to upload their data to the database, thus complementing the data coverage in space, time, and compound dimensions.

Early Career Scientist

YES, I am an early career scientist.

COVID-17B

Chemistry of Atmospheric Fine Particles during the COVID-19 Pandemic in a Megacity of Eastern China

Lei Liu[1], Jian Zhang[1], Rongguang Du[2], Xiaomi Teng[1], Rui Hu[2], Shanshan Tang[3], Chuanhua Ren[4], Xin Huang[4], Liang Xu[1], Yinxiao Zhang[1], Congbo Song[5], Bowen Liu[5], Gongda Lu[5], Zongbo Shi[5], Weijun Li*[1]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

Air pollution in megacities represents one of the greatest environmental challenges. Our observed results show that the dramatic NO_x decrease (77%) led to significant O_3 increases (a factor of two) during the COVID-19 lockdown in megacity Hangzhou. Model simulations further demonstrate large increases of daytime OH and HO_2 radicals and nighttime NO_3 radical, which can promote the gas-phase reaction and nocturnal multiphase chemistry. Therefore, enhanced NO_3^- and SO_4^{2-} formation was observed during the COVID-19 lockdown because of the enhanced oxidizing capacity. The $PM_{2.5}$ decrease was only partially offset by enhanced aerosol formation with its reduction reaching 50%. In particular, NO_3^- decreased largely by 68%. $PM_{2.5}$ chemical analysis reveals that vehicular emissions mainly contributed to $PM_{2.5}$ under normal conditions in Hangzhou. Whereas, stationary sources dominated the residual $PM_{2.5}$ during the COVID-19 lockdown. This study provides evidence that large reductions in vehicular emissions can effectively mitigate air pollution in megacities.

Early Career Scientist

YES, I am an early career scientist.

COVID-18C

Covid-19 induced lower-tropospheric ozone changes

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, AMIGO: Analysis of eMIssions usinG Observations

Abstract

The recent COVID-19 pandemic with its countermeasures, e.g., lock-downs, resulted in decreasing emissions of various trace gases. Here we investigate the changes of ozone over Europe associated with these emission reductions using the MECO(n) model, which couples a global chemistry-climate model with a regional chemistry-climate model. The model is equipped with a source apportionment (tagging) technique which allows us to make a sector-wise attribution of these changes, e.g. to natural and anthropogenic emission sources.

To investigate the impact of strong emission reductions on lower tropospheric ozone in a simplified manner we performed and analysed a business as usual (BAU) and a sensitivity (COVID19) simulation.

Our simulation results show a decrease of ozone of 8% over Europe in May 2020 in COVID19 compared to BAU. The simulated reductions are in line with observed changes of ground level ozone. The results of the source apportionment method indicate that this decrease is mainly due to the decreased ozone precursors from anthropogenic origin. Further, our results show that the ozone reduction is much smaller than the reduction of the total NO_x emissions (around 20 %), mainly caused by an increased ozone production efficiency. Accordingly, more ozone is produced for each emitted NO_x molecule. Hence, more ozone is formed from natural emissions and the ozone productivities of the remaining anthropogenic emissions increase. Our results show that politically induced emissions reductions cannot simply be transferred to ozone reductions, which needs to be considered when designing mitigation strategies.

Early Career Scientist

YES, I am an early career scientist.

COVID-19A

Quantifying and attributing carbon monoxide (CO) emission changes in New York City during the COVID-19 shutdown

Luke D Schiferl[1,2], Bronte Dalton[3], Ricardo Toledo-Crow[4], Brian McDonald[5], Róisín Commane[1,6]
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IGAC Activities

GEIA: Global Emissions Initiative

Abstract

In response to the COVID-19 pandemic, New York ordered state-wide closures of all non-essential businesses in March 2020. On-road transportation and economic activity were

dramatically reduced in the New York City metro area. Fortuitously, we began measuring

carbon gas concentrations at an observatory in Manhattan in January 2020, which continued throughout the lockdown and into summer 2020. This study presents analysis of the observed changes in the atmospheric composition of New York City for CO and discusses the possible causes of these changes. Measured concentrations indicate a clear decline in CO between February and April. To investigate emission changes, we separate the concentration variations from meteorological impacts using footprint analysis techniques with HRRR-STILT. This analysis shows much of the concentration change may be driven by meteorology, with strong winds clearing the metro area throughout late March and early April. We isolate the remaining concentration changes and attribute them to emissions sectors using various baseline emission inventories (e.g., EDGAR, FIVE). While the on-road CO emissions inventory reproduces observed CO concentrations prior to COVID-19, CO emissions reductions tracked to mobility changes underestimates the observed CO concentrations (overestimates the change) during the COVID-19 shutdown. This points to an additional CO source in New York City not tied to on-road transportation.

Early Career Scientist

YES, I am an early career scientist.

COVID-20B

Errors and uncertainties associated with mobility and traffic activity data for estimating fossil fuel CO_2 emissions during the COVID-19 pandemic

Tomohiro Oda[1,2,3], Johannes Gensheimer[4], Chihiro Haga[3], Kotaro Hosomi[3], Takanori Matsui[3], Rostyslav Bun[5,6], Alexander J. Turner[7,8], Ankit Shekhar[9], Frank N. Keutsch[10], Jia Chen[4]
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IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Japan National Committee

Abstract

CO_2 emissions from fossil fuel combustion (FFCO2) can be robustly estimated from fuels used (as activity data, AD) and CO_2 emissions factor, due to the nature of FFCO2. The emission changes under the impact of the COVID-19 pandemic have been estimated using a variety of non-fuel AD, such as global human mobility data that companies reported, due to the unavailability of timely fuel statistics. The use of such unconventional activity data (UAD) might allow us to provide emission estimates in near-real time; however, the errors and uncertainties associated with such UAD-based emission estimates have not been examined/assessed so far. Such estimates should be provided along with a thorough evaluation/validation of the methodology and the resulting estimates for subsequent science analyses and/or policy applications.

We examined the performance of the UAD for informing the emission changes at different spatial scales (country, sub-national and city), as well as corresponding temporal scales (seasonal, weekly, and daily) using available evaluation data. We calculated country total traffic emissions from Japan using fuel consumption data, and found that UAD-based estimates could be biased by -19.6% to 12.6% during the emission reduction peak period (April-May 2020). Even at city scales, where the potential UAD spatial representation error could be mitigated, the performance of UAD as a proxy for traffic data significantly varies over different cities. We identified differences between UAD and traffic data to be more than 60%. We also demonstrated that traffic data do not simply represent emission seasonality. Our assessment highlighted the challenges and difficulties in the use of limited UAD for assessing human emission impacts on the environment. Further, error and uncertainty assessments of the UAD performance should allow us to shed light on the potential limitations of UAD, and potentially come up with better UAD usage for providing more accurate emission estimates.

Early Career Scientist

NO, I am not an early career scientist.

COVID-21C

Impact of the COVID-19 lockdown period in surface Ozone, PM2.5, and SOA in the Mexico Megalopolis

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Center for Atmospheric Sciences UNAM, Mexico City, Mexico

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Despite the many challenges derived from the COVID19 pandemic, the current worldwide lockdown measures still represent a unique opportunity for the development and evaluation of public policies and mitigation measures aimed to abate air pollution. In Mexico, the lockdown that was implemented to achieve social distancing measures, coincided with periods of high temperature and intense solar radiation, which can result in ozone episodes and biomass burning emissions. In addition, given the highly nonlinear dynamics of ozone formation, the effects in air quality might be different among regions according to both their magnitude and spatial distribution of emissions. In this work, the regional contribution of emissions reductions will be presented for the Megalopolis area, which consists of the Mexico Megacity and the 5 surrounding states in Central Mexico. The biomass burning emissions were included using the FINN inventory and the variation in local emissions was estimated based on official mobility data. The variations in surface ozone, PM2.5 and secondary organic aerosols obtained with the WRF-Chem model will be discussed for both the 3 main stages of the lockdown period and the first month of the so-called “new normal”, when some of the main economic activities began to re-open.

Early Career Scientist

NO, I am not an early career scientist.

COVID-22A

Lockdown influences on Ozone, NO2, and CO over Asia: Some contrary affects

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Escalating emissions of several air pollutants over Asia could play a detrimental role in the regional and global atmosphere. Therefore a better understanding of emissions over this region is necessary. Here, we utilized the opportunity of nationwide lockdown over different Asian cities and analyzed satellite data that are more inclusionary over Asian countries, where ground-based observations are limited. We have used the IASI, OMI, TROPOMI, and GOME-2 data to assess the changes in CO, NO2, and ozone, with a primary focus on the tropospheric profiles of ozone and CO. Tropospheric NO2 column, reduced over most of the Asian cities during the lockdown except over western-India and Myanmar (~10%). The CO total column shows an increase (~20%) over central-western India, Bangkok, and Myanmar while decreased (~5%) over northern India, including the Indo-Gangetic plain. However, non-systematic changes were also observed in both CO and NO2 columns over Malaysia and Wuhan. The CO vertical profile shows reduction mainly in the boundary layer (15-20%). In contrast, a consistent increase (~31%) is observed in the free troposphere over most Indian cities. Ozone changes non-uniformly over Asian cities depending upon emission, dynamics, and meteorology. An increase (>20%) in vertical ozone distribution was observed over central-western India, Bangkok, and Myanmar compared to 2019 and 2018 and decreased over the Indian coastal cities and Wuhan. However, over the northern Indian cities, a significant reduction (>20%) compared to 2018 and a dramatic increase (>20%) compared to 2019 is observed. The increased ozone over northern India is caused by the active subtropical dynamics, while, for other places like western-central India, Bangkok, and Myanmar, the effect of photochemistry and surface emissions is suggested. Contrary to surface-based studies, the present study shows an increase in CO, ozone (decrease), and NO2 at several locations and in the free troposphere during the lockdown period.

Early Career Scientist

YES, I am an early career scientist.

COVID-23B

Changes in aerosol over the Indian subcontinent during the COVID19 Lockdown in 2020

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

The outbreak of COVID19 (COronaVIrus Disease 2019) in the first quarter of 2020 prompted governments worldwide to adopt desperate measures, such as restricting human activities, shutting down industries, limiting vehicular movement, etc. Similarly, South Asian countries also announced a lockdown in late March, which results in the reduction of gaseous and particulate emissions from various sectors. Using ground-based and satellite observations along with reanalysis products, we quantify this widespread reduction in aerosol loading. In terms of aerosol optical depth (AOD), loading has reduced up to 40% compared to its pre-lockdown value over the most populated region of India. However, the central part of India shows an unexpected increase (~+20%) in AOD. A simultaneous increase (decrease) in mid-tropospheric relative humidity (wind speed (WS) at 850 hPa) by +85 ± 6.0% (–12 ± 3.9%) occurred during the lockdown. It is found that on a daily scale, the mean AOD is positively (negatively) correlated with mid-tropospheric RH (WS) with a statistically significant linear correlation coefficient of 0.53 (−0.43). An increase (decrease) in RH (WS) of 20% (1 m s–1) was observed to increase AOD by 0.10 (0.04). Thus, we hypothesize that the increased AOD over central India was due to increased atmospheric moisture coupled with stagnant circulation during the lockdown.

Early Career Scientist

YES, I am an early career scientist.

COVID-24C

Exploring Changes in Air Quality Across Africa from COVID-19 in 2020 and 2021: Observations from the AfriqAir Network

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[1]CNRS, OSU-EFLUVE, LISA, Paris, France. [2]AfriqAir, Kigali, Rwanda

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

AfriqAir is a global consortium that brings together air quality scientists and researchers interested in using air quality data to tackle air quality problems in Africa. One of the main activities of AfriqAir is to help set up and operate hybrid networks of low-cost air quality monitors centered around reference monitors. AfriqAir and its partners have deployed over 50 low-cost sensors and a few reference monitors, with plans to deploy another 25 reference-grade PM monitors in multiple East, West, and South African cities in the past few years. The networks of sensors have shed valuable insight into the spatiotemporal patterns of PM and certain gases in generally under-monitored areas of Africa. Here we present the major trends in PM observed with the sensor networks with a special focus on the multiple COVID-19 responses in various countries. Results from Nairobi, Kenya, for example, demonstrate how secondary restrictions in 2021 did reduce ambient PM concentrations compared to baseline but also resulted in less PM reductions as compared to the first set of restrictions in 2020 by 20%.

Early Career Scientist

NO, I am not an early career scientist.

COVID-25A

Investigating Air Quality and Emissions Changes from COVID-19 Lockdown Measures in Mexico City with Satellite Observations

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[3]Milken Institute School of Public Health, Washington DC, USA

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

The COVID-19 pandemic prompted "lockdown" measures around the world to slow the spread of the virus. Numerous studies show that these measures significantly impacted air quality in major cities, including Mexico City. Here we investigate the effects of lockdowns in Mexico City on nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and formaldehyde (HCHO) with satellite observations from the TROPOMI instrument. We present the initial development of a mass balance methodology for estimating emissions changes resolved by sector. We use the TROPOMI satellite observations during the lockdown period and a reference period (one year prior), in conjunction with emissions inventory data, to investigate the impact of lockdown measures on air quality and emissions in Mexico City. Our best estimates find a significant change in urban NO_2 of -39% during the lockdown, significant changes in urban SO_2 averaging +35%, and changes of +1.9% for CO and -3.6% for HCHO that are not statistically significant. These results are in partial agreement with previous work, differing in our observed SO_2 increases. Our mass balance model is unable to clearly identify changes in emissions from four large sectors based on our measured changes in pollutants, as the model gives unphysical changes in emissions, although the model works well with idealized inputs. Potential sources of error include oversimplification in our mass balance model, averaging methods due to uncertainty stemming from natural variability, and difficulties with TROPOMI retrieval algorithms, particularly for SO_2. We then analyze concentration changes as observed from Mexico City's surface air monitoring networks, and test these data as inputs to the mass balance model to attempt to estimate changes in emissions by sector.

Early Career Scientist

YES, I am an early career scientist.

COVID-26B

Hourly Organic Tracer-based Source Apportionment of $PM_{2.5}$ before and during the Covid-19 lockdown: A Case Study in Suburban Shanghai

Student Shan WANG[1], Postdoc Qiongqiong WANG[2], Student Shuhui Zhu[1,3], Professor Jian Zhen Yu[1,2]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, China Working Group

Abstract

During the Covid-19 outbreak, lockdown measures were implemented to suppress human activities and associated emissions, leading to distinct atmospheric pollution characteristics during the restriction period. Here, we present online measurements of $PM_{2.5}$ major components and organic molecular markers in suburban Shanghai before (28 December 2019 to 23 January 2020) and during (24 January to 9 February. 2020) the lockdown. The NO_x levels declined sharply by 59% from 75 to 31 μg m^{-3} during the lockdown, while O_3, which is an important secondary pollutant, rose two times higher to 83 μg m^{-3}. The $PM_{2.5}$ dropped from 64 to 49 μg m^{-3} (-24%). Nitrate, sulfate, and organics were the predominant species, showing reductions of 58%, 17%, and 13%, respectively. Positive matrix factorization (PMF) analysis identifies fourteen factors, including five secondary sources, i.e., sulfate-rich, nitrate-rich, SOA_I (anthropogenic secondary organic aerosols (SOA)), SOA_II (associated with later generation products of organic oxidation), and SOA_III (biogenic SOA)), and nine primary sources. The combined secondary sources contributed to 76% and 63% (43 and 21 μg m^{-3}) of $PM_{2.5}$, respectively, among which the reductions in nitrate-rich (62%) and sulfate-rich (-14%) were prominent. The contributions from coal combustion and biomass burning remained significant, while large reductions (>80%) in primary sources associated with industrial, cooking, and vehicle emissions were observed. Backward trajectories analysis confirmed that regional transport played an important role in $PM_{2.5}$ pollution. Previous studies reported that the restriction during the Covid-19 resulted in enhanced secondary sulfate and SOA formation due to the increasing oxidation capacity, offsetting the substantial reduction of primary emissions in urban areas. While we observed decreased secondary inorganic and SOA formation despite the overall elevated oxidizing capacity in suburban areas, revealing the different mechanisms driving the responses of secondary inorganic and organic formation process to the changes in primary precursors under different atmospheric conditions.

Early Career Scientist

YES, I am an early career scientist.

COVID-27C

COVID-19 LOCKDOWN: DECADAL LOW OF INDIAN METRO AIR QUALITY

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

The outbreak of COVID-19 is a global public health challenge and it is rapidly increasing in Urban India. A drastic decline in the sources of emissions of pollutants under COVID-19 induced lockdown resulted in an unprecedented trends in most hazardous pollutants $PM_{2.5}$, PM_{10} and NO_2 in India. To realize the impact of lockdown in the concentrations of $PM_{2.5}$, PM_{10} and NO_2, we compared the trend of lockdown period (20nd March to 15th April) with several years of past data in four Indian mega cities (Delhi, Pune, Mumbai, and Ahmedabad) of different micro-climate and geography. The declining lockdown curve can be clearly identified when compared with past 7 years of data of Delhi and 3-5 years of data for other cities. The significant reduction in the concentrations of NO_2 in the ranges of ~60-65% is noticed in four megacities within the lockdown period when compared with the averaged data of past years. However, relatively low reduction in $PM_{2.5}$ (~25-50%) and PM_{10} (~36-50%) is observed and city to city variation is found to be significant. The prevailing secondary aerosol formation and enhancement of any natural source of emissions could be some factors preventing $PM_{2.5}$ levels to go down significantly. The ratio of $PM_{2.5}$ to PM_{10} is found to vary from city to city during lockdown. Under near negligible fossil fuel emission, contrary to the expectation, an increase in the ratio as compared to normal scenario is observed in Delhi on some days whereas on some selected days, ratio is found to decline significantly. The study is expected to serve as reference in framing the future environmental policies to control air pollution in urban cities.

Early Career Scientist

YES, I am an early career scientist.

COVID-28A

High-latitude urban air quality: 20 months of aerosol composition data from Fairbanks, Alaska

Ellis S Robinson[1], Mike Battaglia[2], Meeta Cesler-Malon[3], James Campbell[3], Athanasios Nenes[4,2], Jason St. Clair[5,6], Jingqiu Mao[3], Rodney Weber[2], William Simpson[3], Peter DeCarlo[1]
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Abstract

We present continuous, sub-hourly measurements of aerosol composition from Fairbanks, Alaska, USA that span the past 20 months (January 2020 to August 2021) and include times before and after the social and economic disruption of the Covid-19 pandemic. Conditions of extreme cold, minimal sunlight, and Fairbanks' location within a river valley lead to wintertime aerosol concentrations that frequently exceed EPA 24-hour limits. We compare PM2.5 mass and composition measurements from winter 2020 (pre-Covid) with winter 2021 using an Aerodyne Aerosol Chemical Speciation Monitor (ACSM). The ACSM dataset identifies the relative contributions of different aerosol components to air quality in Fairbanks. Positive matrix factorization (PMF) of the mass spectral dataset is used to identify the major contributions to both organic and inorganic aerosol fractions, which include oxidized organic aerosol (OOA, 40-60% of OA mass), biomass burning OA (BBOA, 15-40%), and hydrocarbon-like OA (HOA, 15-25%). Wintertime sulfate concentrations display a diurnal pattern similar to HOA, implicating a primary vehicular source of sulfate in the region. Our analysis shows the relative contribution of the different major emissions sources to PM2.5 in Fairbanks, and how these sources change on diurnal and seasonal time scales and under the influence of different meteorological conditions.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-1A

Hygroscopicity of fresh and aged mineral dust aerosol

Dr Mingjin Tang, Miss Wenjun Gu, Miss Lanxiadi Chen, Miss Huanhuan Zhang
Guangzhou Institute of Geochemistry, CAS, Guangzhou, China

IGAC Regional Working Groups

China Working Group

Abstract

Mineral dust is one of the most abundant aerosols in the troposphere, and hygroscopicity largely determines heterogeneous chemistry of mineral dust aerosol and its climatic effects. Due to its non-sphericity and relatively low hygroscopicity, hygroscopicity of mineral dust is yet poorly understood. A new experimental method, which measures sample mass as a function of RH, was successfully developed to study hygroscopicity of atmospherically relevant particles. This method was then applied to investigate hygroscopicity of fresh and aged mineral dust, and important results include: 1) hygroscopicity of minerals commonly found in mineral dust aerosol and authentic mineral dust samples collected different regions in the world is usually very low, and the mass growth factors at 90% RH, defined as the sample mass at 90% RH relative to that at <1% RH, are typically smaller than 1.10; 2) saline mineral dust samples, collected in various arid and semi-arid regions in China, exhibited diverse hygroscopicity, with mass growth factors at 90% RH ranging from ~1.02 to 6.7, and the hygroscopicity mainly depended on their chemical composition; 3) heterogeneous reactions could substantially increase mineral dust hygroscopicity, and a positive feedback between heterogeneous reactivity and hygroscopicity was found for heterogeneous reaction of calcium carbonate with NO_2. Overall, this work would significantly improve our knowledge of mineral dust hygroscopicity, and thus help better understand the roles mineral dust plays in atmospheric chemistry and climate.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-2B

Health Effects of Global Air Pollution on Reproduction: from Fertility Rate Reduction in United States, to Pregnancy Loss in Africa, and Preterm Births in Beijing China

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IGAC Regional Working Groups

China Working Group

Abstract

Annually 4.2 million deaths are attributed to the exposure to global air pollution. However, this estimation does not include the health effects of air pollution on reproduction, duo to the lack of evidences. In this presentation we will report newly found evidences that air pollution impacts on fertility rate reduction in United States, pregnancy loss in Africa, and preterm births in China.

For fertility rate reduction in United States, we conducted a nationwide spatiotemporal study of ~29 million births in 520 counties from 2003 to 2011. We obtained $PM_{2.5}$ estimates from a downscaling model of in situ observations and outputs from CMAQ. We found each 5 μg/m³ increase in pre-gestational $PM_{2.5}$ exposure was associated with a 0.7% (0.0%, 1.4%) reduction in the fertility rate.

To study pregnancy loss in Africa, we used a self-compared case control study design and collected data on mothers who reported at least two births in the African Demographic and Health Surveys. Gestational exposure to $PM_{2·5}$ was assessed using an estimator based on satellite measurements and chemical transport model outputs. We found each increment of 10 μg/m³ $PM_{2·5}$ was associated with an adjusted OR of 1·122 (95% CI 1·107–1·137) for pregnancy loss.

To evaluate the association between ambient $PM_{2.5}$ concentration and preterm births, we collected daily preterm birth data from a hospital in Beijing, China during 2006 to 2013; a time-series of daily $PM_{2.5}$ concentrations during the same period is assembled with measured data at three monitoring sites in Beijing. A robust association (3.16%, 95% CI: 1.95%, 4.39%; per 10-μg/m³ increment in $PM_{2.5}$) was observed for chronic effects.

Our study established for the first time an association between the fertility rate and $PM_{2.5}$ concentration, and suggest that air quality improvements over a long period could yield significant health benefits.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-3C

Online Measurement of Fine Aerosol Nitrite via a Versatile Aerosol Concentration Enrichment System Coupled with Ion Chromatography

Ph.D. Xiaona Shang, Huihui Kang, Yunqian Chen, Munira Abdumutallip, Ling Li, Huiling Ouyang, Xu Tang, Prof. Jianmin Chen
Fudan University, Shanghai, China

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

China Working Group

Abstract

Particulate nitrite is a major source of hydroxyl radicals; however, it lacks techniques to online measure particulate nitrite in the atmosphere with high resolution due to its low abundance and stability. Therefore, we develop a coupled system using versatile aerosol concentration enrichment system (VACES, an air/particle separation concentrator of particulate concentration) and ion chromatography (IC) to detect hourly nitrite concentration in fine aerosols . The nitrite observations yield two very important findings: 1) the coupled system (VACES-IC) is feasible for use in field studies of particulate nitrite with a lowered detection limit by one order of magnitude (from the conventional 0.01 to 0.001 μg m^{-3}); 2) heterogeneous reaction is a dominant path of particulate nitrite formation demonstrated via the kinetic calculation and multilinear regression analysis. In aspect of policy, mechanism analyses of nitrite formation imply that reducing SO_2 emission could be an effective measure to decrease the aerosol nitrite and sulfate concentration, thereby may further reduce the potential of hydroxyl radical generation. Currently, global measurements on particulate nitrite are sparse, and our technique and field observation could act as an entry point to kick-start online and long-term monitoring to provide a data basis for mechanistic investigation. Although the preliminary experiment is conducted in Shanghai, China, the methodology we have developed can be applied to any country and any region no matter how low the concentration of particulate matter is.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-4A

Atmospheric Environmental Impacts of Freight Transportation

Dr. Huan Liu, Xiaotong Wang, Fanyuan Deng
Tsinghua University, Beijing, China

IGAC Activities

GEIA: Global Emissions Initiative, ACAM: Atmospheric Chemistry and the Asian Monsoon, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

China Working Group

Abstract

Growth of trade, and the freight industry have flourished in recent years. At the same time, measurements and modeling have shown the health and climate impact of shipping emissions. The connection of freight transportation and atmospheric impacts are thus necessary to be explored.

A series of models including SEIM, TraSEIM and GTEMS were developed. A calculation model (SEIM) based on ship Automatic Identification System (AIS) data coupled with time and space allocation model were constructed and shipping emission inventories were established. The SEIM calculates emissions of each ship by time series and interpolation. We found shipping emissions in East Asia accounted for 16-19% of the global shipping emissions, higher than the previously published 4-6 %. Radiative forcing was updated to -0.45 W/m^2, from past results of -0.02 W/m^2. Air quality simulation showed that shipping emissions increased the annual averaged PM2.5 concentrations in eastern China up to 5.2 $\mu g\ m^{-3}$. In Qingdao, Dalian and Yantai, shipping emissions increased the PM2.5 concentrations in summer. We further developed the "trade-shipping-emission-impact" nexus, to attribute shipping emissions to responsible bilateral trades, e.g. US-China bilateral trade is responsible for roughly 2.1% of global shipping emissions and 4,651 premature deaths in 2016.

For road freight transportation, we developed a full-sample enumeration approach TrackATruck. Based on 19 billion trajectories, we estimate the day-to-day HDT emission in the BTH region for 2017 and 2018. The minimum NOx emission of HDTs was 20.56 Mg day^{-1} on the Lunar New Year festival and the maximum NOx emission of HDTs was 552.31 Mg day^{-1} on 29st Sept. The low emission zone (LEZ) policy in Beijing was not so successful as 96 % of the emission reduction benefit from restricted HDTs was offset by an increase in unrestricted vehicles. The long-haul HDT detour caused by the LEZ increased HDT emissions in the upwind regions.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-5B

Dibasic Esters Observed as Potential Emerging Indoor Air Pollutants in New Apartments in Beijing, China

Dr Yingjun Liu, Jia Qiu, Di Xie
Peking University, Beijing, China

IGAC Regional Working Groups

China Working Group

Abstract

Volatile organic compounds (VOCs) emitted from building and furnishing materials represent a major concern of indoor air quality, in particular in new buildings. We carried out multiweek nontargeted VOC measurements in 10 new apartments in Beijing, China, using online chemical ionization mass spectrometry. Dimethyl esters of succinic, glutaric, and adipic acids, which are rarely known for their presence in indoor air, were identified in three apartments. The identification was confirmed using authentic standards and by gas chromatography/mass spectrometry analysis. Despite varying concentrations, the three compounds exhibited largely consistent ratios across the three apartments and throughout the observation periods. The observed ratios resemble chemical composition of dibasic esters (DBE), which are a solvent mixture of the three compounds and have been used in the coating industry. A field “sniffing” experiment further confirms DBE emissions from the coatings of some wooden furniture in at least one apartment. The average airborne DBE concentrations in the three apartments were 41, 5, and 4 μg/m3, respectively, exceeding the screening level of 1 μg/m3 recommended by the Michigan Department of Environmental Quality, United States. In the context of fast-growing DBE usage, the current results suggest that DBE might be emerging indoor air pollutants and merit further investigation.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-6C

Effects of Regional Transport on Haze in the North China Plain: Transport of Precursors or Secondary Inorganic Aerosols

Professor Jie Li, Huiyun Du, Wenyi Yang, Professor Zifa Wang
Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

China Working Group

Abstract

Uncertainties still exist about the sources of secondary inorganic aerosols (SIA), which are one of the crucial drivers of haze pollution. The spatial distribution of precursors is not exactly consistent with that of aerosols, which is puzzling to policymakers. Most existing studies only treat contribution from regional transport of nonlocal emissions as a whole but do not distinguish the transport of secondary aerosols themselves and that of their precursors. Therefore, it is necessary to quantify the contribution from transport of precursors and secondary aerosols. The Nested Air Quality Prediction Model System with an online tracer-tagging module was used to investigate the regional sources of SIA in Beijing and surrounding cities. The regional contribution of nonlocal emissions to SIA in the receptor region was divided into three parts: (1) SIA chemically formed by nonlocal emissions in their source region; (2) SIA chemically formed by nonlocal emissions in transport pathway; and (3) SIA chemically formed by nonlocal emissions in the receptor region, indicating transport of precursors. In the North China Plain, the transport of precursors and SIA produced during transport are the two main transport forms. Furthermore, the contribution from transport of precursors increased under polluted conditions in most cities. The results indicate that joint control of precursors is paramount for mitigating air pollution.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-7A

Overview of the aircraft measurements in the Northeastern and Northern China

Overview of the aircraft measurements in the Northeastern and Northern China Shan Ye
Shandong University, Qingdao, China

IGAC Regional Working Groups

China Working Group

Abstract

Aircraft-based measurements have been applied in many fields such as cloud physics, aerosol, boundary layer dynamics and tropospheric chemistry. Compared with the other observation platforms (such as ground observation stations and satellite remote sensing), aircraft measurements can provide the real-time data with highly spatial and temporal resolution, which has a great significance to understand the three-dimensional distribution, the exchange between boundary layer and the free troposphere, and the regional transportation and transformation of the air pollutants. This study is based on the research platform of the Yun-12 aircraft, and improves the sampling system and the power supply module . Based on the improved Yun-12 aircraft platform, two campaigns (12 flights, 37 h total flight time) were conducted from near the surface up to 3500 m in northeastern China (over Jilin Province during July-August, 2018) and in northern China (over the Shandong and Shanxi Provinces during December, 2019). Gaseous and particulate pollutants, i.e., SO_2, NO, O_3, VOCs, HONO, $PM_{2.5}$, BC, B_{sc} (particle scattering coefficient), particle number size distribution as well as meteorological parameters, were measured. The vertical profiles showed that the concentrations of SO_2, NO, BC and Bsc were highest on the surface and decreased with the increased altitude. However, the O_3 concentration showed the increasing trend with the increase altitude. During a typical regional air pollution process, we found that the surface air mass in the North China Plain can be uplifted to the lower troposphere, and then transmitted to the upper layer in Northeastern China. Backward trajectory analysis and the WRF simulation were used to examine the long-range transport. These results are important for understanding the vertical profiles and the long-range transport of air pollutants in the region of Northeastern and Northern China.

Early Career Scientist

YES, I am an early career scientist.

CHINA-8B

The researches of unstable reactive oxidants in the atmosphere

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Institute of Chemistry, Chinese Academy of Sciences, Beijing, China

IGAC Regional Working Groups

China Working Group

Abstract

There are various oxidants existed in the atmosphere, most of them are unstable, highly reactive and recyclable. Reactive oxidants are the central species in the atmosphere, and they have great impact on secondary particle formation, human health and climate change. Some reactive oxidants are very hard to capture which restrict the investigation of their reaction processes. Therefore, we constructed some methods to capture unstable reactive oxidants, such as HONO, Criegee Intermediates. HONO is one of the most import precursors of OH radical, and was hardly to be detected. A custom-built HONO analyzer was constructed and used in field observation in many areas. Formation mechanisms of HONO in the atmosphere were interpreted in conjunction with the simulations by box-model. We found the important relationship of HONO with $PM_{2.5}$ during severe pollution events. Criegee intermediates (CIs) can be generated by the ozonolysis of alkenes, and few amounts can come from radical-radical reactions. CIs are found to be the important oxidants, and can react with many gases in the atmosphere. The reaction rate of CIs with HCOOH is about 10^{-10} $cm^3molcule^{-1}s^{-1}$, and the reaction rate of SO_2 with CIs is much faster than with OH radical. A Matrix-isolate Vacuum FTIR method was constructed to capture CIs during the reaction of O_3 with alkenes. Different kinds of Primary ozonides (POZs), CIs, and Secondary ozonides (SOZs) were detected, and the reaction processes were deduced. Besides, these CIs are the potential precursors in the formation of secondary organic aerosol. Our findings highlight the importance of these reactive oxidants in the atmospheric chemistry, more methods are needed for the study of unstable reactive oxidants.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-9C

The long-term trend of acidity and chemical compositions of precipitation in Shanghai

Shiyu Ye[1], YuSen Duan[2]
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Abstract

The long-term trend of acid rain in Shanghai has been studied based on the chemical composition of precipitation and anthropogenic pollutant emissions during 2000-2019. The results showed that the pH of acid rain decreased before 2008 and then gradually increased. The pollution level of acid rain in 2019 was comparable to that in 2000. Jinshan District has replaced Baoshan District as the most polluted area by acid rain in Shanghai. SO_4^{2-}, NO_3^-, NH_4^+, and Ca^{2+} are the major ions in precipitation. Similar to SO_2, the concentrations of SO_4^{2-} in the four observation sites have been reduced by 85-94% in the past, indicating that the reduction of SO_2 emissions played a key role in the control of acid rain pollution. The ratio of NO_3^-/SO_4^{2-} increased from ~0.3 to above 1.0, indicating that the acid rain has changed from a sulfate type to a nitrate-dominated mixed type. Vehicle emission become the dominant source of acid rain. The concentration of Ca^{2+} in precipitation has been reduced by more than 70% compared with the beginning of the century, partially offsetting the effect of SO_2 reduction. With the control of dust, the impact of NH_3 on the acidity of precipitation becomes much more significant. For a collaborative control of $PM_{2.5}$ and acid rain pollution, we suggest that NH_3 reduction should be carefully carried out in the Yangtze River Delta.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-10A

The impact of climate change and extreme weather events on ozone formation

Professor Yang Gao, Mingchen Ma, Feifan Yan
Key Laboratory of Marine Environment and Ecology, Ministry of Education, Ocean University of China, Qingdao, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

China Working Group

Abstract

Ozone pollution has been a long issue in many regions of the world, and it is tightly associated with the modulation of meteorology such as extreme weather events and emissions including sources from both anthropogenic and biogenic origin. In this study, we first systematically discuss the enhancement effect of extreme weather events on ozone formation over both United States and China, from the perspective of short-term such as during episodic events and climate scales in the long-term run. The examination also reveals the interesting nonlinear effect from compound events when two or more extreme events concomitantly occur together. In addition to the meteorology, the widely acknowledged biogenic emissions undoubtedly play crucial roles in further triggering the ozone enhancement. Differently from the traditional perspective, this study focuses on two new angles, by focusing on the synergy between anthropogenic and biogenic emissions, as well as the added values through the consideration of biogenic emissions over urban areas. With the discussion, we aim to at least partially reveal the potentially important role of the mutual modulation of extreme weather events, anthropogenic and biogenic emissions, particularly under a warming climate.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-11B

Estimation of heterogeneous ozone oxidation rates of oleic, elaidic, and linoleic acid in urban organic aerosols using their hourly measurement data.

Dr Qiongqiong Wang, Prof. Jian Zhen Yu
The Hong Kong University of Science and Technology, Hong Kong, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CATCH: the Cryosphere and Atmospheric Chemistry, CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

Cooking emissions contribute to a significant fraction of ambient primary organic aerosols (OA) in urban areas. Among the major components of cooking emissions, long-chain unsaturated fatty acids (uFAs) such as oleic acid and linoleic acid, undergo rapid degradation via heterogeneous reaction with atmospheric oxidants upon emission. The oxidation mechanism and kinetics of the cooking uFAs have been extensively studied in laboratory experiments. The laboratory settings, however, can only partially simulate atmospheric conditions. Quantitative knowledge of degradation rate of uFAs derived from real atmospheric conditions is scarce. In this study, the decay rates of three cooking-related uFAs (oleic acid, elaidic acid, and linoleic acid) are estimated via a relative rate approach, taking advantage of hourly measured uFAs and saturated fatty acids in urban Shanghai. Nighttime data (19:00-05:00) are used to estimate the decay rate due to ozone oxidation, thus avoiding complexity arising from OH-initiated degradation. The ambient data are well-fitted by an exponential function during the study time window. On some days, superior fittings are achieved by adopting a two-step reactions model that is described by a much higher initial rate constant representing oxidation of fresher cooking OA and a slower reaction rate corresponding to degradation of more aged cooking OA. The estimated average atmospheric lifetime of oleic acid was 4 h under an ozone level of ~14 ppb and 60-100% relative humidity encountered at our urban location or ~2 h at a higher ozone level of ~40 ppb. The decay rates of elaidic acid linoleic acid are determined to be 0.62 and 1.39 that of oleic acid, respectively. This work provides kinetic data pertaining to real-world conditions that are valuable for constraining the modeling of heterogeneous aging of ambient organic aerosol.

Early Career Scientist

YES, I am an early career scientist.

CHINA-12C

Health Impact of Global Atmospheric Arsenic: 2005-2015

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[2]Atmospheric Sciences Program, Michigan Technological University, Houghton, USA

IGAC Activities

IGAC Regional Working Groups

China Working Group

Abstract

Elemental arsenic and many of its compounds are highly toxic pollutants in the environment. Due to the toxicity of arsenic, a limit of 6 ng/m^3 was established for the atmospheric arsenic by the European Union (EU), and the World Health Organization (WHO) recommends keeping the arsenic concentrations in drinking water below 10 μg/L. Most of the previous studies on arsenic pollution have primarily focused on arsenic contamination in groundwater. Recent studies, however, have reported that high airborne arsenic concentrations well above these threshold values are frequently observed in many parts of the world. In this study, we examine the impact on human health from atmospheric arsenic on the global scale. We first develop an improved global atmospheric arsenic emission inventory and connect it to a global model (GEOS-Chem). Model evaluation using observational data from a variety of sources shows the model successfully reproduces the spatial distribution of atmospheric arsenic around the world. We found that for 2005, the highest airborne arsenic concentrations were found over Chile and eastern China, with mean values of 8.34 and 5.63 ng/m^3, respectively. By 2015, the average atmospheric arsenic concentration in India (4.57 ng/m^3) surpassed that in eastern China (4.38 ng/m^3) due to the fast increase in coal burning in India. Based on potential exceedance of health-based limits, we also find that the combined effect by including both atmospheric and groundwater arsenic may significantly enhance the risks, due to carcinogenic and non-carcinogenic effect. Therefore, this study clearly implies the necessity in accounting for both atmospheric and groundwater arsenic in future management.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-13A

Terpene-derived Nitrooxy Organosulfates

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Hong Kong University of Science & Technology, Hong Kong, China

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

Nitrooxy organosulfates derived from terpenes (NOS_{TP}) represent an important class of products formed between anthropogenic pollution (e.g., SO_2 and NO_x) and natural emissions. NOS_{TP} compounds have been consistently detected in atmospheric environments under varying urban influences. Their chemical linkages to both anthroposphere and biosphere make them valuable markers for tracking anthroposphere-biosphere interactions. However, their quantification, formation and transformation kinetics in atmospheric aerosol are hindered due to the lack of NOS_{TP} standards. We have synthesized eight NOS_{TP} from terpenes including a-pinene, β-pinene, limonene, limonaketone, and β-caryophyllene. Six of them were for the first time positively identified in ambient aerosol samples. The availability of authentic standards allows us to clarify certain misidentifications in previous studies. In addition, irrefutable observation of three carbon skeleton-rearranged NOS_{TP} reveals the occurrence of previously unrecognized transformation pathways in the formation of NOS_{TP}. Two synthesized NOS_{TP} from β-pinene and limonene could not be detected, likely due to rapid hydrolysis of their immediate hydroxy nitrate precursors outcompeting sulfation. Such mechanistic evidence is valuable in understanding atmospheric chemistry of NOS_{TP} and related compounds. This work demonstrates the usefulness of the authentic standards in probing the NOS_{TP} formation mechanisms in the atmosphere. Comparison of NOS_{TP} ambient samples collected from four Chinese cities in two winter months indicates that anthropogenic chemical factors could outcompete terpene emissions in the formation of NOS_{TP}.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-14B

Aerosol Acidity and Water Content as a Driver of Aerosol Formation, Intense Haze Events and Nutrient Deposition

Athanasios Nenes[1,2], Spyros N Pandis[2,3,4], Maria Kanakidou[5,2], Armistead G Russell[6], Shaojie Song[7], Petros Vasilakos[6], Rodney J Weber[6]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

China Working Group

Abstract

Nitrogen oxides (NO_x), ammonia (NH_3) and Chloride contribute to particulate matter (PM) concentrations worldwide. Ecosystem productivity can be modulated by the atmospheric deposition of this inorganic "reactive nitrogen". PM and nitrogen deposition responses to changes in their emissions is complex and typically studied on a case-by-case basis.

Here we present a simple, thermodynamically-based approach that defines domains of sensitivity of PM to NH_3 and HNO_3 availability in terms of aerosol pH and liquid water content. Four policy-relevant regimes emerge: i) NH_3-sensitive, ii) HNO_3-sensitive, iii) combined NH_3 and HNO_3 sensitive, and, iv) a domain where neither NH_3 and HNO_3 are important for PM levels (but only nonvolatile precursors such as NVCs and sulfate). When this framework is applied to ambient measurements or predictions of PM and gaseous precursors, the “chemical regime” of PM sensitivity to NH_3 and HNO_3 availability is directly determined.

The same framework is extended to consider the impact of gas-to-particle partitioning on the deposition velocity of NH_3 and HNO_3 individually, and combined affects the dry deposition of inorganic reactive nitrogen. Four regimes of deposition velocity emerge: i) HNO_3-fast, NH_3-slow, ii) HNO_3-slow, NH_3-fast, iii) HNO_3-fast, NH_3-fast, and, iv) HNO_3-slow, NH_3-slow. Conditions that favor strong partitioning of species to the aerosol phase strongly delay the deposition of reactive nitrogen species and promotes their accumulation in the boundary layer and potential for long-range transport.

The analysis and framework is then extended to defined the sensitivity and deposition domains of PM to chloride in the boundary layer – and applied to polluted regions where high levels of aerosol chloride is observed.

With this new understanding, aerosol pH and associated liquid water content can be understood as control parameters that drive PM formation and dry deposition flux and arguably can catalyze the accumulation of aerosol precursors that cause intense haze events throughout the globe.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-15A

Study on the Ozone Photochemistry in China

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IGAC Regional Working Groups

China Working Group

Abstract

China, as one of the largest industrial countries worldwide, does have a broad spectrum of chemical and meteorological regimes that can challenge different aspects of the current atmospheric chemical mechanisms. Based on active comprehensive field measurements conducted in the last decades, significant advancements were achieved such as the new formation pathways of nitrous acid, auto-oxidation of organic peroxy radicals to regenerate hydroxyl radicals, and the unexpectedly reactive halogen chemistry in the non-polar urban areas, etc. All these newly added knowledge is found to significantly enhance the predicted instantaneous local ozone production rates of which the regional impact were still unclarified. Moreover, fast winter photochemistry was also verified to be true according to direct measurements of hydroxyl radicals and indirectly deduced by the diel variations of the observed total oxidants concentrations. The efficient and fast production of ozone in both winter and summer seems to be the root for both the O_3 and $PM_{2.5}$ pollutions appeared in summer and winter. Therefore the modulation of the ozone production rates might be one the key strategy to realize the joint control of O_3 and $PM_{2.5}$ pollutions for China and other places of the world.

Early Career Scientist

NO, I am not an early career scientist.

CHINA-16B

First comprehensive measurements on atmospheric photochemistry over the Tibetan Plateau

Dr. Chunxiang Ye
Peking University, Beijing, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Tibetan Plateau (TP), the third pole, represents global background of the atmosphere and also features by strong UV and then active photochemistry. Due to the complexity and logistics required, a comprehensive characterization of atmospheric photochemistry over the Tibetan Plateau is however not available until our field campaign on atmosphere change over the Tibetan Plateau in 2019 and 2021, @ Tibet 2019 & 2021. The major objectives of @ Tibet campaign include a) to characterise the oxidative capacity of the atmosphere and the influencing factors, b) to explore the processes driving the atmosphere change, and c) to describe the feedback between atmosphere change and climate change over the Tibetan Plateau. Here we would like to share our hypothesis and preliminary data on surface flux of NO_x (= NO + NO_2) and its role to promote oxidative capacity of atmosphere, as a result of increasing reactive nitrogen deposition and faster warming in this pristine area. With a set of automated dynamic chamber system, NO flux of 0.012 (± 0.009) nmol/m^2s and smaller NO_2 flux with a compensation point NO_2 mixing ratio at ~350 pptv were observed in southeast TP meadows. A biochemical process correlated with temperature and a Re-NOx-ification process relating to surface photochemistry on local plant leaves appeared to dominate together the NO_x flux. With a daytime flux maxima, these processes could substantially sustains the mixing ratio of NO_x and hence promotes the oxidative capacity of the atmosphere.

Early Career Scientist

NO, I am not an early career scientist.

Final category: FF-1A

Identification of Different Generation Oxidation Products and Tracers: Secondary Organic Aerosol Formation from Aromatic Precursors

Dr Deepchandra Srivastava[1], Dr Tuan V Vu[1,2], Dr Shengrui Tong[3], Dr Siqi Hou[1,3], Professor Zongbo Shi[1], Professor Roy M Harrison[1]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Secondary organic aerosol (SOA) formed via the atmospheric oxidation of volatile/semi-volatile organic compounds (SVOCs) is well-known to comprise a significant fraction of fine particulate matter in urban areas. The identification of chemical tracers for the oxidation products of biogenic precursors under different atmospheric condition such as high-/low-NO_x, have reported in number of studies. However, work on aromatic SOA precursors is very limited. In urban environments, aromatic hydrocarbons (e.g., benzene, toluene, xylene) contribute up to 30% of VOCs emissions. These aromatic VOCs have been shown to account for significant fraction of SOA formed and can be substantially higher than biogenic SOA. Therefore, identification of significant SOA tracers and quantification of their 'oxidation products' from anthropogenic precursors could improve our knowledge on SOA formation processes as well as their key role in climate change and air quality. A potential aerosol mass (PAM) chamber was used to investigate the oxidised products from the photooxidation of xylene and toluene at the Institute of Chemistry, the China Academy of Sciences. The experiments were carried out with OH radical as oxidant in the presence of low-/high-NO_x and resultant aerosols samples were collected using quartz filters. The analytical technique has been developed to perform the analysis of filter samples extracted using sonication to identify unknown chemical products using a multi-step derivatisation approach (BSTFA+1%TMCS, PFBHA; derivatising agent) by GC×GC-TOFMS. The work is under progress and aimed at identifying different generation products for each precursor. It will also focus on estimating SOA yields for these products and use in the calculation of a typical mass fraction which can been used later to investigate the total SOA mass produced from a particular class of precursor. Results will also highlight the identification of some unique compounds "tracers" to use in receptor models to derive the secondary contributions.

Early Career Scientist

YES, I am an early career scientist.

FF-2B

Exploring modeled impacts and uncertainties of DMS oxidation mechanisms

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

Americas Working Group

Abstract

Oceanic emissions of dimethyl sulfide (DMS) represent the dominant source of biogenic sulfur to the atmosphere and can have considerable impacts on atmospheric chemistry and composition. Once in the atmosphere, DMS is oxidized to form sulfur dioxide (SO_2) and methane sulfonic acid (MSA), both of which can subsequently contribute to particle formation or growth. These oxidized products and DMS itself can significantly influence atmospheric composition, and newly uncovered knowledge gaps related to their emissions, chemistry, and other properties contribute to uncertainties in the Earth's sulfur budget. While most climate and air quality models used today include some form of DMS emissions and oxidation chemistry, the mechanisms are often simplified, neglecting significant interactions between DMS and O_3 or halogenated species such as bromine oxide (BrO). These simplifications contribute to uncertainties and biases in global and regional DMS budgets – issues that must be resolved to fully assess the role of DMS-derived sulfur on not only climate, but also on the air quality in urban coastal regions strongly influenced by marine, biogenic terrestrial, and anthropogenic emission sources. This work features the integration and evaluation of two expanded DMS oxidation schemes using the GEOS-Chem chemical transport model, as well as an examination of mechanism impacts on urban coastal sulfur budgets. Using these reactions, it is possible to better estimate the ratio of key products such as SO_2 and MSA. We find that inclusion of these species and associated reactions show regional changes in SO_2 and sulfate, in particular in the areas of peak DMS emissions and near coastlines, with possible implications for urban coastal climate and air quality.

Early Career Scientist

YES, I am an early career scientist.

FF-3C

First observations of gas-phase urea in the atmosphere

Ms Emily Matthews[1], Dr Thomas Bannan[1], Mr Archit Mehra[1], Dr Anwar Khan[2], Prof Dudley Shallcross[2], Dr Harald Stark[3], Prof Eleanor Browne[3], Dr Alexander Archibald[4], Prof James Lee[5], Prof Lucy Carpenter[6], Prof Grant Allen[7], Prof Joel Thornton[8], Prof Carl Percival[9], Prof Martin Gallagher[1], Prof Hugh Coe[1]
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Abstract

The deployment of high-resolution mass spectrometry instruments into the field are allowing for more and more novel species to be identified. Here we present the first observations of gas-phase urea in the atmosphere measured using an iodide-high resolution time-of-flight chemical ionisation mass spectrometer (HR-ToF-CIMS) during recent aircraft campaigns over the North Atlantic and East Africa. Our measurements indicate that urea is ubiquitous throughout the atmosphere with mixing ratios frequently exceeding 200 ppt and reaching upto 2 ppb in some environment, these are significant quantities of a trace gas that has never been previously reported in ambient measurements. Our measurements indicate urea being an important flux from biologically rich ocean environments to the atmosphere and as such it is a potential pathway for reduced nitrogen transport to remote parts of the ocean. Other atmospheric implications of this discovery are unclear. However, urea is likely to be climatically important as some theoretical studies have suggested the role of urea in new particle formation (Glasoe et al., 2015; Kirkby et al., 2011; Kumar et al., 2018), cloud condensation nuclei (Lv et al., 2018) and ice-nucelating particle formation (Hazra et al., 2006; Knollenberg, 1966), and in the reduction of NO2 (Lv et al., 2018).

Early Career Scientist

YES, I am an early career scientist.

FF-4A

Coexistence of three liquid phases in individual atmospheric aerosol particles

Yuanzhou Huang[1], Dr. Fabian Mahrt[1], Shaun Xu[1], Prof. Dr. Manabu Shiraiwa[2], Prof. Dr. Andreas Zuend[3], Prof. Dr. Allan K. Bertram[1]
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Abstract

Submicron aerosol particles are ubiquitous in the troposphere and play an important role for air quality and climate. Primary organic aerosol (POA), secondary organic aerosol (SOA), and secondary inorganic aerosol (SIA) constitute a significant mass fraction of these particles, specifically in and downwind of urban areas. Condensation of gases onto primary aerosol and coagulation can form internal mixtures of these aerosols within individual particles. To predict the role of these internally mixed particles in climate, air quality, and atmospheric chemistry, information on their phase behaviour is needed. For instance, a particle with a single homogeneous liquid phase can have different scattering properties, reaction rates, and uptake kinetics compared to a particle with multiple liquid or solid phases.

Here, using fluorescence microscopy, we investigated the relative humidity dependent phase behaviour of particles containing mixtures of proxies of POA, SOA, and SIA. As proxies of SOA, we used 1 of 21 different oxidized organic molecules. We show that three liquid phases frequently coexist within these particles, and that the phase behaviour strongly depends on the oxygen-to-carbon ratio of the SOA proxies. Experiments with SOA generated by dark ozonolysis of α-pinene in an environmental chamber confirm these observations.

Early Career Scientist

YES, I am an early career scientist.

FF-5B

Water as the pH probe for individual particles using micro-Raman spectroscopy

Dr. Xiaoyu Cui, Prof. Tong Zhu
Peking University, Beijing, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Atmospheric aerosol acidity is an important characteristic of aqueous particles, as many key multiphase chemical reactions involving aerosols are highly pH dependent. However, the determination of pH in atmospheric particles is an analytical challenge due to the nonconservative nature of the H^+ concentration ($[H^+]$). Traditional measurements have difficulty in describing the practical state of an aerosol because they comprise chemical components or hypotheses that change the nature of the particles. In this study, we explored a direct approach using water as a general probe to measure $[H^+]$ in individual particles with Raman spectroscopy. The ion-induced spectra, containing the spectral features of water influenced by ion and the ion itself, were decomposed from solution spectra as the standard spectra with the help of multivariate curve resolution–alternating least squares analysis. Meanwhile, the ion ratios were calculated between the measured spectra and standard spectra to evaluate each ion content in the system. It demonstrated that good quantitative models for all ion concentrations including $[H^+]$ can be built with correlation coefficients higher than 0.95. The method was then extended to individual particle pH measurement. The pH value of the sulfate aerosol particle was calculated, and the standard error of pH value was 0.09 using values calculated from the $[HSO_4^-]/[SO_4^{2-}]$ proportion as a reference. Furthermore, the applicability of the method was proved by detecting the pH value in chloride particles. Therefore, utilizing the most common substance, water, as the spectroscopic probe to measure $[H^+]$ without restriction of the ion system, this method is a potential way to measure the pH value of various atmospheric particles.

Acknowledgement. This work was supported by National Natural Science Foundation of China (91844000) and China Postdoctoral Science Foundation (2020M670048).

Early Career Scientist

YES, I am an early career scientist.

FF-6C

Using Measurements of Atmospheric ^{14}CO in a Global Network to Improve Understanding of OH Spatial and Temporal Variability

Vasilii Petrenko[1], Edward Crosier[1], Andrew M Smith[2], Bin Yang[2], Lee T Murray[1], Aidan Colton[3], Bryan Thomas[3], Ross Burgener[3], Gatavai Talamoa[3], Hinrich Schaefer[4], Rowena Moss[4], Gerard Spain[5], Simon O'Doherty[6], Yann Hello[7], Patrick Hernandez[7], Edmund Blades[8], Rebecca Chewitt-Lucas[9], Roxana Kazemi[1], Margaret Scholer[1], Marika Stock[1]
[1]Department of Earth and Environmental Sciences, University of Rochester, Rochester, NY, USA. [2]Australian Nuclear Science and Technology Organisation (ANSTO), Kirawee DC, NSW, Australia. [3]NOAA Earth System Research Laboratory, Global Monitoring Division, Boulder, CO, USA. [4]National Institute for Water and Atmospheric Research (NIWA), Wellington, New Zealand. [5]School of Physics, National University of Ireland Galway, Galway, Ireland. [6]Atmospheric Chemistry Research Group, University of Bristol, Bristol, United Kingdom. [7]Observatoire des Sciences de l'Univers, Université de La Réunion, UAR 3365, France. [8]The Queen Elizabeth Hospital, Ministry of Health and Wellness,, Bridgetown, Barbados. [9]Carribean Institute for Meteorology and Hydrology, Bridgetown, Barbados

Abstract

The primary source of ^{14}C-containing carbon monoxide (^{14}CO) in the atmosphere is via ^{14}C production from ^{14}N by secondary cosmic rays, and the primary sink is removal by hydroxyl radicals (OH). Variations in the abundance of ^{14}CO that are not explained by variations in ^{14}CO production or transport are mainly driven by variations in the abundance of OH. Because of its relatively short atmospheric lifetime (≈2 months on average), ^{14}CO abundance is sensitive to spatial and seasonal OH variability. ^{14}CO measurements in a new global network were started in January 2021 and are expected to continue until January 2022. Simulations in the GEOS-Chem chemical transport model (CTM) indicate that our ^{14}CO network has good sensitivity to variations in both regional and global OH. This presentation will provide an update on the project, showing the new ^{14}CO measurements and CTM results available to-date.

Early Career Scientist

NO, I am not an early career scientist.

FF-8B

Renoxification on Aerosol Particles over the Atlantic Ocean

Simone T. Andersen[1], Rosie Chance[1], Adam R. Vaughan[1], Tomás Sherwen[1], James D. Lee[1], Lucy J. Carpenter[1], Mathew J. Evans[1], Chris Reed[2], Roberto Sommariva[3], William Bloss[3], Graeme Nott[2]
[1]University of York, York, United Kingdom. [2]FAAM Airborne Laboratory, Cranfield, United Kingdom. [3]University of Birmingham, Birmingham, United Kingdom

Abstract

Formation of HNO_3 and its subsequent uptake to aerosol has traditionally been thought of as a loss mechanism for NO_x, however, in recent years laboratory experiments and ambient observations suggest that it could be a source of NO_x through a process called "renoxification". Photolysis of HNO_3 deposited on seasalt particles and urban grime produces HONO and NO_x and has been shown to be enhanced by up to four orders of magnitude compared to gas phase photolysis. Sea salt particulate photolysis coefficients of about 10-50 times larger than corresponding gas phase HNO_3 photolysis coefficients have been shown to explain observations of HONO and NO_x at the Cape Verde Atmospheric Observatory (CVAO). Whilst previous studies have reported observations relevant to sea-salt aerosol, a significant fraction of nitrate over the tropical Atlantic is associated with desert dust. Renoxification on dust aerosol could therefore have substantial impacts on the distribution of NO_x over the Atlantic but these are unknown. In the Cape Verde region, seasalt is the dominant aerosol type in the lower atmosphere over most of the year, but Saharan dust dominates the aerosol composition in winter. Here, we report ground based observations of NO_x and HONO at the Cape Verde Atmospheric Observatory together with aircraft measurements of NO_x, HONO, and particulate nitrate from a summer and a winter campaign over the surrounding tropical Atlantic Ocean, to investigate renoxification on both dust and seasalt particles over the Atlantic Ocean. The results from these campaigns are used to get a better understanding of the NO_x observations made in Cape Verde since 2006.

Early Career Scientist

YES, I am an early career scientist.

FF-9C

Organic nitrate deposition to trees: processes, rates and atmospheric implications

Bryan K Place, Erin R Delaria, Amy X Liu, Ronald C Cohen
University of California, Berkeley, Berkeley, CA, USA

IGAC Activities

Abstract

Organic nitrates influence the oxidative capacity in the atmosphere through their role as sinks of NO_x ($NO_x \equiv NO_2+NO$) and their role of temporarily sequestering NO_x and re-releasing NO_x downwind of its sources. Organic nitrates are produced in the atmosphere via the reaction of peroxy radicals with either NO or NO_2. Organic nitrates are permanently removed from the atmosphere through conversion to HNO_3 and by dry and wet deposition. Foliar deposition is thought to be an important aspect of the dry deposition; however, the rates, processes and mechanisms that govern this depositional pathway are poorly constrained by lab or field observations. Here, we report measurements of the deposition of organic nitrates to North American native conifer and broadleaf trees using a branch enclosure system. Results show that organic nitrate deposition occurs entirely via diffusion through the leaf stomata and increases linearly with ambient organic nitrate concentration. Uptake fluxes scale linearly with stomatal conductance, with a range of observed proportionality constants for different organic nitrate compounds. These observations suggest different rates of leaf mesophyllic processing for different organic nitrates. No tree species dependent-uptake has been measured so far. Maximum observed deposition velocities ranged from 0 to 0.3 cm s^{-1} implying that deposition can be the main loss process of organic nitrates within a forest canopy, and that deposition likely contributes considerably to the total loss of these compounds in the full boundary layer.

Early Career Scientist

YES, I am an early career scientist.

FF-11B

The Viscosity of Organic Films from Cooking Aerosol

Kristian J. Kiland[1], Ying Li[2], Kevin L. Marroquin[1], Shaun Xu[1], Dr. Manabu Shiraiwa[2], Dr. Rachel E. O'Brien[3], Dr. Allan K. Bertram[1]
[1]The University of British Columbia, Vancouver, BC, Canada. [2]University of California, Irvine, Irvine, CA, USA. [3]William & Mary, Williamsburg, VA, USA

Abstract

Organic aerosols generated from cooking processes are abundant in urban environments. The viscosity of cooking organic aerosols (COA) has consequences for their role in atmospheric chemistry, air quality, and climate. In addition, COA can form thin films on indoor surfaces. These COA films are important to understand for air quality indoors, where humans spend a majority of their lives. The viscosity of COA film samples from the HOMEChem field study was measured. The samples had different viscosities based on their collection method. Collection was done by either (1) extraction with acetonitrile or (2) physically scraping with a razor blade. For the acetonitrile extract, the viscosity was measured with the poke-flow technique. The viscosity of the acetonitrile extracts was shown to be semi-solid or liquid-like (viscosity less than 10^4 Pa s), which was much lower than predicted by a molecular-weight based viscosity model. By including unsaturation in the model, the predictions agree with the measurements. Compared to the acetonitrile extract, the scraped sample appeared to be more solid-like. A novel softening technique was developed to measure its viscosity.

Early Career Scientist

YES, I am an early career scientist.

FF-12C

Nitrate-mediated photooxidation of organic acids in the aqueous phase

Dr. Theodora Nah, Mr. Yuting Lyu
City University of Hong Kong, Hong Kong, Hong Kong

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Atmospheric aqueous phases (e.g., cloudwater, aerosol water, fog droplets) are an important reaction media for the formation and evolution of aqueous secondary organic aerosols (SOA). Aqueous-phase photooxidation of biogenic volatile organic compounds (BVOCs) is a major source of aqueous SOA precursors. Monoterpenes contribute a large fraction of BVOC emissions worldwide. α-pinene is one of the main monoterpenes emitted. Once emitted, α-pinene undergoes oxidation in the gas phase and forms many multifunctional organic compounds. One of main organic compounds formed during gas-phase α-pinene oxidation is cis-pinonic acid. Cis-pinonic acid is highly water-soluble and can partition into the aqueous phase where it can undergo oxidation to form SOA. In addition to cis-pinonic acid, numerous water-soluble organic acids are also formed. Inorganic nitrate is a ubiquitous component of atmospheric aqueous phases. The photolysis of inorganic nitrate in aqueous phases produces OH radicals and a variety of reactive nitrogen species (e.g., NO and NO_2 radicals) that can participate in aqueous-phase reactions. We present studies aimed at understanding the aqueous-phase photooxidation of cis-pinonic acid initiated by inorganic nitrate photolysis. We observed faster cis-pinonic acid reaction rates when the photooxidation is initiated by sodium nitrate photolysis compared to when the photooxidation is initiated ammonium nitrate photolysis despite the same molar concentrations of sodium nitrate and ammonium nitrate being used. We also observed that the reaction rate of cis-pinonic acid depended on the pH of the aqueous phase. Cis-pinonic acid exhibited noticeable larger reactivities at higher pH's. We extended our nitrate-mediated photooxidation studies to smaller organic acids (formic acid, acetic acid, malonic acid, and oxalic acid) commonly found in atmospheric aqueous phases. In contrast to cis-pinonic acid, these smaller organic acids reacted slower at higher pH's. These results provide new insights on aqueous-phase SOA formation in BVOCs-rich areas with high levels of inorganic nitrate aerosols.

Early Career Scientist

NO, I am not an early career scientist.

FF-13A

Unveiling Processes in Secondary Organic Aerosol Particles during Isothermal Evaporation

Zijun Li[1], Angela Buchholz[1], Arttu Ylisirniö[1], Luis Barreira[1,2], Liqing Hao[1], Iida Pullinen[1], Siegfried Schobesberger[1], Taina Yli-Juuti[1], Annele Virtanen[1]
[1]Department of Applied Physics, University of Eastern Finland, Kuopio, Finland. [2]Atmospheric Composition Research, Finnish Meteorological Institute, Helsinki, Finland

Abstract

Evaporation modifies the composition, properties, and atmospheric lifetime of secondary organic aerosol (SOA) particles. The volatility distribution of particle constituents and particle viscosity jointly govern the evaporation behaviour of SOA particles. Here, we present results of our laboratory studies of the isothermal evaporation of SOA particles. We systematically examined impacts of relative humidity (RH), precursor compounds (α-pinene vs a sesquiterpene mixture) and NO_x levels on the particle evaporation.

Different types of SOA particles were produced in an oxidation flow reactor (OFR) by varying either precursor compounds or NO_x levels. Monodisperse SOA particles were fed into a stainless-steel residence time chamber (RTC) for isothermal evaporation under a set of RH settings at 25 °C. Particle samples were periodically taken from the RTC to analyse size and compositional changes.

Evaporation of SOA particles was faster with increasing RH, as particulate water reduced particle viscosity by acting as a plasticizer. Compared with the α-pinene SOA particles, the sesquiterpene-mixed SOA particles formed under comparable oxidation conditions evaporated slower at any set RH. This discrepancy was primarily driven by the lower volatility of sesquiterpene-mixed particles and possibly aided by its higher viscosity under dry conditions. Independent of NO_x levels, the evaporation behaviour of α-pinene SOA particles was almost identical under all RH conditions.

Positive matrix factorization (PMF) was deployed to obtain more detailed volatility and composition information from the mass spectra data. By examining the evolution of PMF factors with increasing evaporation time or RH, we concluded that water not only acts as a plasticizer but also facilitates aqueous-phase processes during isothermal evaporation of SOA particles. The effect of particulate water depends on the SOA type and evaporation timescale. The dominant effect can vary between different compound groups in the particle (i.e., as represented by the PMF factors).

Early Career Scientist

YES, I am an early career scientist.

FF-14B

Formation of secondary aerosols, particulate nitrogen- and sulfur-containing organics through anthropogenic-biogenic interactions at night

Li Xu Li Xu
Environment Research Institute, Shandong University, Qingdao, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Formation of secondary aerosols, particulate nitrogen- and sulfur-containing organics through anthropogenic-biogenic interactions at night

Li Xu, Lin Du

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Abstract Mixing of anthropogenic gaseous pollutants and biogenic volatile organic compounds impacts the formation of secondary aerosol, but still in an unclear manner. The present study explores secondary aerosol formation via the interactions between β-pinene, O_3, NO_2, SO_2, and NH_3 under dark conditions. Results showed that aerosol yield can be largely enhanced by more than 330% by NO_2 or SO_2 but slightly enhanced by NH_3 by 39% when the ratio of inorganic gases to β-pinene ranges from 0 to 1.3. Joint effects of NO_2 and SO_2, and SO_2 and NH_3 existed as aerosol yields increased with NO_2 but decreased with NH_3 when SO_2 was kept constant. Infrared spectra showed nitrogen-containing aerosol components derived from NO_2 and NH_3, and sulfur-containing species derived from SO_2. Several particulate organic nitrates (MW 215, 229, 231, 245), organosulfates (MW 250, 264, 280, 282, 284), and nitrooxy organosulfates (MW 294, 310, 324, 326 and 342) were identified using high resolution orbitrap mass spectrometry in NO_2- and SO_2-experiments, and their formation mechanism is discussed. Most of these nitrogen- and sulfur-containing species have been reported in ambient particles. Our results suggest that the complex interactions among β-pinene, O_3, NO_2, SO_2, and NH_3 during the night might serve as a potential pathway for the formation of particulate nitrogen- and sulfur-containing organics, especially in polluted regions with both anthropogenic and biogenic influences.

Early Career Scientist

YES, I am an early career scientist.

FF-15C

Highly oxygenated organic nitrates formed from NO3 radical initiated oxidation of β-pinene

Hongru Shen[1], Defeng Zhao[1,2,3], Iida Pullinen[2], Sungah Kang[2], Luc Vereecken[2], Hendrik Fuchs[2], Stephanie Schrade[2], Ismail-Hakki Acir[2], Ralf Tillmann[2], Franz Rohrer[2], Jürgen Wildt[2], Astrid Kiendler-Scharr[2], Andreas Wahner[2], Thomas Mentel[2]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

The oxidation of biogenic volatile organic compounds (BVOC) by the nitrate radical (NO_3) is known as a major source of night-time organic nitrates (ON) and secondary organic aerosols (SOA), especially in regions influenced by anthropogenic NO_x and natural BVOC emissions. A number of uncertainties remain in the gas-phase chemistry, such as the formation mechanism and yields of highly oxygenated organic molecules. In this study, the reaction of NO_3 with β-pinene was investigated in the SAPHIR chamber in Jülich (Simulation of Atmospheric PHotochemistry in a large Reaction chamber). Substantial production of highly oxygenated organic nitrates (HOM-ON) were observed in the gas phase, including six monomer and five accretion product families. Tentative formation mechanisms are proposed and constrained based on the temporal behavior of closed-shell products along with their precursor peroxy radicals (RO_2). A unimolecular termination pathway of HOM-RO_2 that produces unsaturated carbonylnitrates as a dominant fraction of first-generation HOM-ON in β-pinene + NO_3 reaction system is highlighted. Additional attack by NO_3 to these unsaturated carbonylnitrates was seen to lead to the formation of dinitrates as second-generation products. Accretion products were mainly formed via RO_2 + RO_2 self- or cross-reactions. To evaluate the role of these HOM-ON in the SOA formation from NO_3 oxidation of β-pinene, an estimated HOM production yield was provided.

Early Career Scientist

YES, I am an early career scientist.

FF-16A

An evaluation of the unexplored generation of hydrogen from the photolysis of aldehydes using two photochemistry models

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IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

The global climate crisis has promoted governments to develop plans to use energy carriers like hydrogen. Atmospheric modelling has been previously used to evaluate the impacts of the technology migration and quantify sinks and sources of hydrogen (Derwent et al. 2020). The sinks of hydrogen include reaction with OH and uptake by soil. Sources of hydrogen correspond to emissions and formation from the photolysis of formaldehyde. However, recent laboratory measurements (Harrison et al. 2019) show that other aldehydes also photo-dissociate to yield hydrogen. This occurs either by a triple fragmentation channel, or by direct hydrogen elimination partnered by a ketene molecule. This study investigates the impact of this unexplored photochemistry using the 3D atmospheric chemical transport model, GEOS-Chem, and a box model implementing the Master Chemical Mechanism. The photolysis reactions of aldehydes producing hydrogen were incorporated with a quantum yield of 1%, as guided by acetaldehyde experiments. The results were compared against baseline simulations that neglected this newly discovered photochemistry. For GEOS-Chem, five aldehyde species included in the standard mechanism were tested. An increase of 0.026 Tg yr^{-1} in the global chemical production of hydrogen was calculated, compared to a baseline production of 41 Tg yr^{-1}. This increase was balanced by an increase in the modelled sinks, leading to a negligible change in the hydrogen mixing ratio. The box model was run in urban and pristine environments, and hydrogen was included as a product for eight aldehydes. The box model showed a maximum change of ~0.1% in the hydrogen mixing ratios at the end of the modelling period. Overall, no changes were observed with either model in other species like OH or O_3. The results are placed in the context of a future hydrogen economy by comparing the observed changes against reference estimates of hydrogen emissions and anticipated leakage rates (Bond, 2011).

Early Career Scientist

YES, I am an early career scientist.

FF-17B

Insights into tropical cloud chemistry at La Reunion Island reveals a high supersaturation of low-soluble VOCs in the aqueous phase

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Abstract

We present here the results obtained during an intense field campaign conducted in the framework of the French "BIO-MAÏDO" project. This study integrates an exhaustive chemical and microphysical characterization of cloud water obtained in March-April 2019 at La Reunion Island (Indian Ocean). This is the first time that such a large chemical characterization is performed in cloud waters, including inorganic ions, metals, oxidants, and organic matter (organic acids, sugars, amino acids, carbonyls, and low-soluble volatile organic compounds (VOCs)). Fourteen cloud samples have been collected over the slope of this mountainous island. Cloud samples present high molecular complexity with elevated water-soluble organic matter content partly modulated by microphysical cloud properties.

As expected, our findings shown the presence of compounds of marine origin in cloud water samples (e.g., chloride, sodium) demonstrating an ocean–cloud exchange. However, the non-sea salt fraction of sulphate reaches up to 80%, indicating the presence of other sources.

Variability between events is observed in the dissolved organic content, with levels reaching up to 62 mgC L^{-1}, a quite large content when compared with previous studies on cloud chemical composition. This variability was not similar for all the measured compounds, suggesting the presence of dissimilar emission sources or production mechanisms. This variability is assessed using back-trajectories together with land cover inventory.

Additionally, several VOCs (oxygenated and low-soluble VOCs) were analysed in both gas and aqueous phases. Significant levels of biogenic low-soluble VOCs were detected in the aqueous phase, indicating the cloud-terrestrial vegetation exchange. Cloud scavenging of VOC is assessed and compared to Henry's law equilibrium to evaluate possible super or sub saturation conditions. The evaluation reveals the supersaturation of low-soluble VOC from both natural and anthropogenic sources. Our results depict even higher supersaturation of terpenoids, suggesting their importance in the aqueous phase chemistry in highly impacted tropical areas.

Early Career Scientist

YES, I am an early career scientist.

FF-18C

Spatial heterogeneity of LDSA using a pilot network of LDSA sensors

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations

Abstract

Research in aerosol chemistry has long established aerosol surface area as an important parameter for the reactivity of compounds on or in aerosol particles. With respect to health impacts of aerosol exposure, aerosol surface area and lung deposition are the most implicating parameters linking exposure and impact. As a result, methods have been developed for measuring particle surface area using diffusion charging of particles, especially in the size range relevant for lung deposition and penetration. The measured parameter is often called lung-deposited surface area (LDSA). Since LDSA measurements are a recent development, there is limited information on the spatial and temporal variability of LDSA. The few studies available have identified significant spatial and temporal heterogeneity and point to the need for a network of LDSA sensors to better comprehend the factors responsible for their observations. Here, we present the first results from a network of LDSA sensors deployed in different regions of Zürich, Switzerland. These results show local and regional, as well as meteorological influences on LDSA concentrations. We expect to obtain valuable data for air quality impact monitoring and regulation with the long-term establishment, expansion, and maintenance of this network.

Early Career Scientist

YES, I am an early career scientist.

FF-19A

Stereoscopic remote sensing of atmospheric trace gases

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[1]University of Science and Technology of China, Hefei, China. [2]University of Science and Technology of China, Hefe, China.
[3]AIOFM, Hefei, China

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

Monitoring and modeling/predicting air pollution are crucial to understanding the links between emissions and air pollution levels, to supporting air quality management, and to reducing human exposure. Yet, current monitoring networks and modeling capabilities are woefully inadequate to fully understand the formation of air pollution, and to support air quality management and attribution of sources. We highlight the need for the development of an international stereoscopic monitoring strategy that can depict three-dimensional (3D) distribution of atmospheric composition to beat down the uncertainties, and to advance diagnostic understanding and prediction of air pollution. There are three reasons for the implementation of stereoscopic monitoring: (1) current observation networks provide only partial view of air pollution and this can lead to misleading air quality management actions; (2) satellite retrievals of air pollutants are widely used in air pollution studies, but too often users do not appreciate that they have large uncertainties; (3) air quality modeling and forecasting require 3D observational constraints. The stereoscopic monitoring strategy based on satellite and ground based remote sensing techniques will help us to better characterize the formation of air pollution, optimize air quality management and protect human health.

Early Career Scientist

NO, I am not an early career scientist.

FF-20A

O_2^--induced SO_2 oxidation in aerosol formation

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

China Working Group

Abstract

There has also been strong evidence that the contribution of ions to aerosol formation is non-negligible, and recent researches have been devoted in determining complementary sources of atmospheric sulfate. Motivated by this, many ion-induced SO_2 oxidation mechanisms have been investigated. For example, different combined theoretical studies showed that SO_2 oxidations initiated by O_3^- and SO_4^- ultimately lead to the formation of H_2SO_4, in the mechanisms where each of the ion acts as a catalyst in the $SO_2 + O_3 \rightarrow SO_3 + O_2$ reaction. These mechanisms were shown to contribute to the total H_2SO_4 formation rate by ~2.5%, and have implications in aerosol formation.

In this work, we used *ab initio* calculations based on density functional theory and couple-cluster theory to determine the structures and energies of all species involved in the O_2^--initiated SO_2 oxidation ozone and hydroxyl radical. The modeled reactions are as follows:

$SO_2 + O_2^- + O_3$ à Sulfates à Aerosols (R1)

$SO_2 + O_2^- + OH$ à Sulfates à Aerosols (R2)

We determined the thermodynamics and kinetics of these reactions and assessed their importance in sulfate formation and, ultimately, aerosol formation. We found that while reaction (R1) forms HSO_4^-, reaction (R2) forms HSO_5^-, both of which are effective charge carriers in sulfuric acid clusters formation. The studied reactions provide new mechanisms for sulfate formation from O_2^--induced SO_2 oxidation in the gas-phase, and the present work highlights the importance of including such mechanisms in modeling sulfate-based aerosol formation rates.

Early Career Scientist

NO, I am not an early career scientist.

FF-21C

Influence of atmospheric conditions on the role of trifluoroacetic acid in atmospheric sulfuric acid-dimethylamine nucleation

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Beijing Institute of Technology, Beijing, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Ambient measurements combined with theoretical simulations have shown evidence that the tropospheric degradation end-products of Freon alternatives, trifluoroacetic acid (TFA), one of the most important and abundant atmospheric organic substances, can enhance the nucleation process based on sulfuric acid (SA) and dimethylamine (DMA) in urban environments. However, TFA is widespread all over the world under different atmospheric conditions, such as temperature and nucleation precursor concentration, which are the most important factors potentially influencing the atmospheric nucleation process and thus inducing different nucleation mechanisms. Herein, using the density functional theory combined with the Atmospheric Cluster Dynamics Code, the influence of temperature and nucleation precursor concentrations on the role of TFA in the SA–DMA nucleation has been investigated. The results indicate that the growth trends of clusters involving TFA can increase with the decrease in temperature. The enhancement on particle formation rate by TFA and the contributions of the SA–DMA–TFA cluster to the cluster formation pathways can be up to 227-fold and 95%, respectively, at relatively low temperature, low SA concentration, high TFA concentration, and high DMA concentration, such as in winter, at the relatively high atmospheric boundary layer, or in megacities far away from industrial sources of sulfur-containing pollutants. These results provide the perspective of the realistic role of TFA in different atmospheric environments, revealing the potential influence of the tropospheric degradation of Freon alternatives under a wide range of atmospheric conditions.

Early Career Scientist

YES, I am an early career scientist.

FF-22A

Comprehensive product characterization in the OH oxidation of dimethyl sulfide using an environmental chamber

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IGAC Activities

Abstract

Dimethyl sulfide (DMS) is the largest natural source of sulfur emitted to the atmosphere. Oxidation of DMS forms sulfate aerosol, and thus is an important contributor to the radiative effects of aerosols globally. However, the oxidation process is not completely understood. In this study, DMS was oxidized by OH in an environmental chamber. A number of mass spectrometric techniques were used to detect and characterize a large number of sulfur-containing products, in both the gas and particle phases. Specifically, hydroperoxymethyl thioformate (HPMTF), the recently discovered compound formed from the isomerization of methylthiomethylperoxy radical, was identified and quantified. The isomerization rate constant of the methylthiomethylperoxy radical is estimated to be ~ 0.1 s^{-1}. In addition, key intermediate oxidation products, such as dimethyl sulfoxide (DMSO), methanesulfinic acid (MSIA) and methyl thioformate (MTF) and were also measured. Experiments were conducted under high and low NO levels and under different temperatures to explore the fates of RO_2 on the distribution of sulfur products. Over the course of 18 h atmospheric-equivalent oxidation under low NO condition (sub-ppb level NO), HPMTF is the dominant S species followed by SO_2. Under high NO conditions (~50 ppb NO) and after 2 h oxidation, HPMTF does not form and the S budget is dominated by particle-phase products namely sulfate and methane sulfonic acid. Under low NO conditions and lower temperature (10 C), HPMTF is still the major product formed from the abstraction channel while there is an increased fraction of products from the addition channel.

Early Career Scientist

YES, I am an early career scientist.

FF-23B

Role of photo-generated hydroxyl radicals in the ozone depletion on the surface of and within the polar stratospheric clouds (PSCs)

Prof. Jun He
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative, AMIGO: Analysis of eMIssions usinG Observations, ACAM: Atmospheric Chemistry and the Asian Monsoon, CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group, China Working Group

Abstract

Polar stratospheric clouds (PSCs) is a well-known key meteorological condition contributing to the ozone hole in the polar stratosphere. Previous studies on the role of PSCs in promoting the ozone depletion demonstrated that PSCs provide abundant surface for heterogeneous reactions to cause the formation of the Cl_2 and HOCl, leading to the formation of ·Cl and ·ClO, which are very effective in the chemical destruction of ozone. Recent studies indicated that the ice-air interface on the surface of PSCs is a dynamic liquid water layer, which might consist of aqueous HNO_3 and H_2O_2. Up to date, the possible photochemical contribution and detailed processes involving the surface components of PSCs particles in halogen activation have not been well understood yet. Here through the controlled experiments in the lab, we show that the sunlight drives the stable generation of ·OH in aqueous HNO_3 and its photo-induced byproduct HNO_2 using both electron spin resonance (ESR) and laser flash photolysis (LFP) spectrometer. Furthermore, it has been found that the photo-generated ·OH from aqueous HNO_3, HNO_2 and H_2O_2 have the remarkable capability to react with HCl, Cl- and Br- to form halogen radicals, implying that photochemical reactions involving HNO_3 and H_2O_2 on the surface of and within PSCs might constitute an important halogen activation pathway for the ozone destruction. The results from our study may help strengthen the understanding of ozone depletion mechanism in polar stratosphere.

Early Career Scientist

NO, I am not an early career scientist.

FF-24C

Enabling exchange and adequate use of data for observation based atmospheric research

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[1]MeteoSwiss, Zurich-Airport, Switzerland. [2]Environment Canada, Toronto, ON, Canada. [3]NASA Langley Research Center, Hampton, VA, USA. [4]WMO, Geneva, Switzerland

IGAC Activities

CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report, CATCH: the Cryosphere and Atmospheric Chemistry, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

Abstract

Systematic long-term and field campaign observations have played a vital role in advancing atmospheric research over the past several decades. The use of these observations has expanded from primarily characterizing atmospheric processes and trends to evaluating satellite measurements, assessing models, and improving air quality forecasts. Consequently, the demand for atmospheric chemistry observational data have dramatically increased in terms of scope and coverage of measurements (i.e., parameters/species, spatiotemporal extent). In addition to high quality measurements, certain data reporting standards need to be agreed to ensure the data can be readily exchanged and are sufficiently documented to enable adequate use in different research activities. To this end, WMO has developed and implemented measurement guidelines and community practices for meteorology, climatology, atmospheric and hydrological sciences. In addition, the WMO Expert Team on Metadata Standards manages and evolves the existing metadata standards for the WMO Information System WIS and WMO Integrated Global Observing System WIGOS to support consistent and interoperable data descriptions, ensure relevance to research, and to apply data science principles. This team draws on a wide range of expertise from the research community, including atmospheric measurements, modeling, data management, and data science. The current activities include development of key performance indicators, vocabularies for metadata and the evolution of metadata standards to lower the barrier of application to weather/climate/water/environment data for all operational services and scientific communities and the weather enterprise. This presentation intends to promote awareness of ongoing progress and actively solicit community feedback.

Early Career Scientist

NO, I am not an early career scientist.

FF-25A

Constructing shapes and mixing structures of black carbon particles with applications to optical calculations

Yuanyuan Wang, Yuner Pang, Jin Huang, Lei Bi, Huizheng Che, Xiaoye Zhang, Weijun Li
Zhejiang University, Hangzhou, Zhejiang, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

Black carbon (BC) aerosols strongly absorb the solar radiation, affecting the regional and global climate through direct and indirect radiative forcing. The optical properties of BC are critical factors to estimate their radiative forcing. However, the optical absorption of BC is still under controversy partially due to the weakness in quantifying their complex morphology and mixing structures. Although a Discrete Dipole Approximation (DDA) can calculate optical properties of fine particles with arbitrary shapes, an appropriate definition of realistic BC shape models for optical simulation is essentially required. Here we present a novel Electron-Microscope-to-BC-Simulation (EMBS) tool to construct realistic BC shape models with various morphology and mixing structures for optical calculation using DDA. The optical properties of BC particles with different particle morphology, coating thickness, and embedded fraction (F) are estimated based on electron microscope. We find that absorption enhancement (E_{abs}) of the realistic irregular model is larger than that of the present commonly used spherical model (i.e., BC aggregate with spherical coating). The BC core morphology greatly influences E_{abs} of the embedded BC particles with irregular coating when the volume-equivalent-diameter ratio of particle to core (D_p/D_c) is larger than 1.8. The F significantly influences E_{abs} of BC particles, suggesting that the mixing structure between coating and core is an important factor to determine the optical absorption of aged BC particles. The study highlights that the BC core morphology, coating shape, coating thickness, and mixing structures influence their optical properties and should be considered as important variables in climate models.

Early Career Scientist

YES, I am an early career scientist.

FF-26B

Application of the method to determine the atmospheric carbonyl compounds using liquid chromatography tandem mass spectrometry (LC-MS/MS) to ship measurement

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, GEIA: Global Emissions Initiative, CCMi: Chemistry Climate Model Initiative, CATCH: the Cryosphere and Atmospheric Chemistry, AMIGO: Analysis of eMIssions usinG Observations, ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

China Working Group

Abstract

Carbonyl compounds, including aldehydes and ketones, are ubiquitous in the atmosphere and play an important role in tropospheric photochemistry. They are the oxidation products of various hydrocarbons and precursors of radicals and ozone. Therefore, these compounds are of critical importance in tropospheric photochemistry.[1, 2]It is essential to gain a good understanding of the characteristics and atmospheric behaviour of aldehydes and ketones. But the knowledge of these parts is limited. An analytical method that can provide accurately qualitative and quantitative measurement of carbonyl compounds are required as the first step to understanding them. The conventional method to determine these pollutants using HPLC-UV is not sensitive and selective enough to distinguish all of these compounds. This study established a new method that can determine 39 carbonyl compounds including 36 monocarbonyls and 3 dicarbonyls by using 2,4-dinitrophenyl hydrazine (DNPH) derivatization and ultra-performance liquid chromatography and electrospray ionization tandem mass spectrometry (UPLC-ESI-MS/MS) detection. To improve the portability and operability of the detection, no buffer was introduced into the mobile phase. Good linearity (0.9901-0.9999) and low method detection limits (0.001-0.052 μg m^{-3}) are established in this method. We applied this method to analyse the samples collected in the ship-borne measurement and found that Formaldehyde, acetone and acetaldehyde were the most abundant carbonyl compounds, followed by the 2,3-butanedione, 2-butanone. Nonanaldehyde aldehyde also shows high concentration. These results give us the primary results of the characteristic of aldehydes and ketones in the atmosphere upon the ocean, laying the foundation for further analysis of the contribution to atmospheric chemistry, such as ozone formation.

Early Career Scientist

YES, I am an early career scientist.

FF-27C

Characterizing dynamic behaviors of phthalate monoesters and diesters in an office

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

Phthalates diesters (di-PAEs) are a kind of endocrine disrupting chemicals commonly occurring in the indoor environment. The corresponding phthalate monoesters (mono-PAEs), which have equal or even higher toxicity, are also detected in house dust recently. The dynamic behaviors of these pollutants are not fully understood. In this study, time-resolved measurements of airborne PAEs concentrations and associated gas-particle partitioning data were acquired in a vacant office for four weeks in the summer and three in the autumn, 2020. Two mono-PAEs (monoisobutyl phthalate, monobutyl phthalate) and three di-PAEs (diisobutyl phthalate, dibutyl phthalate, diethylhexyl phthalate) were quantified. Besides diethylhexyl phthalate, all the other four phthalates were mainly present in the gas-phase, and their concentrations correlated well with the indoor temperature, with indiscernible influence from ventilation. In the temperature range of 16 to 28 ℃, the concentrations doubled for every temperature increase of 4℃, which were quantitatively similar to theoretical predictions. The concentrations of mono-PAEs tightly correlated with those of their respective di-PAEs, indicating that the mono- and di-PAEs may have the same sources. The concentration ratios of mono- and di-PAEs exhibited no humidity dependence (20-70% RH). Diethylhexyl phthalate partitioned between the gas and particle phase. The particle proportion increased under higher particle mass concentrations and lower indoor temperatures, consistent with the theory. The bulk airborne concentrations were controlled by temperature, particle concentrations and outdoor atmosphere transmission. Our findings demonstrate that the key parameter controlling the dynamics of semivolatile pollutants is not ventilation but temperature, which should be noteworthy during exposure assessment.

Early Career Scientist

YES, I am an early career scientist.

FF-28A

Reaction Products and Pathways of Alkoxy Radicals in the Condensed Phase

Dr. Victoria P Barber[1], Yaowei Li[2], Dr. Alexander Zaytzev[2], Dr. Francesca Majluf[3], Dr. Jordan Krechmere[3], Professor Frank Keutsch[2], Professor Jesse H Kroll[1]
[1]Massachusetts Institute of Technology, Cambridge, MA, USA. [2]Harvard University, Cambridge, MA, USA. [3]Aerodyne Research, Billerica, MA, USA

Abstract

Condensed phase processes, such as aerosol oxidation aging and aqueous-phase oxidation, are critical in understanding the composition and properties of atmospheric aerosol. Organic radicals including alkoxy (RO) and peroxy (RO_2) radicals are key intermediates in these processes. Because most mechanistic studies of organic radical reactions take place in the gas phase, the underlying radical chemistry that governs these condensed phase processes is comparatively poorly understood. The condensed phase represents a much more complex environment, because locally high concentrations may facilitate additional reactions between organic species, and solvent effects may alter relevant potential energy surfaces. Here, we investigate the condensed-phase chemistry of a photolytically-generated RO radical, which allows for the selection of a specific RO radical isomer, greatly simplifying the subsequent chemistry as compared to oxidation via traditional routes. We generate the 1-pentanoxy radical via photolysis of a 1-pentyl nitrite precursor in hexafluorobenzene. The photolyzed reaction mixture is fed at a constant, low flow rate into an atomizer and nebulized directly into a suite of mass spectrometric instruments, providing real-time chemical kinetics information as well as molecular-formula level identification of the reaction products. Consistent with previous work, the results suggest that the nascent RO radical undergoes only unimolecular reaction, independent of the concentration of the RO radical precursor, and even in the presence of a high concentration of a reaction partner with abstractable H-atoms. This unimolecular reaction produces an alcohol-substituted peroxy radical, with a variety of available product channels, including one that involves successive intramolecular H-atom transfer of RO_2 radicals, leading to highly oxidized products. The kinetics and branching ratios associated with these product channels are investigated, and compared to recent gas-phase results for similar systems, providing insight into the effects of the solution-phase environment on organic radical chemistry.

Early Career Scientist

YES, I am an early career scientist.

FF-29B

A new mobile UAV-based platform of ACTRIS for atmospheric profiling

Dr. Maria Kezoudi[1], Professor Jean Sciare[1], Dr. Christos Keleshis[1], Professor Mihalis Vrekoussis[1,2]
[1]Climate and Atmosphere Research Centre (CARE-C), The Cyprus Institute, Nicosia, Cyprus. [2]Laboratory for Modeling and Observation of the Earth System (LAMOS), University of Bremen, Bremen, Germany

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

The Unmanned Systems Research Laboratory (USRL) of the Cyprus Institute is a new mobile exploratory platform of the EU Research Infrastructure Aerosol, Clouds and Trace Gases Research InfraStructure (ACTRIS). This allows USRL to offer UAV-sensor solutions that can be deployed everywhere in Europe and beyond, for intensive field campaigns through a transnational access scheme in compliance with the drone regulation set by the European Union Aviation Safety Agency (EASA) for the purpose of research, innovation, and training.

UAV-sensor systems allow for cost-effective vertically-resolved in-situ atmospheric observations within the first kilometres of the troposphere. Taking advantage of the private runway and dedicated airspace at the USRL atmospheric observatory in Orounda (Nicosia, Cyprus), USRL performs regular Unmanned Aerial Vehicle (UAV) scientific flights. These flights aim to document and study (i) localised airborne particles and gases, and (ii) long-range transported pollution from Europe, Africa and West Asia and dust aerosols from the largest desert regions in the world (Sahara, Middle East).

The USRL UAVs are equipped with a range of robust in-situ sensors used to perform both trace gases and aerosols measurements of the lowermost atmospheric layers and 3D mapping of plumes close to emission point. Since its establishment in 2015, USRL is participating in major international research projects dedicated to 1) the better understanding of aerosol-cloud interactions, 2) the profiling of aerosol absorption properties in contrasted atmospheric environments, 3) the vertical distribution of air pollutants below and above the planetary boundary layer, 4) the validation of Aeolus satellite dust products by utilizing novel UAV-balloon-sensor systems, and 5) the chemical characterization of ship and stack emissions.

Early Career Scientist

YES, I am an early career scientist.

FF-30C

Submicron aerosol acidity variability at a Mediterranean Coastal site

Anna Maria Neroladaki[1], Iasonas Stavroulas[1,2], Irini Tsiodra[1,3], Pavlos Zarmpas[1], Stelios Myriokefalitakis[2], Aikaterini Bougiatioti[2], Athanasios Nenes[3,4], Nikos Mihalopoulos[1,2], Maria Kanakidou[1,3,5]
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Abstract

Aerosol acidity (pH) is a key factor affecting the atmospheric composition and its impacts. However, direct measurements of aerosol pH, and especially that of submicron aerosol particles, are challenging not routinely done. The most reliable estimates of ambient aerosol pH are inferred from observations interpreted by thermodynamic model calculations – when the latter reproduces the observed liquid water content and semi-volatile partitioning of ammonia (NH_3) and other pH-sensitive species, like nitric acid (HNO_3) and hydrochloric acid (HCl).

Here we used a thermodynamic/observation approach to determine the levels and seasonal variation of submicron aerosol acidity over almost an entire year at the Finokalia observatory in the eastern Mediterranean. Aerosol water content and acidity were here calculated by the thermodynamic model ISORROPIA-II using concurrent measurements of submicron aerosol particles and gas-phase NH_3, HNO_3, and HCl. Consistent with studies to date, we find that the submicron aerosol is highly acidic with an average pH value of 1.16 ± 0.74 when accounting off-line for the contribution of the aerosol water associated with organics, which is overall minor. On average, the total aerosol water associated with all aerosol components was on average 4.01 ± 3.46 μg/m^3 with the organic aerosol water content contributing about 13% of the total aerosol water. Aerosol pH demonstrates a strong dependence on ambient temperature, relative humidity and sulfate levels, which in turn drive an intense seasonal cycle, with summertime pH values being about 1.9 pH units lower than wintertime values. Aerosol acidity was also found to be sensitive to the levels of semi-volatile compounds and in particular to ammonia. Furthermore, the non-volatile cations in the submicron aerosol fraction were found to increase aerosol pH by 0.73 pH units. This work is supported by the PANhellenic infrastructure for Atmospheric Composition and climatE change (PANACEA- MIS 5021516) project.

Early Career Scientist

YES, I am an early career scientist.

FF-31A

Seasonal Variation in Phase State and Chemical Composition of Ambient Particles Collected at the Southern Great Plains Site at Different Altitude

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CATCH: the Cryosphere and Atmospheric Chemistry, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

Abstract

The phase state of ambient particles affects several atmospheric processes such as cloud condensation, pollution transport, growth rate during gas-particle partitioning, heterogeneous ice nucleation, mixing state of particles, and reactivity reaction rate, making ambient particles have important climate effects. However, our understanding of the vertical structure of phase state of submicron size ambient particles remains limited due to lack of observation. The phase state of particles depends on the nature of particles (e.g., source, chemical composition) and environmental factors (e.g., ambient temperature, pressure, and relative humidity, which are highly variable at different seasons and altitudes). Additionally, there are limited field studies of the phase state of ambient particles in the submicron size range at different altitudes. To improve current understanding of ambient particle phase state, we will use a new analytical platform that uses a tilted stage integrated to the Peltier cooling stage interfaced with an Environmental Scanning Electron Microscope (ESEM) to directly observe and assess the phase state of ambient particles as a function of relative humidity at a controlled temperature. Ambient particle samples were collected at the Southern Great Plains (SGP) field site at different seasons and different altitudes by using an automated Size and Time-resolved Aerosol Collector (STAC) via ARM's tethered balloon system. The chemical composition, morphology, and functional groups of individual particles are probed using Computer-controlled scanning electron microscopy with energy-dispersive X-ray spectroscopy (CCSEM/EDX) and scanning transmission X-ray microscopy with near-edge X-ray absorption fine structure spectroscopy (STXM/NEXAFS). Limited samples are analyzed using high-resolution mass spectrometry and molecular corridor approach to assess organic particles' viscosity. We expect to find seasonal and altitude variations of the phase state of ambient particles, which will improve our understanding of their climate effects and roles in the atmospheric process.

Early Career Scientist

YES, I am an early career scientist.

FF-32B

Synergistic Multiphase Chemistry of Isoprene Hydroxy Hydroperoxides (ISOPOOH) with Sulfur Dioxide in Acidic Sulfate Aerosols Leading to Secondary Inorganic and Organic Aerosol Formation

Assistant Professor Yue Zhang[1], Ms. Jin Yan[2], Dr. Yuzhi Chen[2,3], N. Cazimir Armstrong[2], Research Professor Zhenfa Zhang[2], Professor Avram Gold[2], Professor Barbara J. Turpin[2], Professor Jason D. Surratt[2]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Americas Working Group, China Working Group

Abstract

Isoprene is the most abundant non-methane volatile organic compound (VOC) emitted globally. Isoprene hydroxy hydroperoxides (ISOPOOH), key photooxidation products of isoprene, likely comprise the second most abundant class of peroxides in the atmosphere, following hydrogen peroxide. Studies have shown that hydrogen peroxide and ISOPOOH play important roles in the formation of inorganic sulfate in cloud water mimics. However, there is limited information on the role of ISOPOOH in SOA and sulfate formation in wet aerosol oxidation of dissolved reduced sulfur species such as SO_2.

In order to examine the implications of ISOPOOH with aqueous sulfite, ammonium bisulfate particles were injected into the UNC 10-m^3 indoor environmental chamber under humid (i.e., 72% RH) and dark conditions followed by the injection gas-phase 1,2-ISOPOOH, with minimum mass increase of the particles observed. Gaseous SO_2 was then subsequently injected into the chamber and a significant amount of particle mass was produced. The gas-phase ISOPOOH and particle-phase species were sampled with a chemical ionization mass spectrometer (CIMS), an aerosol chemical speciation monitor (ACSM), a particle-into-liquid sampler (PILS) for analysis by ion chromatography (IC), and filter samples were analyzed by an ultra-performance liquid chromatography coupled to an electrospray ionization high-resolution quadrupole time-of-flight mass spectrometry (UPLC-ESI-HR-QTOFMS) to obtain offline molecular-level information. Results show that a significant amount of inorganic sulfate and organosulfates were formed rapidly after injecting SO_2, altering the chemical and physical properties of the particles including phase state, pH, reactivity, and composition. Multifunctional C_5-organic species that were previously measured in atmospheric fine aerosol samples were also reported here as reaction products, including 2-methyletrols and 2-methyltetrol sulfates that were previously thought to be only produced from isoprene-derived epoxydiols (IEPOX). Such results indicate that the multiphase reactions of ISOPOOH could have significant impacts on the atmospheric lifecycle of organic aerosols and sulfur, as well as the physicochemical properties of ambient particles.

Early Career Scientist

NO, I am not an early career scientist.

FF-33C

Identification and quantification of tracer products and influence factors of their yields in the OH-initiated oxidation of toluene and m-xylene

Shuyu He[1], Mengdi Song[1], Ying Liu[1], Xin Li[1], Tianzeng Chen[2], Yujing Mu[2], Min Shao[1,3]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Aromatics comprises an important fraction of atmospheric trace pollutants, and significantly contribute to the formation of ozone and secondary organic aerosol (SOA). Although many efforts have been taken to explore their oxidation initiated by OH radicals, branching ratios of different reaction pathways are still highly controversial due to the difficulties in probing chemically active intermediate products. In this study, toluene and m-xylene were chosen as the typical aromatics, and a series of oxidation experiments under varied initial NO_x concentrations were performed in an environmental chamber individually. Branching ratios of different pathways and effects of NO_x concentration are evaluated by the yield calculations of various tracer products which were identified and quantified by Proton Transfer Reaction-Quadropole interface Time-of-flight Mass Spectrometer (PTR-QiTOF), then product volatility distributions are also discussed. Results show distinct product distributions at different NO_x levels, and yields of small-molecule dicarbonyls were observed to be lower than the Master Chemical Mechanism (MCM) in toluene oxidation, while higher for m-xylene oxidation. And a large fraction still can not be well explained for both toluene (27~34%) and m-xylene (30~41%). When taking newly proposed mechanism into consideration, additionally considerable portion can be explained, which improves our understanding of toluene and m-xylene oxidation. However, better identification and quantification of tracer products to further modify toluene and m-xylene oxidation mechanisms are still required. In addition, phenolic pathway products possessing relatively lower volatility tend to have more potentials to yield SOA, which deserve more attentions in future.

Early Career Scientist

YES, I am an early career scientist.

FF-34A

Supersaturated state accelerates the uncatalyzed autoxidation of SO2 within aerosol droplets

Zhe Chen, Dr. Pai Liu, Dr. Yun-Hong Zhang
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

China Working Group

Abstract

Sulfate is a major PM2.5 constituent closely related to the onset of severe urban haze during the wintertime in China. The mechanism leading to the rapid particulate sulfate production accompanying haze episodes remains unclear and debated. Here we show that the primary salt effect in supersaturated aerosol droplets can significantly enhance the uncatalyzed SO2 oxidation by O2 (hereafter SO2 autoxidation), a mechanism traditionally deemed negligible in contributing to particulate sulfate formation. In this work, we adopted an optical tweezer to trap single aerosol microdroplets within a reaction chamber under controlled relative humidity (RH) and SO2 concentration. Then we measured the rate of sulfate formation within the droplets using Raman spectroscopy. We observed that as ambient RH decreases from ca. 90 to 60%, the first-order rate constant of SO2 autoxidation increases by more than one order of magnitude. Given the characteristic RH during the haze events in Beijing and the abundance of O2 in the air to sustain the continuous oxidation reaction, we pointed out that the uncatalyzed SO2 autoxidation is nontrivial under urban haze conditions. Neglecting such a formation pathway may result in the systematically underestimated sulfate formation by atmospheric models.

Early Career Scientist

YES, I am an early career scientist.

FF-35B

Atmospheric gas-phase alkylamines in the Mediterranean and their relation to new particle formation

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Department of Chemistry, University of Crete, Crete, Greece

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Amines are derivatives of ammonia and like ammonia, are strong basis. They are emitted by a wide range of sources both natural and anthropogenic and are shown to be potentially important contributors to New Particle Formation (NPF) in the atmosphere by stabilizing molecular clusters. In order to determine the atmospheric levels of gaseous amines, the levels of gas phase amines have been determined at the Finokalia monitoring station of the University of Crete from January 2013 to July 2016.

Air samples were collected on glass fiber filters impregnated with phosphoric acid with sampling period of 72 hours and their analysis was performed with a triple quadrupole HPLC-MS. The alkylamines that were detected were dimethylamine, ethylamine, trimethylamine, diethylamine and triethylamine. Dimethylamine and ethylamine were not separated and thus handled as a pair. Together with trimethylamine they were the most abundant alkylamines with a clear seasonal variability showing two maxima, the biggest one during winter and the second one during spring.

In order to investigate potential alkylamines participation in NPF in eastern Mediterranean, the seasonality of NPF events and alkylamines concentrations was compared. NPF events were identified using aerosol size distribution measurements by a Scanning Mobility Particle sizer, detecting particles larger than 9 nm. Alkylamines exhibit different seasonality from NPF events but show a clear correlation with that of the nucleation mode particle number concentration, indicating their potential contribution to nucleation mode particles' production in the region.

Early Career Scientist

YES, I am an early career scientist.

FF-37A

Theoretical Study on the Role of Environmental Factors in EPFRs Formation over CuO Surface

Danli Liang, Professor Xiuhiu Zhang
Beijing Institute of Technology, Beijing, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CATCH: the Cryosphere and Atmospheric Chemistry, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative, CCMi: Chemistry Climate Model Initiative, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

China Working Group

Abstract

Environmentally persistent free radicals (EPFRs) are a novel class of hazardous substances that can exist stably in airborne particles for a period ranging from days to weeks and are potentially toxic to human health. It is found that the EPFRs formation is affected by many factors, especially precursors, transition metals, environmental factors, carriers and so on. As the research moves along, more and more experimental studies have realized the importance about the effect of environmental factors on the EPFRs formation, the impacts of temperature, water and light irradiation are highlighted. Although the mechanism of EPFRs formation on the surface of transition metals have been studied, the effect of environmental factors in EPFRs formation on the surface of transition metals are still unknown. Aiming at revealing the effect of environmental factors on the EPFRs formation over the surface metal oxides, the temperature, water and light irradiation have been considered on C_6H_5OH dissociation over CuO surface by density functional theory (DFT) calculations. These results indicate that EPFRs are easily generated under common temperature conditions except for high-temperature combustion over the CuO surface. And the water and light can contribute to EPFRs formation. Accordingly, these findings provide a pathway toward understanding differences in EPFRs formation on particulate matter and more attention should be paid on the effect of environmental factor in EPFRs formation.

Early Career Scientist

YES, I am an early career scientist.

FF-38B

The role of Organophosphate Esters Flame Retardants and plasticizers (OPEs) in Phosphorus Cycle in the atmosphere of the Mediterranean Sea

scientist Kalliopi VIOLAKI[1], Professor Athanasios Nenes[1,2], senior scientist Richard Sempere[3], researcher Javier Castro Jimenez[4], researcher Christos Panagiotopoulos[3]
[1]EPFL, Lausanne, Switzerland. [2]Institute of Chemical Engineering Sciences, Foundation for Research and Technology, Patras, Greece. [3]Aix-Marseille Univ., Université de Toulon, CNRS, IRD, Mediterranean Institute of Oceanography, Marseille, France. [4]IFREMER, Nantes, France

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

The atmosphere is considered an important external nutrient source for the marine environment, especially in oligotrophic waters or remote oceanic areas. Phosphorus (P) is a critical nutrient affecting primary productivity in large areas of marine ecosystems such as the Mediterranean Sea, a chronically P-limited basin.

In this study, we quantify the anthropogenic organic P in the West and East Mediterranean atmosphere. Several organophosphorus flame retardants and plasticizers were analyzed, including (Tris- (1-chloro-2-propyl) phosphate (TCPP), tris[2-chloro-1-(chloromethyl) ethyl] phosphate (TDCP), Tris-(2-chloroethyl) phosphate (TCEP), tri-nbutyl phosphate (TnBP), triphenyl phosphate (TPhP), 2-ethylhexyl diphenyl phosphate (EHDPP).

Our analysis applied to Total Suspended atmospheric Particles (TSP) collected in Eastern (Crete, n= 67) and Western (Marseille, n=25) Mediterranean area by using high-volume air sampler. The analysis performed with the liquid chromatography coupled to mass spectrometry (Q–TOF–LC/MS).

Higher concentrations of OPEs observed in the West than in the East Mediterranean atmosphere especially for TCPP, TCEP, and TDCP, which considered as the most potentially hazardous. In the western Mediterranean, the most abundant OPEs were the EHDPP (3.04±4.17 pmol m^{-3}) and the TCPP (1.71±1.28 pmol m^{-3}). In East Mediterranean, the most abundant OPEs were the TCPP (0.36±0.29 pmol m^{-3}) and the TCEP (0.24±0.20 pmol m^{-3}), whereas the TDCP and the EHDPP were not detected. The percentage contribution of OPEs in atmospheric organic–P over the West Mediterranean was 9%, while over East was 0.4%.

The total anthropogenic organic P deposited in East Mediterranean during the stratification period (June-September) was calculated at 8 tons, which was 4 times lower compared with the West Mediterranean (29 tons of P) during the same period. Overall, the above anthropogenic compounds represented only 0.4% of anthropogenic P deposited during the stratification period, however, their toxicity and fate to the marine environment warrant further investigations.

Early Career Scientist

NO, I am not an early career scientist.

FF-39C

Physicochemical properties and Ice Nucleation Potential of Long-range Transported Free tropospheric aerosols

Graduate Student Nurun Nahar Lata[1], Bo Zhang[2], Simeon Schum[1], Lynn Mazzoleni[1], Brimberry Rhenton[3], Will Cantrell[1], Claudio Mazzoleni[1], Swarup China[3]
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[3]Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory, Richland, Washington, USA

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

Americas Working Group

Abstract

Free tropospheric aerosols can act as ice nucleating particles (INPs) which in turn affects the cloud properties and precipitation in the North Atlantic. The physicochemical properties of free tropospheric particles are modified upon long-range transport via atmospheric processes, thus affecting the particles' ice nucleation propensity. In this study, we probed the ice nucleation propensity of free tropospheric particles collected at the remote Pico Mountain Observatory at 2225m a.s.l. in the North Atlantic Ocean. We utilized multimodal microscopy and spectroscopy techniques such as computer-controlled scanning electron microscopy with energy-dispersive X-ray spectroscopy and scanning transmission X-ray microscopy with near-edge X-ray absorption fine structure spectroscopy and investigated their ice nucleation propensity using an ice nucleation cell interfaced with an environmental scanning electron microscope. The source of air masses, transport patterns and, plume ages were probed by performing FLEXPART back trajectory analysis. Combining the back trajectory analysis, chemical imaging, and micro-spectroscopy analysis indicated that the chemical composition, mixing state, and phase state of the particles with different transport patterns and similar aging times are substantially different. Physicochemical properties of individual particles influence the ice nucleation propensity of aged particles. Relative humidity-dependent glass transition temperatures were calculated from meteorological conditions extracted from the Global Forecast System model and were found to be consistent with our observation of the phase state of the particles. The sample containing more solid-like, highly internally mixed particles nucleated ice efficiently. Altogether, the integrated chemical characterization of aerosol population and ice nucleating particles, thermodynamic properties of ice formation and, FLEXPART simulations from this study provide a better understanding of the physicochemical properties of long-range transported free tropospheric aerosol and their role in ice cloud formation.

Early Career Scientist

YES, I am an early career scientist.

FF-40A

Development of "Chemspot" instrument for the characterization of organic aerosol

PURUSHOTTAM KUMAR[1], James Frank Hurley[1], Nathan M Kreisberg[2], Braden Stump[3], Susanne V Hering[2], Pat Keady[3], Gabriel Isaacman VanWertz[1]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

Americas Working Group

Abstract

Online measurements of the chemical composition of particulate matter have typically relied on expensive and complex research-grade instruments based on mass spectrometry and/or chromatography. Routine monitoring, which necessarily relies on economical alternatives that can be readily operated autonomously, generally provides very limited chemical information of particulate matter. In particular, these instruments lack information on the degree of oxygenation of particles, a critical parameter in understanding the transformations and impacts of organic aerosols. We present here the development of an aerosol chemical composition monitor ("Chemspot") to measure aerosol mass, volatility, and elemental ratios (O:C, S:C) in a way that maximizes reliability and autonomous operation at moderate cost. Gas Chromatographic (GC) detectors including a Flame Ionization Detector (FID) and Flame Photometric Detector (FPD) are combined with a CO_2 monitor to measure aerosol organic carbon, oxygen-to-carbon ratios, and total inorganic and organic sulfur. Automated calibration can be performed using a very small number of gas-phase calibrants (e.g. CO_2, CH_4, SF_6) due to the usage of common and well-understood GC detectors. Particles are sampled by impaction onto a ~1 mm spot in a custom passivated quartz cell after passing through a condensational growth tube. The collected aerosol sample is thermally desorbed in a few controlled rapid temperature steps (for volatility binned composition) and the vaporized sample is passed through different detectors. We demonstrate here the efficient collection of particles between 10 nm and 1000 nm in diameter. Subsequent rapid thermal desorption at rates of 20 ^{o}C/s is shown to provide separation by volatility with a resolution of less than two orders of magnitude in vapor pressure. Results from initial performance analysis of this instrument using the data obtained from organic aerosol environmental chamber experiments will be presented. Volatility-resolved carbon, oxygen, and sulfur concentrations in ambient aerosol will also be discussed.

Early Career Scientist

YES, I am an early career scientist.

FF-41B

A Kinetic and Mechanistic Study on the Photochemistry of Polycylic Aromatic Hydrocarbons and its Effect on Atmospheric Iron Solubility

Desiree Sarmiento, Dr. Brian Majestic
University of Denver, Denver, USA

Abstract

Polycyclic aromatic hydrocarbons (PAHs) are a group of organic atmospheric pollutants that are among the major products of combustion emissions. Due to their stable fused-ring structures, these compounds tend to have atmospheric lifetimes ranging from hours to several days. Their persistence in the atmosphere poses a serious threat to human health, for they can cause respiratory issues and are suspected to be carcinogenic. In addition, PAHs can affect cloud-water environments. These effects include the solubilization of dust-born iron, which can participate in Fenton reactions with oxygen radical species in the atmosphere. In this study, the mechanism and kinetics for the formation of several oxidized products were investigated for the photoreaction of naphthalene (NAP) and anthracene (ANT). Upon exposure to simulated sunlight, it was observed that the formation of 1,4-naphthoquinone (1,4-NAPQ) occurred within 30 minutes of the reaction for both ANT and NAP. 1-naphthol, however, formed within 30 minutes in the NAP reaction but was not observed until after 90 minutes in the ANT reaction. Decreases in the 1,4-NAPQ and 1-naphthol concentrations after 30 to 60 minutes in the NAP reaction indicate continued reactions of these oxidized products to form humic-like substances (HULIS). HULIS is expected to solubilize atmospheric iron via complexation. Therefore, a future study will investigate the impact of oxidized PAH products on the solubilization of atmospheric iron.

Early Career Scientist

YES, I am an early career scientist.

FF-42C

A new chemical pathway for stratospheric sulfate aerosol formation

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IGAC Activities

CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

Americas Working Group

Abstract

Stratospheric sulfate aerosol have a large impact on the global radiation budget, ozone, and have been proposed as a geoengineering solution to climate change. Simulating the effects of these aerosols requires accurate representation of their chemical formation. A theoretical analysis suggests a previously unconsidered thermodynamically stable product of sulfur oxidation in the stratosphere. The fate of this product and how it affects sulfur partitioning and ozone is currently unknown as experimental and observational data for these reactions are currently lacking. Here, we will investigate the impacts of this new sulfur chemistry by including the relevant reactions in the CESM WACCM model.

Early Career Scientist

NO, I am not an early career scientist.

Final category: GEIA-1A

Road Traffic Emission Inventory in an Urban Zone of West Africa: Case of Yopougon City (Abidjan, Côte d'Ivoire)

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[1]Unité de Formation et de Recherche des Sciences Biologiques, Département Math-Physique-Chimie, Université Péléforo Gon Coulibaly, BP 1328 Korhogo, Korhogo, Côte d'Ivoire. [2]Laboratoire des Sciences de la Matière, de l'Environnement et de l'Energie Solaire, LASMES, Université Fé-lix Houphouët-Boigny, Abidjan, Côte d'Ivoire. [3]Laboratoire de Physique de l'Atmophère et Mécanique des fluides, Université Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire. [4]Institute of Geosciences for Environment, Université Grenoble Alpes, Grenoble, France. [5]Laboratoire d'Aérologie, Université de Toulouse, CNRS, UPS, 311400 Toulouse, Toulouse, France

IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Road traffic emission inventories based on bottom-up methodology, are calculated for each road segment from fuel consumption and traffic volume data obtained during field measurements in Yopougon. High emissions of black carbon (BC) from vehicles are observed at major road intersections, in areas surrounding industrial zones and on highways. Highest emission values from road traffic are observed for carbon monoxide (CO) (14.8 t/d) and nitrogen oxides (NO_x) (7.9 t/d), usually considered as the major traffic pollution tracers. Furthermore, peak values of CO emissions due to personal cars (PCs) are mainly linked to the old age of the vehicle fleet with high emission factors. The highest emitting type of vehicle for BC on the highway is PC (70.2%), followed by inter-communal taxis (TAs) (13.1%), heavy vehicles (HVs) (9.8%), minibuses (GBs) (6.4%) and intra-communal taxis (WRs) (0.4%). While for organic carbon (OC) emissions on the main roads, PCs represent 46.7%, followed by 20.3% for WRs, 14.9% for TAs, 11.4% for GB and 6.7% for HVs. This work provides new key information on local pollutant emissions and may be useful to guide mitigation strategies such as modernizing the vehicle fleet and reorganizing public transportation, to reduce emissions and improve public health.

Early Career Scientist

YES, I am an early career scientist.

GEIA-2B

ESTIMATION OF POLLUTANT EMISSIONS BY INDUSTRIAL SOURCES IN BOGOTÁ UNDER POWER MATRIXES SCENARIOS PROJECTED TO THE YEAR 2050 IMPLEMENTING THE LEAP MODEL

Dr Oscar A Fajardo, Karen D Hernandez
Universidad Central, Bogota, Colombia

IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group

Abstract

The current global economic model of industrialization has historically searched for indefinite growth without considering environmental impacts. Dependence on fossil fuels causes degradation of the global air quality and greenhouse gases (GHG) emissions increase. Colombia and specifically Bogotá is no exception to this problem, causing increasing concern about the negative impacts on its inhabitants. Due to the limitation of investigations contemplating the concentrations of pollutants produced by industries in the city, this study estimates emissions of air pollutants from fixed sources in Bogotá D.C., projected to the year 2050 using the LEAP software. Under three scenarios, we estimated the variation of emissions for different assumptions of industrial energy matrixes, giving proposals for emissions reduction in the city. The results of the study show that for a Business As Usual (BAU) scenario, the emissions of PM 10 , NO x , SO 2 , CO 2 , CO and VOC's in 2050 would increase by 31.39%, 2.50%, 21.42%, 26.22%, 35.04% and 41.84% compared to 2014 in the different industrial sectors analysed. On the other hand, the scenarios proposed for the reduction of emissions have different behaviour. In the Carbon Reduction (RC) scenario, PM 10 and SO 2 emissions in 2050 would decrease by 23.10% and 27.89% respectively, although CO 2 , NOx, CO and VOC's would increase by 38.39%, 1.55%, 14.94% and 41.73%. Finally, the Mitigation scenario (MIT) showed a reduction in emissions of PM 10 , NO x , SO 2 , CO 2 , CO and VOC's by 62.83%, 59.46%, 79.20%, 49.15%, 47.94% and 45.96% during the studied period.

An economic analysis was included for the proposed scenarios to be implemented, concluding that environmentally and economically an MIT scenario is the best option for the cities industrial development. This would stand as long as the power providers have implemented renewable technologies in their generation processes.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-3C

The influence of change the fuel type used in power plants on reduction of carbon dioxide emission in the Energy Sector of Azerbaijan

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IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group

Abstract

The change in the contribution of electricity production to the air pollution as the result of reduction of greenhouse gas emissions after the transfer from residual fuel to natural gas in the thermal power plants has been investigated. The total production of electric energy is about of 20 billion kWh/ year and 85% of that is produced at thermal power plants. Used residual fuel oil and natural gas to generate electricity in steam turbines produce 11,5 million tons of CO_2 (11500 GgCO2 Eq) emissions per year. The burning of these fuels causes the formation of the first "greenhouse gas" - carbon dioxide (CO_2) and other gases that are cause of global warming. The effectiveness of fuel change in the thermal power plants for decrease CO_2 emissions in recent years through changing fuel consumption was investigated. In this study, the reduction of CO_2 emissions from 0.556 grams to 0.540 grams per 1 kWh of produced electricity as changing from the residual fuel (mazut) to natural gas has been estimated. The results show that annual reduction in the amount of CO_2 is 10 173 (10,173Gg) tones. Carbon capture and storage technologies can contribute 13% of CO_2 reductions in the power sector.

Key words: energy efficiency, air pollution, GHG emissions, carbon dioxide, fuel consuption,

Early Career Scientist

YES, I am an early career scientist.

GEIA-4A

Characterising oceanic emissions of alkenes and their impacts

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IGAC Activities

GEIA: Global Emissions Initiative

Abstract

Ethene and propene are short-lived hydrocarbons emitted from the ocean with the potential to impact the oceanic oxidising capacity. We use the long term observations of these compounds collected at the Cape Verde Atmospheric Observatory (CVAO) together with the GEOS-Chem model, together with observations made from the NASA ATom campaigns to explore the magnitude and controlling factors for their emissions. We find that their emissions are related to solar radiation and dissolved organic matter (DOM) and produce a new parameterization for their emission. We explore the impact their emission on the composition of the oceanic boundary layer. We also explore the impact of model resolution on these calculations.

Early Career Scientist

YES, I am an early career scientist.

GEIA-5B

The CAMS Global and Regional Emissions for Global and Regional Forecasts and Reanalyses

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IGAC Activities

GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report, CCMi: Chemistry Climate Model Initiative, AMIGO: Analysis of eMIssions usinG Observations

Abstract

In order to drive atmospheric models performing air quality forecasting, analyses/reanalyses of the atmospheric composition, an accurate quantification of surface emissions from anthropogenic and natural sources is required. As part of the European Copernicus Atmosphere Monitoring Service (CAMS), several emission datasets have been developed for this purpose. Global anthropogenic emissions for several sectors for a large number of atmospheric compounds, including speciated volatile organic compounds for the 2000-2021 period, have been developed at a 0.1x0.1 degree resolution. Regional anthropogenic emissions for Europe are also available for the 2000-2019 period at a spatial resolution of 0.1x0.05 degree, for twelve sectors. In addition, detailed emissions from ships based on ship identification systems are now available both at the regional and global scales, on a daily basis and at a 0.1x0.1 degree spatial resolution. Different datasets providing natural emissions have also been developed, such as the emissions of biogenic volatile organic compounds from vegetation, nitrogen compounds emissions from soils, emissions from the oceans and emissions from volcanoes. Evaluation of the emissions datasets and their consistency at different scales are presented. Temporal profiles, as well as algorithms to take into account the impact of meteorological conditions on emissions will also be discussed.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-6C

Incorporating interactive surface exchange of ammonia into chemistry-climate models

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IGAC Activities

GEIA: Global Emissions Initiative

Abstract

Ammonia is the primary form of reactive N. It has significant impacts on the environment, not only causing acidification and eutrophication in water systems, damaging vegetation and reducing biodiversity, but also affecting air quality and climate by the formation of aerosols. NH_3 originates mainly from agriculture, including livestock housing, manure storage and application, and fertiliser usage, which accounts for over 85% of all atmospheric releases of NH_3 in Western Countries. According to the EDGAR v4.3.1 inventory, global NH_3 emissions in 2010 were 55 Tg-N, of which agricultural activities contributed 85%. Current estimates were mostly calculated from statistical data, applying fixed emission factors that only considered climatic impacts to a limited extent. However, simply using fixed values may not reflect real inter-annual variations and longer-term trends as these methods can introduce large uncertainty because NH_3 volatilisation is strongly influenced by climate through temperature and water interactions.

To provide more reliable estimates, we developed a process-based model to quantify NH_3 emissions which considers meteorological effects. This current process-based emission scheme simulates and predicts the temporal variations of NH_3 by following the relevant evolution pathways of N. Progress has been made on estimating global NH_3 emissions from chicken agriculture. The next step will be quantifying NH_3 emissions from other major livestock, such as cattle, sheep and pigs. This will allow us to establish climate-dependent NH_3 emissions inventories and process-based interactive algorithms, which provides more accurate inputs to chemistry-climate models. Future efforts will also be directed towards developing a bi-directional exchange scheme for NH_3, which will improve understanding of NH_3 fluxes from weak sources and in areas away from large emission sources. The process-based modelling will be incorporated into interactive CCMs to simulate NH3 changes in a more dynamic way, allowing us to make future projections and to study the implications for atmospheric chemistry.

Early Career Scientist

YES, I am an early career scientist.

GEIA-7A

Secondary Organic Aerosol Formation from Emissions of Coastal Sage Shrubs

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Abstract

Plants emit a diverse range of biogenic volatile organic compounds (BVOC) whose oxidation leads to secondary organic aerosol (SOA) formation. The majority of studies of biogenic SOA have focused on single or simple multi-component VOC mixtures thought to be representative of Northern Hemispheric deciduous or mixed forest conditions. Gaps remain in our understanding of SOA formation from complex mixtures of real plant emissions in other environments.

Black sage (*Salvia mellifera*) and California sagebrush (*Artemisia californica*) are the most common plant species in southern California's coastal sage ecosystem and play a critical ecological role in maintaining these ecosystems. Towards the goal of understanding SOA in this ecosystem we conducted the first comprehensive study of SOA from oxygenated monoterpenes, the dominant emissions from these plants.

Emissions from sage plants, and single compounds representing their major emissions (camphor, camphene and eucalyptol) were oxidised in an Aerodyne potential aerosol mass oxidation flow reactor (PAM-OFR). The chemical composition was characterised using a high-resolution time-of-flight iodide-anion chemical-ionization mass spectrometer equipped with a Filter Inlet for Gases and AEROsols (FIGAERO-I-HR-ToF-CIMS) under low and medium-NO_x conditions.

SOA from oxygenated monoterpenes showed higher order oligomer content and a greater presence of highly oxygenated organic molecules (HOM) than non-oxygenated monoterpenes. Results highlight the potential importance of oxygenated monoterpene emissions and suggest that projected expansion of sage shrub communities due to climate change could have significant impacts on atmospheric chemistry processes.

Early Career Scientist

YES, I am an early career scientist.

GEIA-8B

Connecting seasonal variability in monoterpene concentrations to features in the biosphere of a southeastern U.S. forest.

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Abstract

More than 10,000 hours of chemically speciated biogenic volatile organic compound (BVOC) data have been collected at the Virginia Forest Research Lab, in Fluvanna County, Virginia. Data were collected using gas chromatography – flame ionization detection that was automated to take hourly air samples from within the forest canopy. With these data, changes in the diurnal profiles of individually resolved monoterpene species are identified over the course of the year. While all monoterpene species exhibit peak concentrations in the nighttime and early morning hours in the fall, winter, and spring, a small number of compounds shift to daytime and early evening peak in the summer months. Some of the species that exhibit this shift are highly reactive, with significant implications for daytime ozone reactivity in the summer months. The variation in emission is attributed to a vegetation source that emits monoterpenes in a light and temperature-dependent manner. . To confirm the source of the emissions, additional ecological measurements of sap flow, stomatal conductance, and PhenoCam data were used alongside positive matrix factorization to separate the light-dependent contribution from the temperature-dependent contribution of limonene concentrations in the summer months. We discuss the implications of this light-dependent emission of highly reactive monoterpenes for local and regional ozone chemistry.

Early Career Scientist

YES, I am an early career scientist.

GEIA-9C

Evaluation of black carbon emissions in East Asia: Comparisons of six inventories and constraints from surface observations and model simulations

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IGAC Regional Working Groups

Japan National Committee

Abstract

Black carbon (BC) is a short-lived climate forcers (SLCF) that affect the climate by absorbing solar radiation. Emission inventories of BC are used to assess its impacts on the climate and air quality in chemistry-transport models as well as chemistry-climate models. However, bottom-up emission inventories of BC still have large uncertainties. East Asia is the is the region with the largest emissions of anthropogenic BC, accounting for about 30% of the global emissions. We compared BC emissions in East Asia of six inventories by source region and sector. The inventories used in this study included REASv2.1, HTAPv2, MACCity, ECLIPSEv5a, CEDS, and EDGARv4.3.2. The annual BC emissions from China were estimated to be 1.32–2.44 Tg year^{-1} for 2010 with 80% difference between the maximum (CEDS) and minimum (EDGARv4.3.2). The differences were mainly attributed to those in the emissions from domestic, industry, and energy sectors. We also evaluated BC emissions of six inventories by comparing BC concentrations calculated by a chemistry-transport model, GEOS-Chem, with those observed at Fukue Island located in the western Japan. To examine Chinese BC emissions, we used a tagged method to select BC data strongly affected by BC transported from China and excluded data influenced by wet scavenging during transport. The comparisons after the data selection showed that the simulated BC concentrations using each inventory were 24–116% larger than the observed values, suggesting that the inventories tend to overestimate BC emissions from China. We estimated BC emissions from China to be 1.14 Tg year^{-1} averaged for 2009–2011. This result suggested that CEDS used in CMIP6 simulations overestimates Chinese BC emissions by a factor of two and their experiments overestimate the impacts of BC from China on the climate.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-10A

Investigation of major emission sources and photochemical processes of Volatile Organic Compounds (VOCs) at a suburban site of New Delhi, India in the winter

Miss Nidhi Tripathi[1], Dr. Lokesh Sahu[1], Mr. Purushottam Kumar[2], Prof. Sachchida N. Tripathi[2]
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Abstract

Volatile organic compounds (VOCs) are emitted from both anthropogenic and biogenic sources. VOCs play a crucial role in atmospheric chemistry and climate change through the formation of ozone and secondary organic aerosols. Exposure to the elevated levels of some VOCs, such as BTEX, can adversely affect human health and plants. In this paper, we present the results obtained from the measurements of important VOCs using Proton Transfer Reaction Time-of-Flight Mass Spectrometer (PTR-TOF-MS) instrument at Delhi during the winter (Jan-Feb 2018). Delhi is facing severe air pollution problem in which VOCs are important component. The levels of VOCs were influenced by the episode of local anthropogenic emissions, long-range transport biomass burning and biogenic. In addition to this, day-to-day change in weather conditions also played important role in determining the levels and variability of VOCs. The oxygenated VOCs (OVOCs) make the largest contribution (~80%) among the major VOCs measured in this study. The mean mixing ratios of methanol, benzene and toluene were 28.30±11.21, 2.45±1.64 and 4.46±4.05 ppbv, respectively during the study period. The simultaneous enhancements in the levels of furfural, acetonitrile, furan and CO on March 2, 2018 at the measurements site indicate the effect of wood-burning (bonfire) during the *Holi* bonfire festival. We have estimated the photochemical age using toluene/benzene ratio to study the evolution of air masses. The mixing ratios of acetaldehyde, acetone and methanol tend to increase in moderate photochemical aged (0-25 hr) air masses and then decreased at higher ages. It confirms secondary formation of OVOCs. The strong correlation of OVOCs, toluene and Xylene with CO and benzene during nighttime indicates influence of anthropogenic emission. The contributions of anthropogenic sources to OVOCs, isoprene, and MTs were 40-70, 43, and 47%, respectively. The OH reactivity and ozone formation potential of dominant VOCs were also calculated.

Early Career Scientist

YES, I am an early career scientist.

GEIA-11B

Forecasting policy, innovation and new technologies for reducing transport emissions in Chile 2020-2050

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IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

This work presents the results of the study "Development and application of methodology to quantify emissions of PNIM 2050". PNIM 2050 is a strategic planning program of the Ministry of Public Works, to evaluate different alternatives for the provision of mobility infrastructure for goods and passengers, with an emphasis on intercity connectivity with a 2050 horizon. The variables to be used to estimate pollutant emissions are identified according to two analysis scenarios. The Carbon Neutral scenario is aligned with Chile's carbon neutrality policies. The Conservative scenario considers a late adoption or lower penetration of emission reduction measures in the transport sector, compared to those adopted in the most ambitious case of neutrality by 2050. The selected measures are required to have official support policies, such as: official government plans, electromobility and decarbonization strategies, among others. Scenarios include regulatory and technological promotion measures. Regulatory measures correspond to those in which there is a legal framework that allows specific responsibilities to be assigned for their implementation throughout the national territory. Technological promotion measures are those that are part of a State policy for dissemination of the use of a new technology, being its implementation of a voluntary nature. The estimate of emission scenarios 2020-2050 applies to all modes included in mobility plans: road, air, maritime and rail transport. In summary, for the Carbon Neutral scenario there is a positive decoupling between increased mobility and emissions, with reductions of 24%, 47%, 74% for CO_2, NO_x, $PM_{2.5}$ respectively, when compared to the rate of growth of vehicle activity (VKT) by 2050. Based on these results, the study establishes specific decision criteria, indications and recommendations to be taken into account for the subsequent implementation of the PNIM 2050, in relation to the policy, innovation and new technologies in the field of emissions.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-12C

Aerosols in Western Mediterranean Basin: three complementary approaches for source emission identification

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IGAC Activities

IGAC Regional Working Groups

Abstract

Fine aerosols (PM2.5) constitute a dominant proportion of atmospheric aerosols and have often been associated with human health disorders, regional climate changes and more lately to food security. A good understanding of their sources is crucial to establish effective emission control policies in order to reduce their atmospheric concentration level and to protect public health. For this purpose, from Tetouan city located in northern Morocco, we attempted to better figure out the main aerosol transport pathways and their respective aerosol load and chemical profile by employing three complementary approaches: backward trajectory analysis, chemical mass closure and receptor models (such as positive matrix factorization). The back trajectory analysis throughout the sampling period led to three main clusters: 1/ the most frequent cluster corresponds to polluted air masses coming from the Mediterranean Basin, characterized by urban and marine vessels emissions out of Spain and of Northern Africa; 2/ the second group is of local origin, with a marked contribution from urban aerosol (Rabat, Casablanca) and from biomass burning aerosols; 3/the third cluster defines air masses from the near Atlantic Ocean, affected by pollutants emitted from the Iberian coast. Chemical mass closure was attempted considering soluble inorganic species, particulate organic matter, elemental carbon, mineral dust matter and sea salt. The sum of these components accounted for about 92% of the measured PM2.5 concentrations. The calculations indicate that the major contributions were due to organic matter (about 33%), BC (17%) and sulfate anion (about 17%). The application of Positive Matrix Factorization (PMF) revealed the existence of four drivers of the fine aerosol size fraction: secondary sulfate formation, traffic emissions, sea salt and biomass burning.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-13A

Road Traffic Emission Inventory in an Urban Zone of West Africa: Case of Yopougon City (Abidjan, Côte d'Ivoire)

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IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Road traffic emission inventories based on bottom-up methodology, are calculated for each road segment from fuel consumption and traffic volume data obtained during field measurements in Yopougon. High emissions of black carbon (BC) from vehicles are observed at major road intersections, in areas surrounding industrial zones and on highways. Highest emission values from road traffic are observed for carbon monoxide (CO) (14.8 t/d) and nitrogen oxides (NO_x) (7.9 t/d), usually considered as the major traffic pollution tracers. Furthermore, peak values of CO emissions due to personal cars (PCs) are mainly linked to the old age of the vehicle fleet with high emission factors. The highest emitting type of vehicle for BC on the highway is PC (70.2%), followed by inter-communal taxis (TAs) (13.1%), heavy vehicles (HVs) (9.8%), minibuses (GBs) (6.4%) and intra-communal taxis (WRs) (0.4%). While for organic carbon (OC) emissions on the main roads, PCs represent 46.7%, followed by 20.3% for WRs, 14.9% for TAs, 11.4% for GB and 6.7% for HVs. This work provides new key information on local pollutant emissions and may be useful to guide mitigation strategies such as modernizing the vehicle fleet and reorganizing public transportation, to reduce emissions and improve public health.

Early Career Scientist

YES, I am an early career scientist.

GEIA-14B

A comprehensive and spatially resolved Mercury Emission Inventory for Indian Subcontinent

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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CATCH: the Cryosphere and Atmospheric Chemistry, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Mercury (Hg) is a pollutant of global importance due to its enormous emission from various anthropogenic sources and its hazardous health impact. Rising industrial activity is considered to be the prime sources of Hg emission. In India, there is limited information regarding industrial Hg emission. The sources of Hg is numerous and unorganized. Some earlier research have established that the coal combustion in industries and primary non-ferrous metal production are the major sources of mercury emission. Hg emission from annual fly ash generation from coal based industries and captive power plants are another major sources. This study is an attempt to identify all possible industrial sources of Hg emission and its quantification over Indian sub continent for the base year 2018. The emissions are estimated using bottom-up based emission factors (EFs) approach where the country specific EFs is key. Apart from this the emission from industrial sectors like cement, iron and steel and glass production, petroleum refineries and municipal waste, biomedical waste were taken into account to build reliable and spatially resolved inventory. According to the estimation, coal combustion accounts 269tons/yr of Hg emission from various industries followed by 79 tone/yr from captive power plants and 70 tons/yr from primary non-ferrous metal. The impact of huge Hg contaminated fly ash generation and its utilization to fulfill the human need is a key concern due to its adverse impact with respect to human health. The emission in 2018 is found between 24.0 g/km^2 to 81.8g/km^2. The per capita annual emission is found between 60 to 199 milligram. The above information can be used in formulating future Hg- pollution control mechanism in India.

Early Career Scientist

YES, I am an early career scientist.

GEIA-15C

Quantification of methane emissions from offshore oil & gas platforms in the Norwegian Sea.

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

Abstract

Atmospheric methane (CH4) is an extremely potent greenhouse gas, with ever-increasing global emissions expected to have a significant influence on the Earth's climate. The oil and gas sector is considered to be a significant source of CH4 to the atmosphere, estimated to make up approximately 22% of global emissions. Offshore facility emissions are poorly ground-truthed, with their quantification being heavily dependent on "bottom-up" scaling of inventory data. It is therefore important to devise reliable methods for locating these emissions and to pinpoint their sources, as this will aid emission quantification and validation against reported data.

As part of the UN CCAC objective to quantify global CH4 emissions from oil and gas facilities, this study quantifies CH4 emissions from active O&G facilities in the Norwegian Sea using a Lagrangian mass balancing approach. We report measurements of CH4 mixing ratios and fluxes sampled by 2 research aircraft downwind of 20 emitting facilities during 13 flights in July and August 2019. The FLEXPART dispersion model was used to confirm the facility origin of sampled plumes. Comparisons are made with operator-supplied annualised emissions and daily activity data from individual facilities in order to identify agreements or discrepancies, as well as to evaluate the efficacy of emissions reporting procedures in the Norwegian Sea. Emission estimates from an annualised global inventory are also compared against measured data, to provide insight into the relative accuracy of a hierarchy of emissions accounting approaches.

Early Career Scientist

YES, I am an early career scientist.

GEIA-16A

Experimental determination of isoprene and other BVOCs emissions from *Platanus x hispanica* under urban conditions

Dr. Carmen Kalalian[1], Dr Christophe Boissard[1,2], Dr Valérie Gros[1], François Truong[1], Dr Luis Leitao[3], Dr Ruben Puga Freitas[3], Dr Anne Rapellin[3], Dr Séverine Planchais[4], Dr Juliette Leymarie[3]
[1]LSCE, CNRS-CEA-UVSQ, I PSL, Gif sur Yvette, France. [2]Univ. de Paris, Paris, France. [3]Univ Paris Est Creteil, CNRS, INRAE, IRD, IEES-Paris, Créteil, France. [4]Sorbonne Université, CNRS, IRD 242, INRA, PARIS 7, UPEC, IEES-Paris, Paris, France

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations

Abstract

Urban vegetation is beneficial for the environment, the human health and the well-being, which makes it a priority topic for many cities like Paris. However, vegetation is a source of Biogenic Volatile Organic Compounds (BVOC), which are key compounds in the urban photochemical pollution. BVOC emissions strongly depend on environmental conditions (temperature, incident solar flux, water…). As water scarcity remains the main constraint to the growth and development of urban trees in Paris, the aim of this work is to evaluate the impact of water stress on BVOC branch emissions from plane trees (*Platanus x hispanica*), a common urban tree grown in a dense urban area (Vitry sur Seine near Paris).

Practically, 12 young potted plane trees grown under semi-controlled environmental conditions were studied, and compared to *in natura* adult trees. BVOC emissions were followed at the branch scale using dynamic chambers coupled to a Proton Transfer Mass Spectrometer (PTR-MS). A first measurement campaign was held in summer 2020, where the intra- and inter-trees variabilities in BVOC emissions were investigated. Marked and typical diurnal cycles were observed for the target BVOC with midday maximal emissions. Isoprene was the most emitted compound (50-91%) with values up to 91 $\mu g.gdw^{-1}.h^{-1}$, the remaining emission was that of oxygenated compounds (mainly Methanol and acetone). This relative composition was, however, variable during the day and within different branches of a same tree. Isoprene emission factors were determined for each branch, where the branch-to-branch and tree-to-tree variabilities were of factors of 3.5 and 1.5, respectively. Besides, two other campaigns are planned in spring and summer 2021 on the same trees, to assess the variability of BVOC emissions under water stress progressively started in late spring. The daily and seasonal fluctuations in BVOC emissions will be then related to the variations in climatic parameters characterizing urban areas.

Early Career Scientist

YES, I am an early career scientist.

GEIA-17B

Emission sources and health risk of volatile organic compounds during heating season in rural northern China

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

China Working Group

Abstract

Severe volatile organic compound (VOC) pollution has become an urgent problem during the heating season in the North China Plain (NCP), as exposure to hazardous VOCs can lead to chronic or acute diseases. Two campaigns with online VOC measurements were conducted at a rural site in Wangdu, NCP during 2017-2019 heating seasons to characterize the compositions and associated sources of VOCs and to assess their potential health risks. 94 species of VOCs have been quantified. The average mixing ratios of VOCs were 69.5 ± 51.9 ppb and 77.2 ± 54.4 ppb for 2017-2018 and 2018-2019, respectively. Based on the receptor model, coal combustion, biomass burning, LPG, solvent usage, industrial, vehicular emission, secondary formation, and background were found to be the main sources. The emission ratios (ERs) of VOCs were calculated by the photochemical-age parameterization method. Very high ERs of oxygenated VOCs (OVOCs) compared with earlier studies in Beijing, Mexico City and Changdao were observed in Wangdu. In addition to the secondary formation, primary emission can contribute to OVOCs) in a range of 29%-77%. Acrolein, 1.2-dichloroethane, 1,2-dichloropropane, chloroform, 1,3-butadiene, and benzene were identified as the key hazardous VOCs in Wangdu. Benzene had the highest average carcinogenic risk. Our study showed that particular attention should be paid to the cumulative health risk of hazardous VOCs in heavily polluted rural areas in the NCP.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-18C

The CAMS Global Anthropogenic Emissions

Antonin Soulié[1], Sabine Darras[2], Thierno Doumbia[1], Jukka-Pekka Jalkanen[3], Marc Guevara[4], Cathy Liousse[1], Claire Granier[1,5]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative

Abstract

The European Copernicus Atmosphere Monitoring Service (CAMS: https://atmosphere.copernicus.eu/) is currently providing global forecasts of the atmospheric composition as well as global reanalyses for the 2003-2020 period. In order to provide input for the CAMS simulations, an inventory of global anthropogenic emissions has been developed, which covers the 2000-2021 period. This inventory is based on the emissions provided by the Emissions Database for Global Atmospheric Research (EDGAR) version 5 inventory (1970-2015) and on the most recent version of the Community Emissions Data System (CEDS) (up to 2019). The CAMS global inventory called CAMS-GLOB-ANT version 5.1 provides emissions for greenhouse gases (CO_2, CH_4 and N_2O) and reactive compounds (CO, NO_x, NMVOCs, SO_2, NH_3, BC, OC and 25 speciated volatile organic compounds) at a 0.1x0.1 degree resolution. The dataset covers the 2000-2021 period, and we will detail the methodology used to develop the emissions, including the extrapolation to the most recent years.

The CAMS inventory includes a new dataset providing emissions from international and inland shipping called CAMS-GLOB-SHIP. This dataset is based on Automatic Identification System (AIS) data, which describes the vessel activity as a function of time and is mandatory for all large ships. The emissions from ships are calculated using the Ship Traffic Emission Assessment Model (STEAM), which will be described in the presentation.

The global emissions are provided as monthly averages, based on the seasonal variation provided by the CAMS-GLOB-TEMPO, which development will be explained.

We will describe the dataset, and show evaluations of the emissions through comparisons with the most recent global and regional emissions inventories. The access to the dataset, its visualization and download will also be described.

Early Career Scientist

YES, I am an early career scientist.

GEIA-19A

Estimation of Methane emissions from Akouédo landfill through a modelling approach

Séka Louis Hermann Yapo[1], Georges Kouamé Kouadio[2], Eric-Michel Assamoi[1], Veronique Yoboué[1], Julien Bahino[1], Sékou Kéita[3]
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IGAC Activities

GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Municipal Solid Waste landfilling is the most common waste elimination in the developing countries in general and particularly in Côte d'Ivoire. However, gaseous emissions from waste landfilled constitute an environment and human health concern by contributing to greenhouse gas effects, odour problems, explosion and fire hazards as well as sources of air pollution. In this study, methane emissions rates from Akouédo (Abidjan) landfill have been estimated using three theoretical models such as Landfill Gas Emission Model (LandGEM, version 3.02), Intergovernmental Panel on Climate Change (IPCC) waste model and Solid Waste Emissions Estimation Tool (SWEET). Two types of parameters have been used to estimate methane emissions, default parameters and site-specific parameters. The results of simulations of the three models are compared as well as the results from their default and site-specific parameters. Results show that LandGEM simulations using both default and site-specific parameters are higher than IPCC waste model's simulations, whilst SWEET predicts the lowest methane emissions. SWEET seems to make better simulations than LandGEM and IPCC waste model, for it uses more parameters. The results from this study were compared to the predictions made in previous studies in the world. These results show that Akouédo landfill is one of the most emitting methane sites after Kahrizak landfill in Tehran (Iran). The high methane emission may be due to the fact that these landfills have no landfill gas collection system. In addition, the relatively higher methane emissions in Akouédo landfill than Nigerian landfills (Afofunra, Ajakanga, Awotan, Mpape) may be explained by its size and the annual waste acceptance rate.

Early Career Scientist

YES, I am an early career scientist.

GEIA-20B

Global Emission trends to 2020 from the Community Emissions Data System (CEDS)

Steven J Smith, Andrea Mott, Hamza Ahsan
PNNL/JGCRI, College Park, MD, USA

IGAC Activities

GEIA: Global Emissions Initiative, AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report, CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Americas Working Group, MANGO: Monsoon Asia and Oceania Networking Group, Southern Hemisphere Working Group, China Working Group, Japan National Committee

Abstract

Emissions of air pollutants and greenhouse gases into the atmosphere impact human health and the global climate. The Community Emissions Data System (CEDS) project produces estimates of global emissions by country, sector, and fuel consistent with detailed country-level emission inventories (Hoesly et al. 2018). This presentation will provide an overview of CEDS emissions from 1750 to 2020, which is an overall update to the historical emissions data used for the Coupled Model Intercomparison Project phase 6 CMIP6 (Feng et al. 2019, Gidden et al. 2019). The large-scale distribution of air pollutant emissions has changed substantially over the last few decades, shifting from North America and Europe to Asia. This distribution over the last few years is starting to shift further, with many air pollutant emissions from China decreasing (Zheng et al., 2018), most dramatically for sulfur dioxide. The fraction of global emissions from the rest of Asia have been increasing since 2010 for most species. Emissions from Africa, Centra/South America, plus the Middle East region also have increased in relative importance for most species. Work to incorporate satellite and other point source data into the inventory will also be described. While bottom-up inventories have complete sectoral coverage, satellite-derived estimates can provide global information on large emission sources, potentially with minimal time lags. We will also report on work to generate historical uncertainty ensembles, expanding on a recent analysis of uncertainty in reported energy data (Hoesly and Smith, 2018).

Early Career Scientist

NO, I am not an early career scientist.

GEIA-21C

Annual changes of ship emissions around China under gradually promoted control policies from 2016 to 2019

Xiaotong Wang, Wen Yi, Huan Liu
Tsinghua University, Beijing, China

IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

China Working Group

Abstract

Ship emissions and coastal air pollutions around China are expected to be alleviated with the gradually implemented of domestic ship emission control (DECA) policy. However, there is so far a lack of a comprehensive post assessment on the ship emission response after the policy implementation. This study developed a series of high spatiotemporal ship emission inventories of China's inland rivers and the 200 Nm zone from 2016 to 2019 based on an updated Ship Emission Inventory Model (SEIM v2.0) and analysed the interannual changes of emissions under the influence of both ship activity increase and gradually promoted policy. The route restoration technology in SEIM v2.0 has greatly improved the spatial distribution of ship emissions and the river vessels are better distinguished by using the spatial frequency distribution method. From 2016 to 2019, SO_2 and PM emissions from ships decreased by 29.6% and 26.4%, respectively, while ship NO_X emissions increased by 13.0%. Although the DECA 1.0 policy has been implemented since 2017, it was not until 2019 with the DECA 2.0 that significant emission reduction was achieved, e.g., 33.3% regarding SO_2. Considering the potential emissions brought by continuous growth of maritime trade, however, an even larger emission reduction effect of 39.8% was achieved in 2019 compared with the scenario without switching cleaner fuel. The four-year consecutive daily ship emissions for major ports, which timely reflects the response of step-by-step DECA policy on emissions. Annual change of the spatial distribution shows that a number of ships detoured outside the scope of DECA 2.0 in 2019 to save the cost on more expensive low sulphur oil, increasing emissions in farther maritime areas. These results provide high-quality datasets for air quality modellings, as well as verifications for in-situ observation experiments.

Early Career Scientist

YES, I am an early career scientist.

GEIA-22A

Third Revision of the Bottom-up Global Surface Seawater Dimethyl Sulphide Climatology (DMS-Rev3)

Dr Shrivardhan S Hulswar[1], George Manville[2], Dr Rafel Simo[3], Dr Marti Gali[4], Dr Thomas G Bell[5], Paul Halloran[2], Dr Arancha Lana[6], Dr Anoop S Mahajan[1]
[1]Indian Institute of Tropical Meteorology, Pune, Maharashtra, India. [2]University of Exeter, Exeter, United Kingdom. [3]Institut de Ciències del Mar, Barcelona, Spain. [4]Barcelona Supercomputing Centre, Barcelona, Spain. [5]Plymouth Marine Laboratory, Plymouth, United Kingdom. [6]Instituto Mediterráneo de Estudios Avanzados, Mallorca, Spain

IGAC Activities

Abstract

An updated estimation of the bottom-up global surface seawater dimethyl sulphide (DMS) climatology, DMS-Rev3, is the third of its kind and includes six significant changes from the last climatology, 'L11' (Lana et al., 2011) that was released about a decade ago. The first change is the inclusion of new observations that have become available over the last decade, i.e., the total number of observations included in DMS- Rev3 are 872,427 as compared to 47,313 data points used in the last estimation (~1744% increase in raw data). The second was significant improvements in data handling, processing, filtering, to avoid bias due to different observation frequencies. Thirdly, we incorporated the dynamic seasonal changes observed in the ocean biogeochemical provinces and their variable geographic boundaries. Fourth was refinements in the interpolation algorithm used to fill up the missing data. Fifth change was an upgraded smoothing algorithm based on observed DMS variability length scales (VLS) which helped reproduce a more realistic distribution of the DMS concentration data. And finally, the sea-ice coverage recognition to remove values from regions with sea-ice cover. The results show that DMS-Rev3 estimates the global annual mean DMS concentration at 2.22 nM, 8% lower than the current bottom-up 'L11' climatology. However, significant regional differences of more than 100% are observed. The largest changes are observed in high concentration regions such as the polar oceans, although oceanic regions which were under-sampled in the past also show large differences. DMS-Rev3 reduces the previously observed patchiness in high productivity regions.

Early Career Scientist

YES, I am an early career scientist.

GEIA-23B

A Technological Inventory of Particulate Matter Emission for Indian Megacity Kolkata

Poonam Mangaraj, Saroj Kumar Sahu
Environmental Science, Department of Botany, Utkal University, Bhubaneswar, Odisha, India

IGAC Activities

GEIA: Global Emissions Initiative

Abstract

The degrading air quality in megacities is a potential hazard to the existence of living beings and has become an emerging issue in recent years. The accelerated urban sprawl and changing lifestyle have deteriorated the regional air quality by elevating the concentration of atmospheric pollutants in most megacities across the globe where Asian cities are among the most polluting city list. To understand the ambient air quality and identify the sources responsible for anthropogenic as well as natural emission sources is of great significance to understand atmospheric chemistry. These sensitive data could also be a critical input to air quality modelling studies. As the sources of pollutants vary both spatially and temporally, an accurate and reliable estimation of surface emission is the most essential tool for further air quality studies. The present study is the first-of-its-kind attempt to compile a very high-resolution gridded emission inventory (i.e. ~400m X ~400m) for megacity Kolkata, the cultural capital of India, for the most recent base year 2020. The targeted pollutants of the present study are Particulate Matter <2.5microns ($PM_{2.5}$), Particulate Matter <10microns (PM_{10}). This would be the first-ever technological emission inventory which could also be used as an input into the air quality model to address environmental issues and public health. This would also be an essential tool in formulating new environmental mitigation strategies and policies to improve air quality and public health.

Early Career Scientist

YES, I am an early career scientist.

GEIA-24C

Unfolding Inventory of Indoor Air Pollutant Emission in Indian Household: An Invisible Potential Threat

Dr. Saroj Kumar Sahu[1], Miss Poonam Mangaraj[1], Prof G Beig[2]
[1]Utkal University, Bhubaneswar, India. [2]Indian Institute of Tropical Meteorology, Pune, India

IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Whenever we discuss about 'air pollution', it usually rings the bell outdoors. However, indoor air pollution is just as deadly as the outdoor. Most of the research focus around the world has been on outdoor air pollution, but in India we have a more severe problem of Indoor Air Pollution (IAP). About 60-65% of population in India resides in rural areas; where ~60% of them rely on use of solid biomass as cooking fuel due to lacking access to cleaner fuel. Lack of proper ventilation and poor life style has make the indoor air quality an important matter of concern leading to elevated poor air quality in Indian households. These considerations have induced the discussion IAP and its disastrous impacts on health due to various kind of combustion sources in Indian household. However, sources of indoor air pollution are not confined only to cooking activities. Many unattended sources like use of incense sticks, cigarettes, use of mosquito coils add up to the trail of IAP. As there are no specific norms for IAP in India, urgent need has arisen for implementing the strategies to create public awareness. So, in this present study, we have developed an ultra-high-resolution emission inventory (i.e. ~10 km × ~10 km) of various important air pollutants in Indian household, for the most recent base year 2020. This work could impel the policy makers to modify fuel quality and would also contribute to curb this national health issue.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-25A

EMISSIONS FROM STATIONARY SOURCES AND THEIR IMPACT ON AIR QUALITY IN CUBA

Dr. Cuesta Santos Osvaldo
Cuban Meteorological Institute, Havana, Cuba

IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group

Abstract

The determination quantitative of air pollutant emission and dispersion in the atmosphere from main stationary sources in Cuba and its effects on healthy environment, is an urgent and necessary study, taking into the account that a number considerable of emission sources. The knowledge of these emissions is a useful tool to know for mitigating air pollution, climate change and environmental management. The first emissions inventory from the country's stationary sources is showed. The methodologies corresponding to USEPA and the European Environmental Agency are used. In-situ emission measurements are also one of the tools used. The results showed atmospheric emissions rate of SO_2 is upper than 366 thousand ton/year while NO_2 emission rate is about 101 thousand ton/year. Furthermore, particulate matter (PM_{10} and $PM_{2.5}$) reach 98 000 ton/year, which are known for its potential damage for human health and atmospheric chemistry. Holguin, Artemisa and Camagüey are the provinces to emit more SO_2 to the atmosphere. The oil refinery and power plant are present in these provinces. The municipalities: Moa, Mariel and Nuevitas are major emitters of air pollutants gaseous species (SO_2, NO_2, CO and VOCs). Also Cienfuegos, Matanzas and Regla are great emitters and coinciding with urban areas with bad air quality. Environmental control and regulation measures should therefore be maintained to mitigate emissions. In addition to implementing reduction plans with technological improvements. This inventory using the bottom-up methodology can verify the calculations obtained in Greenhouse Gas Emissions Inventories by reducing uncertainties and thus achieving more accurate mitigation scenarios for climate change.

Key words: emissions inventory, pollution sources, air quality management.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-26B

The CAMS-REG v5 high-resolution European emission inventory for air pollutants and greenhouse gases (2000-2018) to support air quality and climate change modelling

MSc Stijn Dellaert[1], Dr. Hugo Denier van de Gon[1], Ir. Jeroen Kuenen[1], Ir. Antoon Visschedijk[1], Dr. Ingrid Super[1], Dr. Jukka-Pekka Jalkanen[2], Dr. Marc Guevara Vilardell[3]
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IGAC Activities

GEIA: Global Emissions Initiative

Abstract

Emission inventories are essential input for air pollution and climate modelling as well as for defining mitigation strategies. In support of the Copernicus Atmospheric Monitoring Service (CAMS) an European regional emission inventory (CAMS-REG v5) for anthropogenic emissions of CO_2, CH_4, CO, NOx, NH_3, NMVOC, PM10, PM2.5, and SO_2 is compiled covering the years 2000 – 2018. For CO_2, a distinction is made between CO_2 from fossil fuel sources and CO_2 from biofuel/biomass burning. The resolution is 0.1 x 0.05 degree (~6 x 6 km). The spatial disaggregation is performed using a number of spatial proxy maps representative of the spatial patterns in the activities underlying the emissions. Examples are road transport networks, population density, E-PRTR for industrial point sources, CORINE data for land use related emissions. The emission data are disaggregated among 16 (GNFR) sectors with an identifier for area sources or point sources. An important aspect of the dataset are the specific profiles that can be applied for temporal disaggregation, emission height, PM speciation and NMVOC speciation. The CAMS-REG inventories are mostly based on official country reporting to EMEP or UNFCCC but for a number of sectors, emissions were based on different sources such as AIS data (shipping) or satellite data (agricultural waste burning). Country reported emission data are regularly revised and we will compare the new timeseries data with previous versions as well as, for example, the EDGAR database. Moreover, trends in pollutants and recent improvements will be discussed as well as the pollutant ratios between for example CO_2 and co-emitted species. Significant effort was made to gapfill missing emissions for power plants and other large industrial sources to improve the coverage and consistency of the point source data. This information is important for source attribution when the data are used in data assimilation or inversion systems.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-27C

Understanding the Effect of Drought on Biogenic Isoprene and the Biosphere-Atmosphere-Chemistry Relationship with NASA GISS ModelE+MEGAN Simulations

Elizabeth Klovenski[1], Yuxuan Wang[1], Susanne Bauer[2], Kostas Tsigaridis[3,2], Gregory Faluvegi[3,2], Nancy Y Kiang[2], Igor D Aleinov[3,2], Xiaoyan Jiang[4], Alex Guenther[4], Wei Li[1], Nan Lin[5]
[1]University of Houston, Houston, Texas, USA. [2]NASA Goddard Institute of Space Studies (GISS), New York, New York, USA. [3]Columbia Univeristy, New York, New York, USA. [4]University of California - Urvine, Irvine, California, USA. [5]Tsinghua University, Beijing, China

Abstract

Drought is a hydroclimatic extreme that causes perturbations to the terrestrial biosphere. As a stressor for vegetation, drought can induce changes to vegetative emissions known as BVOCs (Biogenic Volatile Organic Compounds). Biogenic isoprene represents about half of total BVOC emissions and is a precursor to ozone (O_3) and secondary organic aerosol (SOA), both of which are climate forcing species. In order to simulate isoprene during drought and the feedbacks associated with these complex BVOC-chemistry-climate interactions, we implemented the MEGAN3 (Model of Emissions of Gases and Aerosols from Nature) isoprene drought stress parameterization in NASA GISS (Goddard Institute of Space Studies) ModelE, a leading Earth System Model. New diagnostics are programmed into ModelE to allow for the evaluation of the algorithm's performance and comparisons to limited isoprene flux measurements and satellite derived HCHO (formaldehyde) column. Offline and online drought stress simulations will be used to demonstrate the effect of the parameterization.

Early Career Scientist

YES, I am an early career scientist.

GEIA-28A

The Effects of Light on the Emission of Biogenic Isoprene and Monoterpenes : A Review

Xinyu Wang, Yisheng Zhang
Qingdao University of Technology, Qingdao, China

Abstract

Light is a key factor that affects the physiological processes of plants. Through the sorting and analysis of articles on biogenic volatile organic compounds (BVOCs) under different light gradients, the effects of a single light gradient (including natural conditions and stress scenarios) and other environmental factors (including diurnal changes, seasonal changes and the effects of canopy and leaf development) on the emission of isoprene (ISO) and monoterpenes (MTs) are reviewed, and the emission mechanism of BVOCs with different light intensities is summarized. The results showed that (1) in the range of 0 to the saturation point of BVOCs, ER_{ISO} or ER_{MTs} increased with the increase of PAR, and then remained unchanged or increased slowly. In the dark environment, ISO and MTs emissions first dropped rapidly, followed by re-emissions, with peaks occurring about 10 to 20 minutes after the lights was turned off. (2) isoprene was emitted directly, and the concentration was highest at the height of the strong isoprene emitting tree species inside the canopy. Its concentration change was basically consistent with the emission rate, which reached peak at 12:00~14:00. Monoterpenes were emitted and accumulated at night, leading to a lag in canopy concentration. The peak concentration mostly occurred near the ground (0~2m) in the morning of the next day. (3) in most studies, the isoprene emission rate of mature leaves was high, followed by young leaves and senescent leaves, which were 90%~130% higher than that of young leaves and senescent leaves. Monoterpenes were mainly synthesized during the bud stage when the leaf age is 1~30 days. And the highest and lowest emission rates of monoterpenes were the bud stage and mature leaves, respectively. This review will provide references for reducing the uncertainty of BVOCs emission factors and for optimizing regional BVOCs emission models.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-29B

Downscaling method: Increasing the resolution of EDGAR emission inventory data for complex terrains like Switzerland

Curdin Spirig, Dr. Jacinta Edebeli, Dr. Julien G. Anet
ZHAW, Winterthur, Switzerland

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CCMi: Chemistry Climate Model Initiative

Abstract

Air quality modelers often apply emission inventory data like the Emission Database for Global Atmospheric Research (EDGAR 5.0) data in local and regional air quality models. Despite the relatively high resolution of the EDGAR 5.0 data (0.1° × 0.1°), quite sufficient for regional models, the topographic complexity of a country like Switzerland results in poor local model output compared to measurement data from local monitoring stations. Therefore, a much finer resolution is required to capture the topographically induced variability in the distribution of emission sectors. As a result, we have developed a method for downscaling the EDGAR inventory data to locations of local emission sectors. This method involved land area coverage of emission sectors from Open Street Map, GIS tools, and python. The result is an emission inventory dataset at 0.02°× 0.02° resolution, which may be increased to even higher resolution. This finer resolution inventory data resulted in improved model output compared to measurement data. Such downscaling methods can be easily applied globally as global land use information are available in and easily extractable (using *QuickOSM* tool in QGIS) from Open Street Map, although the quality of mapped data may be limited in certain regions.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-30C

Sensitivity of different BVOC emission schemes in WRF-Chem(v3.6) to vegetation distributions and its impacts over East China

Mingshuai Zhang[1], Chun Zhao[1], Yuhan Yang[1], Qiuyan Du[1], Yonglin Shen[2], Shengfu Lin[1], Dasa Gu[3]
[1]University of Science and Technology of China, Hefei, China. [2]China University of Geosciences, Wuhan, China. [3]Hong Kong University of Science and Technology, Hongkong, China

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

China Working Group

Abstract

Biogenic volatile organic compounds (BVOCs) simulated by current air quality and climate models still have large uncertainties, which can influence atmosphere chemistry and secondary pollutant formation. These modeling sensitivities are primarily due to different treatments in the physical and chemical processes and vegetation types distributions. In this study, the simulations over East China with different versions (v1.0, v2.0, v3.0) of Model of Emissions of Gases and Aerosols from Nature (MEGAN) in WRF-Chem are examined and documented. Sensitivity experiments with these three versions of MEGAN and two vegetation datasets are conducted to investigate the difference of three MEGAN versions in modeling BVOCs and its dependence on the vegetation distributions, and the seasonality of spring (April) and summer (July) are also examined. The results indicate that MEGANv3.0 simulates the largest amount of biogenic isoprene emissions and the different performance among MEGAN versions is primarily due to their different treatments of applying emission factors and vegetation types. In particular, the results highlight the importance of considering sub-grid vegetation fraction with large area of urbanization. Among all activity factors, temperature-dependent factor dominates the seasonal change of activity factor, while the different response to the leaf area index (LAI) change determines the difference among the three versions in seasonal variation of BVOC emissions. The simulated surface ozone concentration due to BVOCs can be significantly different and the difference can be up to time times in some regions. This study documents the modeling sensitivity of different versions of MEGAN and the response to vegetation distribution and seasonal change, and its impacts on photochemistry and ozone production are also investigated. The results suggest more accurate vegetation distribution and measurements of biogenic emission flux and species concentration are needed to evaluate the model performance and constrain the model better.

Early Career Scientist

YES, I am an early career scientist.

GEIA-31A

BVOCs emission factors of urban green trees

Yuran Tan
Qingdao University of Technology, Shandong province, China

Abstract

Biogenic volatile organic compounds (BVOCs) are important precursors of ozone and secondary organic aerosols in the atmosphere. It is very important to understand the emission of BVOCs in the period of China's concerted control of ozone and PM2.5. At present, China's green area is constantly improving, and the number and species of green plants in cities have increased greatly. As a limited area of VOCs, the contribution of BVOCs to ozone has become a part that can not be ignored under the condition of more NOx. Therefore, in order to understand the emission capacity of urban greening plants BVOCs. In this paper, the BVOCs emission factors of various urban greening tree species were summarized. The standard emission factors of isoprene, monoterpene and sesquiterpene were calculated by Guenther algorithm, and the BVOCs emission capacity of each greening tree species was classified. The results showed that the release rates of isoprene, monoterpene and sesquiterpene varied greatly among different families and genera. Most of the greening tree species can release isoprene, especially Salicaceae showed a strong isoprene emission capacity, in the range of 30 ~ 90 μg g^{-1} h^{-1}. However, there are some differences among different varieties of the same family and genus. Luteaceae, Rosaceae and Aceraceae mainly emitted monoterpenes and sesquiterpenes, among which Fraxinus chinensis and Acer truncatum had the highest release rates of 10.6% μg g^{-1} h^{-1} and 11 μg g^{-1} h^{-1}。 The emission rate of BVOCs from elm is low. The emission factors of various tree species can provide reliable data support for the selection of urban greening tree species. When selecting tree species, we can refer to the tree species with lower BVOCs emission rate.

Early Career Scientist

YES, I am an early career scientist.

GEIA-32B

A case study to clarify emissions of biogenic volatile organic compounds (BVOCs) based on measurements of total ozone reactivity in the ambient air of a suburban forest in Japan

Jun Matsumoto[1], Shungo Kato[2]
[1]Waseda University, School of Human Sciences, Tokorozawa, Saitama, Japan. [2]Tokyo Metropolitan University, Hachioji, Tokyo, Japan

IGAC Regional Working Groups

Japan National Committee

Abstract

Biogenic volatile organic compounds (BVOCs) have been focused on as precursors of tropospheric ozone (O_3) and secondary organic aerosols. To capture BVOCs comprehensively, a total ozone reactivity (R_{O3}) analyzer has been developed and explored in our previous studies [1-4]. The analyzer was designed to cancel out contribution of ambient O_3. The detection limit of analyzer reached $2x10^{-5}$ s^{-1} (S/N=3, 60-s average). Ambient observation tests were also conducted at a suburban forest in Japan (Tokorozawa campus, Waseda University) in the summers of 2016 and 2017. R_{O3} data were acquired successfully for a total of 8 days, including high temperature days up to 36.2 degC. In this study, the acquired data were investigated further. Fractional contributions of VOCs, NO, and NO_2 as reaction partners of O_3 were also investigated. It was confirmed that R_{O3} could be significantly quantified utilizing the present analyzer when temperature was high enough and NO level was insignificantly low. A clear dependence of R_{O3} on ambient temperature was observed in the afternoon and the temperature sensitivity was acquired as 0.23±0.03 K^{-1} (26% K^{-1}), which was comparable to those reported for monoterpene emissions from vegetation. The R_{O3} analyzer might also capture the early morning peak of monoterpene emission. Consequently, it was confirmed that the present R_{O3} analyzer be useful for investigating BVOCs in a forest. Especially, monoterpene emission under elevated temperature conditions was significantly captured in the forestall atmosphere. In this paper, we also intend to present similar analysis of acquired data during another campaign in the summer of 2018.

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Early Career Scientist

NO, I am not an early career scientist.

GEIA-33C

RTEII: A new high-resolution (0.1° × 0.1°) road transport emission inventory over India of 74 VOCs, CO, NOx, NH3, SO2, CH4, CO2 , PM2.5 constrained by measured emission factors and regional vehicular activity data

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Indian Institute of Science Education and Research Mohali, Mohali, Punjab, India

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, ACAM: Atmospheric Chemistry and the Asian Monsoon, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

21 of 30 most polluted cities for particulate matter ($PM_{2.5}$) are in India, yet the distribution, identity and emissions of volatile organic compounds (VOCs) from traffic, which are $PM_{2.5}$ and ozone precursors, remain unknown. We present here a new road transport emission inventory for India (RTEII) at 0.1° × 0.1° spatial resolution of 74 speciated VOCs, CO, NOx, NH_3, CH_4, CO_2 and PM2.5, complied using measured emission factors for varied fuels and vehicle technologies extant over India. We find that the road transport sector contributed 1.2±0.3 Tg yr^{-1} VOCs, 0.13±0.06 Tg yr^{-1} CH_4, 227.4±12.1 Tg yr^{-1} CO_2, 1.1±0.1 Tg yr^{-1} NO_x, 12.6±1.8 Gg yr^{-1} NH_3, 5.0±0.9 Tg yr^{-1} CO, 0.24±0.04 Tg yr^{-1} SO_2 and 0.18±0.02 Tg yr^{-1} $PM_{2.5}$ over India in 2015. Toluene (137±39 $Ggyr^{1}$), isopentane (111±38 $Ggyr^{-1}$), and acetaldehyde (41±6 $Ggyr^{-1}$) were identified as the top 3-VOC emissions, but have scarcely received attention over India. Petrol-2-wheelers and LPG-3-wheelers had the highest emission factors (EFs> 50 gVOC/L) and had highest secondary pollutant formation potential, so their replacement with electric vehicles/clearer alternatives can bring significant improvement in air quality. Although CNG vehicular exhaust emissions were relatively cleaner and non-toxic, they emitted up to 116% more CO_2eq emissions than others. EDGARv4.3.2 and REASv.2.1 emission inventories overestimated total road sector emitted VOCs due to obsolete EFs and vehicle usage data, in particular over-estimating ethene, propene, ethyl benzene, 2,2- dimethyl butane, CO, NO_x while significantly under-estimating acetaldehyde. Nitromethane emissions were missing from previous inventories and with isocyanic acid and benzene contributed significantly to toxic emissions (sumtotal~41±4 $Ggyr^{-1}$). Knowledge of key VOCs emitted from the world's third largest road-network provides critical new data for mitigating secondary pollutant formation over India and will enable more accurate modelling of atmospheric composition over South Asia.

Early Career Scientist

YES, I am an early career scientist.

GEIA-34A

A new "hybrid" gridded 1 km × 1 km emission inventory for paddy stubble burning reveals that stubble burning is a massive source of VOCs unaccounted for by existing emission inventories and overwhelms other anthropogenic activities over the Indo-Gangetic Plain.

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Indian Institute of Science Education and Research Mohali, Mohali, Punjab, India

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, GEIA: Global Emissions Initiative, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Approximately 1.7 billion tons of paddy stubble is burnt openly in the Indo-Gangetic Plain (IGP) every year during the post-monsoon season. This large-scale biomass burning activity over two months results in massive emissions of reactive organic and particulate species that exacerbate the problem of persistent smog and air quality deterioration over the entire IGP. There is still a considerable knowledge gap regarding the identification, amounts and spatial distribution of volatile organic compounds (VOCs) which drive the surface ozone and aerosol formation. Global fire emission inventories rely on limited satellite overpasses for mapping burnt areas and fraction of fuel combusted and also have poor VOC speciation. Here, we present a new "hybrid" gridded emission inventory for paddy stubble burning over Punjab and Haryana in 2017 at 1km x 1km spatial resolution. First, the emission factors (EFs) of 77 VOCs were measured in smoke samples collected from the on-field paddy fires. These were then combined with 1 km × 1 km stubble burning activity, which was constrained by annual crop production yields and satellite-detected fires. Our results reveal that paddy stubble burning is a significant source of oxygenated VOCs like acetaldehyde (37.5±9.6 Ggy^{-1}), 2-furaldehyde (37.1±12.5 Ggy^{-1}), acetone (34.7±13.6 Ggy^{-1}), and toxic VOCs like benzene (9.9±2.8 Ggy^{-1}) and isocyanic acid (0.4±0.2 Ggy^{-1}) that are unaccounted for by existing global emission inventories (GFED, GFAS, FINN). Emissions of 346±65 Ggy^{-1} NMVOC; 38±8 Ggy^{-1} NOx; 16±4 Ggy^{-1} NH_3; 129±9 Ggy^{-1} $PM_{2.5}$; 22.1±3.7 Tgy^{-1} GHG CO_2 equivalents from paddy stubble burning during October-November 2017, were more than 20 times larger than corresponding emissions for the same two month period from traffic and municipal waste burning over north-west India. This shows that mitigation of this source alone can yield massive air-quality climate co-benefits for more than 500 million people.

Early Career Scientist

YES, I am an early career scientist.

GEIA-35B

Volatile chemical product emissions and criteria pollutant enhancements in the United States

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IGAC Activities

GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Volatile chemical products (VCPs) are a broad assortment of sources that emit reactive organic carbon (ROC) to the atmosphere. Among these sources are personal care products, general cleaners, architectural coatings, pesticides, adhesives, and printing inks. Here, we present VCPy, a new framework to model ROC emissions from VCPs throughout the United States. Evaporation of a species from a VCP mixture is a function of the compound-specific physiochemical properties that govern volatilization and the timescale relevant for product evaporation. For 2016, VCPy predicts emissions from VCPs to be 3.1 Tg nationwide, making VCPs a significant source of anthropogenic ROC in the United States. We then incorporate this inventory, which will be included as part of the EPA's 2020 National Emissions Inventory, into the Community Multiscale Air Quality (CMAQ) model, with VCP-specific updates to better model air quality impacts. These updates include a refined mapping of explicit inventory compounds to new model species that better represent secondary air pollutant formation pathways from non-oxygenated intermediate volatility organic compounds (IVOCs), oxygenated IVOCs, and siloxanes. The model configuration implemented here yields predictions of particulate organic carbon and ozone that often meet the highest standards of regional air quality modeling performance metrics. Results suggest VCPs enhance the nationwide annual-average, population weighted secondary organic aerosol (SOA) concentration by ~0.15 μg m^{-3}, which is ~11% of the modeled, population weighted SOA mass. Daily SOA enhancements attributable to VCPs can fluctuate substantially, with some urban areas often featuring noontime enhancements > 1.0 μg m^{-3}. While the ozone enhancements from VCP emissions are more modest on average, their influence can cause a several ppb increase on select days in populated cities. In addition, we assess contributions from various VCP categories (e.g. Personal Care Products) on SOA and ozone.

Early Career Scientist

YES, I am an early career scientist.

GEIA-36C

Global NH_3 emissions from livestock management : implementation of a dynamical module within a land surface model and impact on atmospheric chemistry

Maureen Beaudor[1], Nicolas Vuichard[1], Juliette Lathière[1], Martin Van Damme[2], Pierre-François Coheur[2], Lieven Clarisse[2], Didier Hauglustaine[1]
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IGAC Activities

GEIA: Global Emissions Initiative, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group, China Working Group

Abstract

Ammonia (NH3) is a key species in the atmosphere, playing a crucial role in the alteration of air quality and climate through the formation of nitrate particles. Moreover, NH3 is involved in surface deposition processes altering ecosystems. About 85% of NH_3 global anthropogenic emissions are related to food production and in particular to the use of mineral fertilizers and manure management. We investigate the impact of NH3 emissions on atmospheric chemistry and the associated feedbacks through the development of an interactive nitrogen cycle model in a coupled climate-chemistry-vegetation model. Presently, the global terrestrial ecosystem model ORCHIDEE computes only ammonia agricultural soil emissions driven by yearly inventory of organic and synthetic fertilizer application, implying that the emissions from the whole manure management chain (housing, storage and grazing) are missing. Our approach consists in estimating the global emissions coming from every livestock activity, implementing appropriate parameterisations within ORCHIDEE.

We present our new developments, that include a detailed integrated scheme of livestock management going from housing and storage to grazing emissions. In addition, our approach includes an animal feeding module where the biomass ingested is constrained by the global and local resource production computed by ORCHIDEE and accounts for the calculation of grazing intensity. We compare the new emissions with previous inventories such as EDGAR or CEDS. The emissions are then used to investigate the impact on atmospheric chemistry, using the global atmospheric chemistry transport model LMDZ-OR-INCA. We evaluate the model results by comparing the calculated ammonia column with the spaceborne IASI instrument observations. Future simulations are conducted using the new inventory in order to investigate the impact of agriculture practices on atmospheric chemistry based on different scenarios.

Early Career Scientist

YES, I am an early career scientist.

GEIA-37A

Airborne measurements of formaldehyde from biomass burning plumes and urban and wetland emissions using Laser-Induced Fluorescence Spectroscopy

Samuel Seldon[1], Grace Ronnie[1], Trevor Ingham[1], Dwayne Heard[1], Lisa Whalley[1], James Lee[2], Dominika Pasternak[2], Samuel Cliff[2], Thomas Bannan[3], Emily Matthews[3], Hugh Coe[3], Archit Mehra[4], Stéphane Bauguitte[5], Hannah Price[5], David Spronson[5], Alex Archibald[6]
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IGAC Activities

Abstract

Formaldehyde is the most abundant carbonyl compound in the atmosphere and is produced by the photochemical processing of VOCs as well as being emitted from biomass burning (BB), fossil fuel burning, and soil and plant matter.

In the Methane Observations and Yearly Assessments (MOYA) campaign in January/February 2019, airborne measurements of formaldehyde were taken using the University of Leeds Laser-Induced Fluorescence instrument to investigate oxidation processes in BB plumes in northern Uganda, where mixing ratios of formaldehyde of up to 177 ppb, which correlated strongly with peaks in NO_x and CO, were observed. Urban emissions of formaldehyde with mixing ratios of up to 9 ppb were measured over Kampala, the capital of Uganda. Wetland emissions of formaldehyde in Zambia, during the ZWAMPS campaign immediately following MOYA, were also measured.

Airborne measurements of formaldehyde were also taken over the north Atlantic Ocean during the ACSIS-5 campaign in August 2019, where elevated formaldehyde in a plume originating from Canadian wildfires was detected. Fire plumes originating from West Africa were measured off the coast of Senegal during the Atmospheric Reactive Nitrogen over the remote Atlantic (ARNA-2) campaign in February 2020.

These data were used to distinguish between formaldehyde produced photochemically in BB plumes and directly emitted formaldehyde, to advance our understanding of oxidation processes in fire plumes and the oxidation VOCs in urban plumes.

Early Career Scientist

YES, I am an early career scientist.

GEIA-38B

Modeling and Mapping Biomass Burning for High Northern Latitudes with the Wildland Fire Emissions Inventory System (WFEIS)

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IGAC Activities

GEIA: Global Emissions Initiative

Abstract

The Wildland Fire Emissions Inventory System (WFEIS) came out of NASA's Carbon Cycle and Applied Sciences programs focused on creating maps of regional-scale wildland fire carbon emissions for the United States. Emissions inventory tools and underlying datasets have evolved and expanded in geographic scope. For this study, we consider emissions from fires in the circumpolar High Northern Latitudes (HNL), where emissions of black carbon (BC) from fires are known to have a strong impact on climate through atmospheric forcing and deposition on snow and ice, causing a reduction snow albedo.

Three data layers are needed to map fire emissions: (1) where and when fires occur; (2) vegetation fuel maps; and (3) daily weather across the region of interest to characterize combustion conditions and model fuel consumption. These data are combined within a geospatial data framework to estimate and map emissions. HNL biomes and ecosystems are often poorly represented in global data sets. Improved products for burn area developed for the circumpolar HNL region will be described show that more emissions are expected when using regionally-tuned burn area maps. Data sets and results originating from the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF) Land Cover Change Initiative program can be used to characterize the circumpolar landscape. This information combined with WFEIS estimates can help quantify how fire impacts these ecoregions.

In this presentation we will review the basics of WFEIS, recent updates to its functionality, and demonstrate WFEIS for calculating and mapping emissions from fires across the high northern latitudes (HNL) regions of North America. In addition to showing results from HNL regions of North America, we present a conceptual review of how WFEIS could be used in the circumpolar HNL using regional data sets to improve estimates of emissions from fire in the boreal and tundra regions.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-39C

Improving the bottom-up estimates of natural geologic emissions via microseepage

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Abstract

Methane (CH_4) is an important greenhouse gas with both natural and anthropogenic sources. The magnitude of emissions from natural geologic methane sources (mud volcanoes, marine and terrestrial seeps, microseepage and geothermal areas) is highly uncertain. Recent bottom-up studies have argued for a relatively large (≈40 – 60 Teragrams CH_4 per year) geologic methane source, while top-down estimates from ice core measurements of ^{14}C of methane indicate that the geologic source is approximately an order of magnitude lower. Bottom-up studies have further postulated microseepage as the single largest component of geologic emissions. We are engaged in a project that aims to help resolve this discrepancy via improving bottom-up estimates of microseepage emissions. A first limited set of measurements from the Appalachian Basin indicates that microseepage emissions are not as widespread in this region as previously believed. The planned work will focus on eight different hydrocarbon basins in the US, will greatly increase the number of available microseepage measurements and will attempt to develop a quantitative understanding of parameters that predict seepage on basin scale (e.g., seismic activity of a basin) and local scale (e.g., proximity to a fault). The measurements will be interpreted in a machine-learning framework to construct a microseepage flux estimate for the entire contiguous US. We will present the framework for the project as well as measurements that will be available to date.

Early Career Scientist

YES, I am an early career scientist.

GEIA-40A

Assessing vehicle fuel efficiency using a dense network of CO2 observations

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IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group

Abstract

Transportation represents the largest sector of anthropogenic CO_2 emissions in urban areas, making a timely reduction in urban transportation emissions critical to reaching climate goals set by international treaties, national policies, and local governments. Transportation emissions also remain one of the largest contributors to poor air quality. As municipal and regional governments create policy targeted at reducing transportation GHG and AQ emissions, the ability to track the efficacy of such strategies in a timely manner is critical. The BErkeley Air Quality and CO2 Network ($BEACO_2N$) is a dense (~2km) network with measurements of CO_2, AQ gases and particles at more than 50 locations. Inversion of the network CO_2 observations has previously been shown to provide useful constraints on urban CO2 emissions with hourly resolution and sector specific attribution on time scales of ~6 weeks. Here, we focus on a ~5 km, high volume, stretch of highway in the SF Bay area, and compare traffic count derived emissions estimates to those using inversion of the $BEACO_2N$ observations. We show that BEACO2N measurements constrain the speed and vehicle fleet composition dependence of fuel efficiency.

Early Career Scientist

YES, I am an early career scientist.

GEIA-41B

Comparison of bottom-up and top-down road transport emission inventories

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IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group

Abstract

Differences in results from bottom-up and top-down approaches for estimating road transport emission inventory (EI), were analyzed in the medium-sized city of Manizales, Colombia. Manizales (with 434,403inhabitants) is located on the Central Cordillera of the Andes at 2,150 meters above sea-level, therefore it has a complex orography (road slopes even greater than 22%). Further, the city has a high motorization rate of 455 vehicles / 1000 inhabitants - year 2018. The EI from on-road mobile sources was estimated using the COPERT 5.4 model – year base 2017. Emission fluxes included criteria pollutants (CO, NO_x, SO_2, PM_{10}, $PM_{2.5}$), black carbon, volatile organic compounds (VOC) and greenhouse gases (CO_2, CH_4, N_2O), for five vehicle categories. This work shows the importance of performing bottom-up EI to reduce the inherent uncertainty regarding top-down EI estimation, considering that EI are indispensable tools for designing and implementing environmental regulations. This work is a starting point to evaluate the application of the COPERT model in cities with high road slopes using air quality models.

An estimation using the bottom–up approach was developed with the transportation model PTV-VISUM to obtain specific activity information (traffic volumes, vehicular speed) of the vehicle fleet. Emission factors were obtained from the COPERT 5.4 model and adjusted for local conditions of the city as vehicular age and fuel characteristics. On the other hand, the top-down approach using the COPERT 5.4 software was aggregated considering activity information (total vehicles fleet, annual mileage and average vehicle speed). The results show lower emission fluxes from the top-down approach compared with the bottom-up for: NMVOC (-28%), PM_{10} (-26%), VOC (-23%), CO (-23%), $PM_{2.5}$ (-11%), SO_2 (-10%) and CO_2 (-2%). This suggests that using detailed information of the vehicle activity from the application of transport models (bottom-up approaches) reduces sub estimations of emissions with top-down approaches.

Early Career Scientist

YES, I am an early career scientist.

GEIA-42C

COvid-19 adjustmeNt Factors fOR eMissions (CONFORM): A dataset for atmospheric models

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

In order to fight the spread of the global COVID-19 pandemic, most of the world countries have taken control measures such as lockdowns, resulting in changes in economic and personal activities in many countries. For the propose of providing input for model simulations, CONFORM (COvid-19 adjustmeNt Factors fOR eMissions) dataset has been developed. This dataset represents gridded daily/monthly emission adjustment factors (AFs) at a spatial resolution of 0.1x0.1 for the main economic sectors (power, industrial, residential and transportation including road, aviation and shipping); and can easily be applied to current global and regional inventories. The emission AFs are applied to the CAMS global inventory (CAMS-GLOB-ANT_v4.2_R1.1), and used in a global Community Atmosphere Model (CAM-chem). Changes in emissions of the given primary chemical species and for the first six months of 2020 are discussed. Results show substantial reduction in emissions of air pollutants (i.e. NOx, NMVOCs, CO, SO_2, OC and BC) with a high variation across regions and sectors, due to the differences in the duration of the lockdowns before partial or complete recovery. The evaluation of the dataset in China using model indicates that, during the lockdown of February, the surface concentration of NOx was severely reduced (40%-50%) in most areas, while the concentration of Ozone increased in the northeastern part of China and locally in several large urban areas of the other regions. CONFORM dataset is distributed by the Emissions of atmospheric Compounds and Compilation of Ancillary Data (ECCAD) database (https://eccad.aeris-data.fr/).

Early Career Scientist

NO, I am not an early career scientist.

GEIA-43A

Global high-resolution emissions of soil NOx, sea salt aerosols, and biogenic VOCs

Hongjian Weng[1], Jintai Lin[1], Randall Martin[2], Dylan B. Millet[3], Lyatt Jaeglé[4], David Ridley[5], Christoph Keller[6], Chi Li[7], Mingxi Du[1], Jun Meng[8]
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Abstract

Natural emissions of air pollutants from the surface play major roles in air quality and climate change. In particular, nitrogen oxides (NO_x) emitted from soils contribute ~15% of global NO_x emissions, sea salt aerosols are a major player in the climate and chemistry of the marine atmosphere, and biogenic emissions are the dominant source of non-methane volatile organic compounds at the global scale. These natural emissions are often estimated using nonlinear parameterizations, which are sensitive to the horizontal resolutions of inputted meteorological and ancillary data. Here we use the HEMCO model to compute these emissions worldwide at horizontal resolutions of 0.5° lat. × 0.625° lon. for 1980–2017 and 0.25° lat. × 0.3125° lon. for 2014–2017. We further offer the respective emissions at lower resolutions, which can be used to evaluate the impacts of resolution on estimated global and regional emissions. Our long-term high-resolution emission datasets offer useful information to study natural pollution sources and their impacts on air quality, climate, and the carbon cycle.

Early Career Scientist

YES, I am an early career scientist.

GEIA-44B

The impact of land cover change and biogenic emissions from urban green space on summer ozone formation over North China Plain

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

China Working Group

Abstract

The biogenic volatile organic compounds (BVOC) emissions such as isoprene and monoterpene, play crucial roles in ozone formation. In this study, we find that BVOC emissions are enhanced due to factors previously not considered, such as land cover change and the BVOC emissions from urban green space. The regional three-dimensional air quality model WRF-CMAQ was used to investigate the effects of BVOC emissions on the subsequent influence on ozone formation in summer. On the one hand, the Chinese government's vigorous afforestation policies induce a great increase in forest coverage from 2003 to 2016, leading to nearly doubled BVOC emissions over North China Plain (NCP). During the heavy ozone pollution episodes in June 2017, BVOC emissions driven by land cover change yield an extra mean MDA8 ozone of 1.32 ppbv over the NCP and 2.79 ppbv in Beijing. On the other hand, BVOC emissions released by urban green space yield abnormally low BVOC concentration in the urban area. Therefore, the BVOC emissions from urban green space were added to investigate the effects on ozone in 2017 summer in Beijing. Through the comparison with observations, we first find that the urban BVOC emissions not only increase the simulated isoprene concentration by an order of magnitude but also its diurnal cycle is improved and more consistent with the observations. Secondly, the simulations show that the urban BVOC emissions contribute to MDA8 ozone of 4.74 ppbv in Beijing during the heavy ozone pollution episodes in June 2017, and the ozone formation rate from isoprene is almost twice as high in urban as that in rural areas. Lastly, as NOx is further reduced in the future, isoprene emitted over urban of megacities may become more important in ozone formation and even exceed that from rural areas.

Early Career Scientist

YES, I am an early career scientist.

GEIA-45C

Municipal solid waste burning is a neglected source of highly reactive VOCs that fuel ozone formation over rural India

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Indian Institute of Science Education and Research, Mohali, SAS Nagar and Punjab, India

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Open waste burning is a widely established practice of waste disposal in developing nations. According to the official government data, 56 Tg of municipal solid waste is generated annually in India. However, in reality, waste generation is much larger. Previous studies have estimated the true total waste generation in India in the year 2015 to be somewhere in the range between 70-300 Tgy^{-1}. The large uncertainty of waste generation estimates is caused by lack of observational data from rural regions within India and severely hampers our ability to construct accurate open waste burning emission inventories.

In this study we collected activity data in understudied rural regions across India and established a relationship between waste generation and household income. We use this relationship to draw up an open waste burning emission inventory for India for year 2020, at a spatial resolution of 0.1° (11km x 11km) after segregating both the rural and urban population into 5 income group with the help of socioeconomic data from the national health surveys.

We find that out of 168 (102−231) Tgy^{-1} waste generated in the year 2020, 56 (40−88) Tgy^{-1} was burned in the open. Open waste burning emits a suite of very reactive VOCs, which act as precursors to tropospheric ozone and secondary aerosol. The anthropogenic emissions of formaldehyde from this source are 4.6 times larger than India's total anthropogenic budget of formaldehyde, in the EDGARv4.3.2 inventory, while the budget of ethylene (83−193 Ggy^{-1}) and propene (59−132 Ggy^{-1}) increase by 7-16% and 11-26%, respectively, with the inclusion of this source. Waste burning is also a significant source of continental chlorine emissions and contributes to secondary inorganic aerosol formation via the emission of 96 (48−162) Ggy^{-1} of HCl and gas phase ammonia 48 (27−79) Ggy^{-1}.

Early Career Scientist

YES, I am an early career scientist.

GEIA-46A

Residential heating emissions cause more aerosol pollution than paddy-residue burning and in rural northwest India

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IISER Mohali, Mohali (Punjab), India

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

November onwards, the poor air quality over northwest India is blamed on the large-scale paddy residue burning in Punjab and Haryana. However, the emission strength of this source remains poorly constrained due to the lack of ground-based measurements over rural areas and issues in the satellite detection of paddy residue fires. In this study, we report the first-ever particulate matter (PM) measurements at Nadampur, a village in the Sangrur district with the highest reported paddy residue fires, from 1 October to 19 December 2019, using the Airveda low-cost PM sensors. The daily average PM_{10} and $PM_{2.5}$ mass concentration at Nadampur correlated well ($r > 0.7$) with the daily sum of Visible Infrared Imaging Radiometer Suite (VIIRS) fire counts in a 50 km × 50 km area surrounding the village. Agreement of the Coefficient of Emissions (Ce) estimated in this study (0.038 kg MJ^{-1}) with the reported value (0.04 kg MJ^{-1}), and a disagreement of the top-down estimate of PM emission factors with the laboratory reported values indicates an under-detection of paddy residue fires. Residential burning of solid fuels such as cow-dung cakes and fuelwood for space heating triggered by a dip in the temperature led to poor air quality from 20 November onwards. Source apportionment performed using Multiple Linear Regression (MLR) and Positive Matrix Factorization (PMF) revealed that paddy residue burning increased the PM_{10} ($PM_{2.5}$) at Nadampur by 97.0 ± 36.6 μg m^{-3} (53.4 ± 16.8 μg m^{-3}), which was more than the contribution of harvesting activities 44.8 ± 1.7 μg m^{-3} (20.1 ± 5.2 μg m^{-3}), but lower than residential heating emissions 151.2 ± 47.2 μg m^{-3} (120.1 ± 8.8 μg m^{-3}). Unlike agricultural activities, which typically affect the air quality for roughly one month, heating-related emissions profoundly impact the air quality for multiple months.

Early Career Scientist

YES, I am an early career scientist.

GEIA-47B

Agricultural particulate matter emissions in the Colombian Orinoco region

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[1]Universidad Nacional de Colombia, Bogotá, Colombia. [2]Universidad EAN, Bogotá, Colombia

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Increasing population, food and industrial feedstock demands have led to continuous incorporation of new areas into agriculture. Classic intensive agriculture, i.e. without conservation practices, can emit substantial amounts of particulate matter (PM), both fine from diesel combustion, and coarse from soil operations. The Northern South America Orinoco River savannas or Llanos have been steadily transformed into agriculture since 1930s. The Llanos are also a highly biodiverse region. Sown area in the Colombian Llanos has increased ~4 fold in the last 20 years (1996-2017). The crops with largest sown areas are currently oil palm, rice, soybean, cocoa, and other fruit trees. We comprehensively analyzed all the activities conducted for all the relevant crops in the Colombian Llanos and their emission factors (EF), including from soil preparation, sowing, maintenance, and harvesting. The estimated EFs show that crops with short harvest cycles, i.e. harvested 2-3 times per year in the Llanos, such as rice, corn and soybean are significantly higher (14, 12 and 11 kg PM_{10} ha^{-1} $year^{-1}$, respectively) than those with long cycle such as oil palm and fruit trees (1.1 and 0.6 kg PM_{10} ha-1 year-1, respectively). Agricultural emissions have steadily grow from 2007 (3.1 kton PM_{10}) to 2017 (7.2 kton PM_{10}). In 2017, 79% of emissions were due to soil preparation, 13% to harvest, and only 8% fossil fuel combustion in agricultural machinery. Although short-cycle crops are the main contributors to the total emissions (55% rice, 20% corn, 8.5% soybean), they are also the ones that provide the country's food base.

Early Career Scientist

YES, I am an early career scientist.

GEIA-48C

Particulate matter emission factors for light and heavy-duty vehicles in a South American megacity (São Paulo, Brazil)

Dr Guilherme M Pereira[1,2], Mr Leonardo Y Kamigauti[2], Mr Djacinto Santos[3], Dr Thiago Nogueira[2], Professor Paulo Artaxo[3], Professor Pérola C Vasconcellos[1], Professor Maria F Andrade[2]
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IGAC Activities

GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

The urban planning of the Metropolitan Area of São Paulo (MASP) has historically prioritized road transport and its fleet is characterized by the use of biofuels as ethanol and biodiesel. Tunnel studies are employed to assess vehicle emissions and calculate vehicular emission factors (EFs), for both exhaust and non-exhaust emissions. Organic and elemental carbon (OC and EC), polycyclic aromatic hydrocarbons (PAHs) levels were determined in particulate matter ($PM_{2.5}$) samples collected in quartz fiber filters, inside and outside of two tunnels at MASP: Jânio Quadros Tunnel (impacted by light-duty vehicles) and the Rodoanel Tunnel (impacted by heavy-duty vehicles). OC/EC ratios were 1.2 and 0.8 for the LDV- and HDV-impacted tunnels, respectively; ratios equal to or lower than 1 are observed in roadway tunnels and related to fresh traffic emissions. EC levels were higher in the HDV-impacted tunnel, presenting 15-fold higher emission factors; higher EC emissions are observed for heavy-duty vehicles. PAHs of five or more aromatic rings represented about 50 % of the total measured inside the Jânio Quadros tunnel (impacted by gasohol and ethanol exhausts), while the PAHs of three and four aromatic rings represented 80 % in the case of the Rodoanel tunnel (impacted by diesel and biodiesel blend exhausts). In the LDV-impacted tunnel, the highest calculated EFs were observed for four-ring PAHs, such as pyrene and chrysene, and five- and six-ring PAHs, such as benzo[a]pyrene, benzo[b]fluoranthene, and benzo[g,h,i]perylene, known for their carcinogenic potentials. In the HDV-impacted tunnel, the highest calculated EFs were observed for three- and four-ring PAHs, as phenanthrene, pyrene, and fluoranthene. A trend of reduction of measured PAHs and carbonaceous species concentrations inside both tunnels was observed in the last decade and can be attributed to the effectiveness of the programs for the reduction of pollutant emissions.

Early Career Scientist

YES, I am an early career scientist.

GEIA-49A

Reactive Nitrogen Emissions from Turfgrass Systems: Emission, Emission Factor, and Modeling

Professor Viney P. Aneja[1], Graduate Student Alberth C Nahas[1], Dr. John Walker[1], Dr. Limei Ran[2], Professor Fred Yelverton[1]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, GEIA: Global Emissions Initiative

Abstract

Turfgrass management is characterized by intensive use of fertilizers, and irrigation that contributes to reactive nitrogen (Nr) emissions into the atmosphere. Ammonia (NH3), nitric oxide (NO), and nitrous oxide (N2O) emissions from turfgrass systems are measured by combining measurements from field experiments and simulations from a biogeochemical EPIC model. Field experiments were conducted seasonally using a dynamic flux chamber on a 50 ft by 50 ft experimental plot of tall fescue at Lake Wheeler Turfgrass Field Laboratory, Raleigh, NC. Measurements indicate a wide range of emissions for NH3 (3.5-117.5 ng NH3-N m-2 s-1), NO (1.9-80.1 ng NO-N m-2 s-1), (and N2O (7.2-24.3 ng N2O-N m-2 s-1). Both NH3 and NO emissions were higher during summer and fall, suggesting that the emissions are influenced by temperature-regulated soil processes (e.g., NH3 volatilization and microbially-driven denitrification). N2O emissions do not show an apparent linear relationship with temperature, but are influenced by the N-fertilizer application. Meanwhile, Nr emission factor was determined to quantify how much Nr is being loss from the system. Emission factors for NH3, NO, and N2O vary depending on the amount of N-fertilization application (NH3: 0.126-0.179; NO: 0.066-0.086; and N2O: 0.018-0.027).

The biogeochemical modeling simulations were performed using the Environmental Policy Integrated Climate (EPIC) model. The model utilized customized input files such as site information, daily weather data, soil physical and chemical characteristics, fertilizer types, and the site management options. Trace gas fluxes predicted by EPIC showed moderate to good correlation with measured fluxes (0.5-0.8) but tended to be biased low. This underestimation can be attributed to smaller NH4+ and NO3- concentrations in soils that are simulated by EPIC. Development of different simulation scenarios is an example of how to use EPIC in addressing different management practices, which can provide a better comprehension of how Nr emissions differ under varying conditions.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-50B

Concentrations of Atmospheric VOCs Emitted from Fireworks in Southwest Mexico City Measured by a Real-time Vocus PTR-TOF-MS

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Fireworks and bonfires are commonly used during cultural and religious festivals, producing pollution plumes concentrated in short periods of time and may be associated with detrimental effects on air quality and health[1].

A Vocus proton transfer reaction time of flight mass spectrometer (Vocus PTR-TOF-MS) allows for continuous real-time measurements of volatile organic compounds (VOCs) with an ultralow detection limit (sub-ppt).

Outdoor ambient air measurements were carried out at the southwest region of Mexico City, from December 7th to 14th, 2020 using a high resolution Vocus 2R PTR-TOF-MS (Tofwerk, Switzerland) operated in a positive ionization mode with H_3O^+ as a primary ion.

During the December 12th festival (in celebrations of the Virgin of Guadalupe Day) intensive fireworks and bonfires were associated with large enhancements of numerous reduced and oxygenated VOCs. Among the hundreds of VOCs, some prominent compounds were identified including acetic acid, butanal/butanone as well as benzene and toluene. The concentration increases on the 12th day received special attention, particularly for benzene, which concentrations were more than 100 times higher in contrast to the rest of the period. On the other hand, the enhancements of acetone, benzaldehyde, butanal/butanone, C_8 aromatics, furan and toluene were by a factor from 10 to 50 times higher. Finally, formic acid, acetonitrile and C_9 aromatics exhibited less extreme enhancements, all of which were less than 10 times higher than the typical concentration.

This work contributes with chemical fingerprinting of firework and bonfire plumes and discusses the impact of these episodic sources on urban air quality. Acknowledgments for the financial support to CONACyT- Infrastructure 300618.

[1] Singh et al. (2019). Air quality during and after festivals: Aerosol concentrations, composition and health effects. *Atmospheric Research* vol. 227 220–232.

Early Career Scientist

NO, I am not an early career scientist.

GEIA-51C

Geostatistical analysis and inventory of emissions from sugarcane pre-harvest burning in Southwest Colombia

Environmental engineer ANDREA CARDOZO[1], Environmental engineer PABLO GUTIERREZ[1], Dr. Engineering GERMAN RUEDA[1], Dr. Sc. Atmospheric sciences RODRIGO JIMENEZ[2]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Almost 80% of Colombia's sugarcane is intensively produced in the Cauca River Valley (CRV, ~5000 km2), a region with one the highest sugarcane yields (120 ton/ha) in the World. About 34% of the 238 thousand hectares sown in 2018 were burned prior harvesting. As CRV is also densely populated (4M inhabitants), and biomass burning emissions are highly toxic, the regional environmental authority has achieved to steadily reduce the burned area from ~80% of the sown area in 2009 to the current 34%. We will briefly discuss the social and economic reasons that have supported pre-harvest sugarcane burning (PHB), and will present our reconstruction of the sown and burned area time series, which shows that we are past peak emissions. We will also present and discuss the spatial-temporal variability, including time of burning and duration of the PHB events. We will present a unified approach to the PHB emission factor calculation and our spatially and time disaggregated emission inventory for 2018, and will end by discussing the environmental and public health impact of the PHB practice.

Early Career Scientist

YES, I am an early career scientist.

GEIA-52A

Updating the 2013 National Emissions Inventory for air quality modeling in Central Mexico

MSc Jose A Rodriguez, Dr Agustin Garcia
National Autonomous University of Mexico, Mexico City, Mexico

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group

Abstract

Air pollutant emissions inventories are an essential air quality model input parameter. During its elaboration process, there are uncertainties that cause errors in numerical simulations. The need to continually improve the data accuracy or adjust it to the current conditions that are trying to describe is indisputable. In this work, the spatial, temporal and chemical speciation distribution model (DiETE) was applied to the 2013 Mexico National Emissions Inventory in order to obtain a spatially and temporarily disaggregated database, ready for numerical modeling with Weather Research and Forecasting Model with Chemistry (WRF-Chem) in Central Mexico. Also, the model performance was evaluated for ozone in an environmental contingency episode that took place between May 15th and 21st , 2017, based on the comparison with stations observations from the Red Automatica de Monitoreo Atmosferico. Statistical metrics showed lower correlation for all variables analyzed and it was decided to update the inventory through a nonparametric methodology based on scale factors. This led us to obtain statistical parameters with larger correlations, with model values closer to the observations and accurately describing the spatial and temporal behavior of the variables. The adjustments made to the inventory were validated through its application in another case of environmental contingency from March 14th to 17th , 2016, with considerable improvements in the performance of the model.

Early Career Scientist

YES, I am an early career scientist.

GEIA-53B

Estimating Road Transportation Emissions using CNNs and Satellite Imagery

Ryan Mukherjee, Derek Rollend, Gordon Christie, Armin Hadzic, Sally Matson, Anshu Saksena, Marisa Hughes
JHU/APL, Laurel, MD, USA

IGAC Activities

GEIA: Global Emissions Initiative

Abstract

Road transportation is one of the largest sectors of greenhouse gas emissions affecting climate change. To better understand road transportation emissions and make progress towards reducing them, we must develop scalable inventory capabilities. As such, our team has been experimenting with convolutional neural networks (CNNs) to estimate road transportation emissions from satellite imagery.

Our initial work is focused on the conterminous United States, where high-resolution gridded inventory estimates are available for training our models. We trained multiple U-Net and MA-Net architectures using ResNet-34 and EfficientNet-B3 backbones, with each model accepting a variety of inputs including Sentinel-2 visual imagery ($100m^2$ resolution), rasterized road networks, atmospheric CO_2, and population. Imagery surrounding 3753 cities in the US was used for training, while 118 cities were used for validation.

Our best model used an MA-Net architecture with EfficientNet-B3 backbone and operated on only Sentinel-2 imagery and rasterized road networks. This model was trained using a loss function based on root mean squared logarithmic error (RMSLE) and achieved a RMSLE of 0.616, mean absolute error of 39.5 kg CO_2, and mean absolute percentage error of 55% on our validation set. Models trained using atmospheric CO_2 and population did not perform as well.

With this model, we can begin to scale globally. CNNs trained to segment roads from satellite imagery enable us to replace the rasterized road network information used for training US-based models. As a result, an initial global estimate can be produced using satellite imagery alone. However, significant challenges remain in validating these neural-network-based estimates and further improving them by training on more geographically diverse data and road transportation emissions estimates from complementary inventory efforts.

Early Career Scientist

NO, I am not an early career scientist.

JNC-1A

Light absorption properties of brown carbon aerosols in the Asian outflow: Implications from a combination of filter and ground remote sensing observations at Fukue Island, Japan

Dr Chunmao Zhu[1], Takuma Miyakawa[1], Hitoshi Irie[2], Yongjoo Choi[1], Fumikazu Taketani[1], Yugo Kanaya[1]
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Japan National Committee

Abstract

Brown carbon (BrC) aerosols have unignorable warming effects on earth's radiative forcing. However, information on evolution of light absorption properties of BrC aerosols in the Asian outflow region is very limited. In this study, we evaluated the light absorption properties of BrC using combined approaches of in-situ filter measurement and sky radiometer observation in the ground remote sensing SKYNET network at Fukue Island, western Japan in 2018. The light absorption coefficient of BrC based on filter measurement showed similar trend with ambient concentration of black carbon, indicating their general combustion sources. Absorption Angstrom Exponent (AAE) over the wavelength range of 340–870 nm derived based on sky radiometer observation was estimated 15% higher in spring (1.81 ± 0.30) than that over the whole year (1.53 ± 0.50), suggesting that the Asian outflow is carrying light absorbing aerosols to Fukue Island and the western North Pacific region. After eliminating the contributions of BC, AAE of sole BrC based on filter observations showed a positive linear correlation ($r = 0.98$, $p < 0.001$) with those derived from SKYNET observation but 49% higher values, indicating that the light absorption properties of BrC was successfully captured by both methods. With this comparison, we propose that AAE of BrC based on SKYNET column observations should be converted to the surface value by a factor of 1.49. Based on atmospheric transport model FLEXPART and fire hotspots obtained from the Visible Infrared Imaging Radiometer Suite product, we identified high BrC event being related to air mass origins from regions with consistent fossil fuel combustions and sporadic open biomass burning in central East China. The study adds information to better understand the dynamics and climatic effects of BrC aerosols in East Asia.

Early Career Scientist

NO, I am not an early career scientist.

JNC-2B

Evaluation of a Low-Cost Mobile PM2.5 Sensor and Application to the Measurements along the Japan National Route 1

Mr Kenta Kanegae[1], Mr Takayuki Yamasaki[2], Mr Wataru Okamoto[2], Dr Yutaka Matsumi[2], Dr Tomoki Nakayama[1]
[1]Nagasaki University, Nagasaki, Japan. [2]Nagoya University, Nagoya, Japan

IGAC Regional Working Groups

Japan National Committee

Abstract

Exposure to $PM_{2.5}$, results in an array of negatively impacts on human health and leads to premature mortality of many people in the world. Because $PM_{2.5}$ is spatially and temporally variable and individuals also move in time and space, it is important to understand personal exposures of $PM_{2.5}$ for better assessment of the health impact. We developed a low-cost optical $PM_{2.5}$ sensor with and Panasonic Corporation, and evaluated its performance for environmental monitoring at fixed sites [*Nakayama et al. Aerosol Sci. Tech.* (2018)]. This sensor was designed to measure $PM_{2.5}$ mass concentrations by detecting light scattering intensities from individual aerosol particles with diameters greater than 0.3μm. This sensor has several advantages including small size, low operating noise, high temporal-resolution, low power consumption, and the ease of the operation. However, the sensitivity of the sensor can be change if the sensor is tilted or swung, because aerosol particles flow into the sensor via an updraft generated by a heater and flow rate may change during tinting or swinging. In this study, the changes in the sensitivity of the sensor during tilting, swinging, and walking have been investigated. From these tests, it is found that the sensor can be applied for mobile measurements. We applied this sensor to the mobile measurements during walking along the National Route 1 (from Tokyo to Kyoto) for two weeks. The $PM_{2.5}$ data obtained using the mobile $PM_{2.5}$ sensor is compared with those measured at the nearest observatories of the Ministry of Environment, Japan. The result suggests that contribution of emission of $PM_{2.5}$ from automobiles on Route 1 is insignificant. We believe that this research will provide useful information for applications of the compact $PM_{2.5}$ sensor to personal exposure monitoring for epidemiological research and to mobile measurement for detection of local and community sources.

Early Career Scientist

YES, I am an early career scientist.

JNC-3C

Effects of marine nitrogen fixation on the formation of atmospheric water-soluble organic nitrogen revealed by a laboratory incubation experiment

Tsukasa Dobashi[1,2], Koji Suzuki[3], Yuzo Miyazaki[2]
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IGAC Regional Working Groups

Japan National Committee

Abstract

Marine atmospheric aerosols formed in the sea surface play a key role in the climate system. Water-soluble organic nitrogen (WSON) in marine aerosols affects the physicochemical properties of particles. Previous ship-board measurements in the subtropical North Pacific suggests that nitrogen-fixation in the ocean surface significantly contributed to the aerosol WSON formation. However, effects of nitrogen fixation in the ocean surface on the formation of atmospheric reactive nitrogen have not been understood. This study aims to elucidate the contribution of nitrogen-fixing organisms to the formation of atmospheric reactive nitrogen including WSON by a laboratory incubation experiment.

In the experiment, *Trichodesmium,* one of the most representative nitrogen-fixing organisms, was cultured in artificial seawater under controlled temperature. $PM_{2.5}$ and gas samples were collected on filters set at three stages of an impactor every 24 hours. Water-soluble total nitrogen (WSTN) and water-soluble organic carbon (WSOC) concentrations in the atmospheric samples as well as dissolved nitrogen (DN) and dissolved organic carbon (DOC) concentrations in the seawater samples were measured. The WSON concentration was defined as the difference between the concentrations of WSTN and inorganic nitrogen (IN). Chlorophyll *a* (Chl *a*) and heterotrophic bacterial concentrations in the seawater were also measured.

During the incubation period of about one month, the increase in the DN and DOC concentrations and the DN/DOC ratio in the seawater corresponded with the increase in the Chl *a* concentrations in the growth phase. The result suggests that the growth of *Trichodesmium* released DN and DOC in the seawater, where DN was preferentially released more than DOC. Moreover, the Chl *a* concentration showed a positive correlation with the WSON concentration in the atmospheric samples. The overall results demonstrate that the growth of *Trichodesmium* in seawater contributed to the formation of atmospheric WSON, mostly through the nitrogen fixation process.

Early Career Scientist

NO, I am not an early career scientist.

Categories

JNC-5A

A chemistry-transport modeling to support satellite observations of NO_2 and CO_2 emitted from megacities

Dr. Yousuke Yamashita, Dr. Hiroshi Tanimoto
National Institute for Environmental Studies, Tsukuba, Japan

Abstract

About 60% of the world's population lives in urban areas, and CO_2 emissions from urban areas reaches about three-quarters of global CO_2 emissions, having high reduction potential. To ensure the effectiveness of emission reductions in urban areas such as megacities, the satellite observation is useful in estimating the emissions around the cities. The aim of this study is to develop a new approach that combines global modeling and satellite observations to better quantify the anthropogenic emissions of CO_2 and NO_x from megacities, in particular, for the GOSAT-GW satellite to be launched in 2023. The estimation method proposed in Janardanan et al. (2016) for CO_2 is applied to multiple gases (CO_2, CO, and NO_2) observed from the GOSAT-2 and TROPOMI. We present preliminary results of the anthropogenic emission from Tokyo area, which is one of the megacities in the world, using the difference in concentrations between the Tokyo area and the surrounding background area. The results will be compared with the outputs of NICAM-based transport model, which has a horizontal resolution of about 110 km and is suitable for studying multiple gases emitted from a large area of megacities.

Early Career Scientist

NO, I am not an early career scientist.

Categories

JNC-6C

Temperature and acidity dependence of secondary organic aerosol formation from α-pinene oxidation: implication for SOA models

Dr. Yange Deng, Dr. Satoshi Inomata, Dr. Kei Sato, Dr. Sathiyamurthi Ramasamy, Dr. Yu Morino, Dr. Shinichi Enami, Dr. Hiroshi Tanimoto
National Institute for Environmental Studies, Tsukuba, Japan

IGAC Regional Working Groups

Japan National Committee

Abstract

Secondary organic aerosols (SOAs) affect human health and climate change prediction; however, the factors (e.g., temperature, acidity of pre-existing particles, and oxidants) influencing their formation are not sufficiently resolved. Using a compact chamber, the temperature and acidity dependence of SOA yields and chemical components of SOA from α-pinene ozonolysis and α-pinene photooxidation under low NOx conditions were systematically investigated under 278–298 K temperatures using neutral ($(NH_4)_2SO_4$) and acidic (H_2SO_4+$(NH_4)_2SO_4$) seed aerosols. SOA components with *m/z* less than 400 were analyzed using negative electrospray ionization liquid-chromatography time-of-flight mass spectrometry. Based on the slightly negative temperature dependence of the SOA yields, the enthalpies of vaporization were estimated to be 25–48 kJ mol^{-1}, which is in agreement with the value of 40 kJ mol^{-1} applied in the CMAQv4.7 model (Carlton et al., EST, 44, 8553-8560, 2010). In addition, SOA yields increased ~10–30 % with the increase in the acidity of seed particles ($[H^+]$ = 220 nmol m^{-3}; solid/near-solid state) at low SOA mass loadings, when compared with the seed particle amounts. The peak abundances of some dimer esters and organosulfates increased with the increase in the acidity of seed particles, while decreases in the peak abundances of some chemical compounds were observed. The former can be tracers indicating the existence of acidic aerosol particles in the ambient atmosphere. To achieve better simulation of monoterpene SOA formation in models like CMAQ, we propose that the time constant (τ) of the conversion of semi-volatile organic compounds (SVOCs) to non-volatile compounds (NVOCs) should be smaller under acidic conditions compared with that under neutral conditions.

Early Career Scientist

YES, I am an early career scientist.

JNC-7A

Modelling the sources of air pollution over the East China Sea

Adedayo R Adedeji[1], Alastair Lewis[1,2], Stephen Andrews[1], Mathew Evans[1,2], Takuya Saito[3]
[1]Wolfson Atmospheric Chemistry Laboratories, University of York, York, United Kingdom. [2]National Centre for Atmospheric Science, Leeds, United Kingdom. [3]National Institute for Environmental Studies, Tsukuba, Japan

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Japan National Committee

Abstract

The island of Hateruma is the southernmost inhabited island of Japan. For a number of years observations of key atmospheric constituents have been measured at the site. We interpret some of these observations with the GEOS-Chem atmospheric chemistry and transport model. We simulated the concentrations of species including C2H6 and C3H8 with a model resolution of 0.5x0.625 degree. The model captured the seasonality of pollution at the site where the concentrations are low during summer and high during winter reflecting the seasonality of air-mass origins. Polluted air from Asia (China, Korea, Japan) is observed in the winter and air from the cleaner central Pacific is observed in the summer. Over the year the model performance is generally good with correlation coefficients (r) of 0.90 and 0.88 respectively.

C2H6 concentrations during winter are underestimated which we attribute to uncertainties in the seasonality of the emissions used in the model. Also, we see weak signals for both Asian boreal and tropical, biomass burning emissions. These interpretations highlight the usefulness of observations made at the site for a number of scientific objectives.

Early Career Scientist

YES, I am an early career scientist.

JNC-8B

First Concurrent Observations of NO2 and CO2 from Power Plant Plumes by Airborne Remote Sensing

Dr Tamaki Fujinawa[1], Dr Akihiko Kuze[2], Dr Hiroshi Suto[2], Dr Kei Shiomi[2], Dr Yugo Kanaya[3], Dr Takahiro Kawashima[4], Dr Fumie Kataoka[4], Mr Shigetaka Mori[5], Dr Henk Eskes[6], Dr Hiroshi Tanimoto[1]
[1]National Institute for Environmental Studies, Tsukuba, Japan. [2]Japan Aerospace Exploration Agency, Tsukuba, Japan. [3]Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan. [4]Remote Sensing Technology Center of Japan, Tsukuba, Japan. [5]JASTECS corporation, Kanagawa, Japan. [6]Royal Netherlands Meteorological Institute, De Bilt, Netherlands

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group, Japan National Committee

Abstract

Combined NO_2 and CO_2 observations have the potential to constrain the identification of the locations and strength of urban CO_2 emissions, in particular, point sources such as power plants. We report the first results of airborne spectroscopic NO_2 and CO_2 observations over an urban area in Japan in February 2018. Inversed emission rates of two stacks of the coal-fired power plant for CO_2 showed relatively good agreement with those estimated by a bottom-up inventory—the Regional Emission inventory in ASia (REAS) v3.1—within 11–67% because the plume shapes were well identified due to constraint by NO_2 measurements. The estimated NO_x emission rates showed discrepancies more than 80% with those estimated by the REAS v3.1, mainly due to the uncertainties in activity data and emission factors, or in the greatly varying NO/NO_2 ratios in fresh plumes, which warrant further investigations when estimating NO_x emissions from satellite NO_2 observations on km-scales.

Early Career Scientist

YES, I am an early career scientist.

JNC-9C

A comparison of the impact of TROPOMI and OMI tropospheric NO_2 on global chemical data assimilation and emission inversion

Takashi Sekiya[1], Kazuyuki Miyazaki[2], Henk Eskes[3], Folkert K Boersma[3,4], Kengo Sudo[5,1], Masayuki Takigawa[1], Yugo Kanaya[1], Koji Ogochi[1]
[1]Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan. [2]Jet Propulsion Laboratory/California Institute for Technology, Pasadena, CA, USA. [3]Royal Netherlands Meteorological Institute (KNMI), De Bilt, Netherlands. [4]Wageningen University, Meteorology and Air Quality Section, Wageningen, Netherlands. [5]Graduate School of Environmental Studies, Nagoya University, Nagoya, Japan

IGAC Activities

GEIA: Global Emissions Initiative, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Japan National Committee

Abstract

Satellite observations of tropospheric NO_2 columns have proven useful for constraining surface NOx emissions and its impact on air quality, atmospheric chemistry, and climate change. The Tropospheric Monitoring Instrument (TROPOMI) provides improved global pictures of global tropospheric NO_2 columns as compared with the Ozone Monitoring Instrument (OMI) through better global coverages and reduced uncertainty of individual pixels. This study demonstrates the advances in global NOx emission estimates using TROPOMI NO_2 retrievals (v1.2) through a systematic comparison against the estimates using OMI NO_2 retrievals (QA4ECV v1.1) for April—May 2018, using global chemical data assimilation (DA) system based on ensemble Kalman filter technique, while applying a super-observation technique for both retrievals at a 0.56° model resolution. The greater global root-mean-square error (RMSE) reductions against the assimilated retrievals in the TROPOMI DA (by 54%) than in the OMI DA (by 38%) are attributed to 16% smaller super-observation errors and 44% larger observation coverages of the TROPOMI retrievals. DA led to improved agreements against independent surface monitoring networks and the AToM-4 aircraft-campaign observations, which were more obvious in the TROPOMI DA (by 12–84%) than in the OMI DA (by 2–70%) for many cases. Global mean of absolute values of emission analysis increments from the TROPOMI DA was 42% larger than that from the OMI DA, which suggested stronger constraints on spatial and temporal variations in NOx emissions by the TROPOMI DA. Meanwhile, estimated global total NOx emissions reflected systematic differences between the two retrievals (15% smaller in the TROPOMI DA) and could also be affected by retrieval updates in the near future. These results demonstrate that the greater potential of TROPOMI over OMI in various DA applications, which would benefit evaluation of bottom-up NOx emission estimates including short-term temporal variations associated with human activity changes and biomass burning.

Early Career Scientist

NO, I am not an early career scientist.

JNC-10A

Aerosol soluble iron production under clean, haze and fog conditions at a coastal site of China

Dr. Jinhui Shi[1], Miss Yang Guan[1], Dr. Akinori Ito[2], Dr. Huiwang Gao[1], Dr. Xiaohong Yao[1], Dr. Alex R. Baker[3], Dr. Daizhou Zhang[4]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Japan National Committee, China Working Group

Abstract

Aerosol soluble iron (Fe) depositing into seawater promotes marine primary productivity, alters global ocean carbon storage and ultimately affects global climate. The current poor understanding of soluble Fe yield in atmospheric aerosols leaves two observational facts having not yet been correctly simulated in numerical models: the high Fe solubility in aerosols with low Fe content and, hence, the wide range of observed Fe solubility. We quantified the contents of total and soluble Fe in aerosol samples collected at the coastal city Qingdao, China. Results showed that aerosol soluble Fe in fog aerosols was produced much more efficiently than in haze and dust aerosols, consequently leading to much higher soluble Fe concentration and Fe solubility in fog aerosols than in non-fog aerosols. The comparison with simulated results of the latest improved IMPACT model indicated that the underestimation of aerosol soluble Fe by the model was mainly caused by the inaccurate simulation under fog conditions. In addition, the model overestimated the soluble Fe concentration in haze and dust aerosols and compensated somewhat the underestimation due to the absence of the fog enhancement in model projections. We propose that fog enhancement is a missing process for the conversion of Fe from insoluble to soluble form in current regional and global models, causing a potentially large underestimation of aerosol soluble Fe in simulation results. In order to reduce the large discrepancy between model simulation and field observation, proper inclusion of fog enhancement of soluble Fe formation in the models is necessary.

Early Career Scientist

NO, I am not an early career scientist.

JNC-11B

Significant Anthropogenic Contribution to Particulate Chloride in Marine Aerosol in the Northern China

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

Chlorine-containing aerosol originated from anthropogenic activities in cities can be transported to oceans, which has important impact on marine atmospheric chemistry. However, current studies on spatial distribution and sources of particulate chloride over China seas are still insufficient. In this study, offline samplers were applied to collect $PM_{2.5}$ and different size fractions, and online single particle aerosol mass spectrometer (SPAMS) was applied to investigate the mixing state of Cl^--containing particles over Bohai Sea, North Yellow Sea and South Yellow Sea during November 2012.

Our preliminary results show that (1) the average concentration of chloride in $PM_{2.5}$ was found the highest in Bohai Sea, which was much lower than that in urban cities in China; (2) the Cl^-/Na^+ ratio in $PM_{1.8}$, $PM_{2.5}$ and PM_{10} exhibited a decreasing trend from north to south, indicating the significant chloride depletion in the southern South Yellow Sea but obvious chloride enrichment in Bohai Sea in the north; (3) chloride enrichment in Bohai Sea was mainly due to biomass burning and coal combustion; (4) based on SPAMS results, the Cl^--containing particle was classified to six types including K-rich, Pb-rich, carbonaceous, heavy metal, dust and sea salt. Our data also showed that Pb-rich and carbonaceous particles were more abundant in Bohai Sea, providing supporting evidence that anthropogenic impacts were higher in northern Chinese seas; (5) the air mass in north of China seas was more polluted due to transport from Jing-Jin-Ji area while the air mass in southern seas was more aged with higher fraction of secondary components. To our best knowledge, this is the first study to report that anthropogenic chloride has significant contribution to marine aerosol, especially in Bohai Sea in the north and identify its main sources as coal combustion and biomass burning.

Early Career Scientist

YES, I am an early career scientist.

JNC-12C

Investigation of the wet removal rate of black carbon in East Asia: validation of a below- and in-cloud wet removal scheme in FLEXible PARTicle (FLEXPART) model v10.4

Dr Yongjoo Choi[1], Dr Yugo Kanaya[1], Dr Masayuki Takigawa[1], Dr Chunmao Zhu[1], Mr Seung-Myung Park[2], Prof Atsushi Matsuki[3], Prof Yasuhiro Sadanaga[4], Prof Sang-Woo Kim[5], Dr Xiaole Pan[6], Dr Ignacio Pisso[7]
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Japan National Committee

Abstract

We accessed the wet removal rate of BC in East Asia based on long-term measurements over the 2010–2016 period at Baengnyeong and Gosan in South Korea and Noto in Japan. The average wet removal rate, represented by transport efficiency (TE; the fraction of undeposited BC particles during transport) was estimated to be 0.73. According to the relationship between accumulated precipitation along trajectory and TE, the wet removal efficiency was lower in East and North China but higher in South Korea and Japan, implying the importance of the aging process and frequency of exposure to below- and in-cloud scavenging conditions during air mass transport. The average half-life and e-folding lifetime of BC were 2.8 and 7.1 d, respectively. Next, by comparing TE from the FLEXPART version 10.4, we diagnosed the scavenging coefficients (s−1) of the below- and in-cloud scavenging scheme implemented in FLEXPART. The overall median TE from FLEXPART (0.91) was overestimated compared to the measured value, implying the underestimation of wet scavenging coefficients in the model simulation. The median of the measured below-cloud scavenging coefficient showed a lower value than that calculated according to FLEXPART scheme by a factor of 1.7. On the other hand, the overall median of the calculated in-cloud scavenging coefficients from the FLEXPART scheme was highly underestimated by 1 order of magnitude, compared to the measured value. From an analysis of artificial neural networks, the convective available potential energy, which is well known as an indicator of vertical instability, should be considered in the in-cloud scavenging process to improve the representative regional difference in BC wet scavenging over East Asia. For the first time, this study suggests an effective and straightforward evaluation method for wet scavenging schemes (both below and in cloud), by introducing TE along with excluding effects from the inaccurate emission inventories.

Early Career Scientist

NO, I am not an early career scientist.

JNC-13A

Changes in tropospheric nitrogen dioxide vertical column densities over Japan and Korea during the COVID-19 using Pandora and MAX-DOAS

Dr Yongjoo Choi[1], Dr Yugo Kanaya[1], Dr Hisahiro Takashima[1,2], Prof. Kihong Park[3], Mr Haebum Lee[3], Dr Jihyo Chong[3,4], Prof Jae Hwan Kim[5]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Japan National Committee

Abstract

We investigated the impact of COVID-19 on the tropospheric nitrogen dioxide vertical column density (NO_2 TropVCD) at two sites in Korea (Gwangju and Busan) and two sites in Japan (Yokosuka and Cape Hedo) from MAX-DOAS and Pandora. Compared to monthly mean NO_2 TropVCD that from 2015 to 2018 and in 2019, that in 2020 was lower due to social distancing in Korea and Japan and lockdown in China. High negative relative changes were observed from May to September at the three urban sites; Cape Hedo, a remote site, did not show a significant difference in relative changes between previous years and 2020, suggesting that only anthropogenic emission sources dramatically decreased. In the case of Yokosuka, the 15-day moving average of the NO_2 TropVCD exhibited a good relationship with transportation (R=0.48) and industry (R=0.54) mobility data. In contrast, the NO_2 TropVCD at Korean sites showed a moderate to low correlation with the industrial sector (R=0.39 for Busan and R=0.19 for Gwangju) and insignificant correlations with transportation. The differences in correlations might be caused by the different social distancing policies in Korea (voluntary) and Japan (mandatory). By applying generalized boosted models to exclude meteorological and seasonal effects associated with the variation in NO_2 TropVCD, we revealed that the decreasing trend from 2019 to 2020 was much steeper than that from 2015 to 2020, and a significant change identified in January 2020, when the first cases of COVID-19 were observed in both Korea and Japan. This result confirmed that the reduction in NO_2 can be largely explained by the NOx emission reduction resulting from social distancing for COVID-19 rather than annual meteorological differences; however, in the cold season, NO_2 suddenly recovered to its previous level due to an increase in human activities.

Early Career Scientist

NO, I am not an early career scientist.

JNC-14B

Observing anthropogenic emissions of greenhouse gases and air pollutants with the GOSAT-GW satellite: Scientific targets and policy contributions

Hiroshi Tanimoto[1], Tsuneo Matsunaga[1], Nobuko Saigusa[1], Takafumi Sugita[1], Hisashi Yashiro[1], Isamu Morino[1], Makoto Saito[1], Hirofumi Ohyama[1], Satoshi Inomata[1], Kohei Ikeda[1], Yu Someya[1], Tamaki Fujinawa[1], Yousuke Yamashita[1], Tazu Saeki[1], Yugo Kanaya[2], Takashi Sekiya[2], Prabir Patra[2], Masayuki Takigawa[2], Yasko Kasai[3], Tomohiro Sato[3]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Japan National Committee, MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Emissions inventories are one of key research elements in Atmospheric Chemistry. The bottom-up inventories provide, for example, accurate estimates of greenhouse gases (GHG) emissions from fossil fuel use, but can have large uncertainties in other sectors and are restricted to managed lands. Inventories can also be derived by the top-down approach using atmospheric inverse models, complementing the bottom-up methods by providing an integrated constraint on surface fluxes from all sectors/processes on spatial scales. For these models a variety of observations are used, including those from ground-based, ship, aircraft and satellite platforms. In particular, recent improvements in the capability of satellite observations of atmospheric composition are driving great advances in the modeling. There are several plans to launch additional GHG and air quality (AQ) observing satellites in near future. In Japan there is a plan in progress to launch the third satellite in the GOSAT series, named “Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW)”, that will make observations of CO_2, CH_4, and NO_2 at a horizontal resolution of 3 km or less. The missions of GOSAT-GW include (1) monitoring of whole atmosphere-mean concentrations of GHGs, (2) validation of nationwide anthropogenic emissions of GHGs, and (3) detection of GHGs emissions from large sources, such as megacities and power plants. We will provide an overview of the project, including its objectives, current status, and scientific targets with a focus on synergetic benefits of the combined GHG-AQ observations. We will also discuss the approach to support the Global Stocktake (GST) mechanism, a key element in the Paris Agreement.

Early Career Scientist

NO, I am not an early career scientist.

JNC-15C

Model analysis of the atmospheric aerosol concentrations and depositions by ship-onboard observations over the Eastern Indian Ocean

Dr Kazuyo Yamaji[1,2], Mr Katsuhiro Kawamoto[1,2,3], Ms Moe Tauchi[1,2], Dr Yoko Iwamoto[4], Dr Fumikazu Taketani[2], Dr Masayuki Takigawa[2], Dr Prabir K. Patra[2], Dr Kazuhiko Matsumoto[2], Dr Makio Honda[2], Dr Yugo Kanaya[2], Dr Takashi Sekiya[2], Dr Maki Noguchi Aita[2], Dr Tomoki Nakayama[5], Dr Satoru Chatani[6], Professor Yutaka Matsumi[7], Professor Surendra K. Dhaka[8], Dr Mizuo Kajino[9], Professor Sachiko Hayashida[10,11]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Japan National Committee

Abstract

The remarkable increase in air pollution over the megacities of South Asia has caused major attention from all over the world. During the dry season, from October to February, the pollution level tends to be worse over the megacities and surroundings in India due to enhanced anthropogenic emissions such as agricultural burning and atmospheric stagnations characterized by meteorological conditions. Meanwhile, the northeast dry monsoon in that season further would raise concerns that the continental airmass transport might affect the marine atmosphere and marine ecosystem in the Bay of Bengal. Ship-onboard observations during the KH-18-6 cruise by the research vessel (R/V) Hakuho Maru performed over the Bay of Bengal and the Southeast Indian Ocean in the early dry season (November, 2018) captured outflow effect of the heavily polluted continental airmass. The gases, aerosols and rainwater samples also showed the signature of continental nitrogen outflow and subsequent deposition into the Ocean (Iwamoto et al, 2019, 2020).

We have investigated the sources and controlling factors of the observed high concentrations of gas and aerosol species, and mechanisms of their deposition by using a regional chemical transport model, WRF/CMAQ. Our model simulation captured well general features of the variabilities in the observed gas and aerosol concentrations over the Bay of Bengal. The changing in the concentrations of these pollutants, during the passing of the Cyclone Gaja (November 10-16, 2018), were simulated well by the model, excepting a few individual chemical species. Relatively high concentrations at around 5 degrees north latitude in the both observed and simulated concentrations are shown to be associated with transports from Southern India and the Middle East ship route.

Early Career Scientist

NO, I am not an early career scientist.

JNC-16A

Investigation of adhesivity of marine organic aerosols by atomic force microscopy

Mr. Kohei Ono[1,2], Dr. Ayumi Iwata[3], Dr. Takeshi Fukuma[4], Dr. Yoko Iwamoto[5], Dr. Koji Hamasaki[6], Dr. Atsushi Matsuki[7]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Japan National Committee

Abstract

The adhesion force is the force by which aerosol particles continue to remain in contact with the deposition surface. The adhesion behavior of ambient aerosol particles is largely controlled by this force but has not earned enough attention. Aerosol particles can trigger various environmental issues even after their deposition on the surface. For example, sea spray aerosols (SSA) can deposit on the surfaces and cause corrosion of infrastructures such as electricity transmission tower and cables especially in coastal areas. However, to what extent the organic coatings found within individual SSA affect their adhesion behavior is not well understood. The aim of this study was to evaluate the adhesion forces of simulated SSA on an individual particle basis using atomic force microscopy (force-distance curve mapping method). In order to simulate an organic enriched SSA, aerosols were generated using a bulk sea foam sample collected at Noto Peninsula during the Sea Surface Microlayer-Aerosol Project (SSMAP). The adhesion force of sea foam particles was compared with that of standard monosaccharide (glucose and fucose), artificial sea salt (ASS), as well as ambient sea salt (SS) particles. Mono saccharide particles showed significantly larger adhesion forces than ASS and SS. In addition, it was found that a few of sea foam particles and ambient SS particles showed similar adhesion forces and morphological features as the pure mono saccharides, suggesting that organic (e.g. mono saccharides) enriched SSA can be significantly more adhesive than the inorganic salts. Therefore, in the case of evaluating adhesive property of SSA, it is necessary to consider the presence of organics such as saccharides.

Early Career Scientist

YES, I am an early career scientist.

JNC-17B

Chemical characteristics of humic-like substance (HULIS) organic aerosol in a cool-temperate forest area of Japan

Sonia Afsana[1], Ruichen Zhou[1], Yuzo Miyazaki[2], Eri Tachibana[2], Dhananjay Kumar Deshmukh[3], Kimitaka Kawamura[3], Michihiro Mochida[1,4]
[1]Graduate School of Environmental Studies, Nagoya University, Nagoya, Japan. [2]Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan. [3]Chubu Institute for Advanced Studies, Chubu University, Kasugai, Japan. [4]Institute of Space and Earth Environment, Nagoya University, Nagoya, Japan

IGAC Regional Working Groups

Japan National Committee

Abstract

Organic aerosol (OA) is a major component of atmospheric aerosol and humic-like substance (HULIS) is considered to be one of the key components of OA. HULIS remain poorly understood despite of their ubiquity and light-absorbing capability. The chemical composition of HULIS is important to understand their contribution to aerosol properties. In this study, the chemical structural characteristics of HULIS and other solvent extractable organic matter in submicron aerosol particles, collected in a cool-temperate forest of Japan, were investigated using mass spectrometry. Aerosol samples were collected on quartz filters (cut-off diameter: 0.95 micrometer) throughout a year in Tomakomai Experimental Forest. HULIS and other OA components in the samples were extracted and fractionated on the basis of their polarity. Water-soluble organic matter (WSOM) and water-insoluble organic matter (WISOM) were extracted sequentially by using multiple solvents. HULIS and highly-polar water-soluble organic matter (HP-WSOM) were fractionated by solid phase extraction from WSOM. A High-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) was used to quantify the mass of organics and their ion groups and elemental analyses. The mass concentrations of the extracted organic matter (EOM = HP-WSOM + HULIS + WISOM) for all samples were 1.58 ± 0.45 μgm^{-3} (mean ± SD) and HULIS was the most abundant fraction (mean: 51%), followed by WISOM (mean: 28%) and HP-WSOM (mean: 21%). The average mass concentrations of HULIS in summer were on average ~2 times higher than those in winter. The O/C ratios of HULIS fractions were 0.80 ± 0.06 (mean ± SD) while the lowest were observed for WISOM fractions (mean ± SD: 0.24 ± 0.05). The HR-AMS mass spectra show that HULIS and HP-WSOM fractions had relatively high proportions of oxygenated hydrocarbon fragments (mean: 38% & 40% of $C_xH_yO_1$; 21% & 28% of $C_xH_yO_{>1}$, respectively) and that WISOM consisted mainly of the C_xH_y fragment, which accounted for 76% (mean) of the organics.

Early Career Scientist

YES, I am an early career scientist.

MANGO-1A

Indoor Air Quality Indicators and Toxicity Potential at the Hospitals' Environment in Dhaka, Bangladesh

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[1]University of Dhaka, Dhaka, Bangladesh. [2]Enam Medical College and Hospital, Dhaka, Bangladesh

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Indoor air quality (IAQ) is a leading apprehension currently especially in the perilous atmosphere, like hospitals. Clean and fresh air is very crucial for the patients and healthcare professionals in the hospitals. Therefore, we examined IAQ indicators ($PM_{1.0}$, $PM_{2.5}$, PM_{10}, NO_2, CO_2, and TVOC) at sixteen locations of three hospitals with an emphasis on seasonal variations, indoor/outdoor correlation, and concomitant toxicity potential (TP) of human exposure between October 2019 and January 2020. For the measurement of trace gases (NO_2, CO_2, and TVOC) Aeroqual 500 series (New Zealand) sampler was used, Particulate matter ($PM_{1.0}$, $PM_{2.5}$, and PM_{10}) concentrations and relative humidity (RH) were measured using the IGERESS Air quality monitoring device (WP6930S, China). The total average concentration of IAQ indicators were 104.1±67.6 ($PM_{1.0}$), 137.4±89.2 ($PM_{2.5}$), 159.0±103.3 (PM_{10}) μgm^{-3}; 0.11±0.02 (NO_2), 1047.1±234.2 (CO_2), 176.5±117.7 (TVOC) ppm. Significant variations of IAQ indicators were observed between different locations of the hospitals. Winter IAQ indicators were much higher than post-monsoon season. Indoor particulate matter (PM) levels were lower than outdoor, but gaseous pollutants were higher in indoor than outdoor except NO_2. Indoor TVOC was about two times higher than outdoor and also higher in post-monsoon than winter. A good positive correlation was observed between indoor and outdoor particulate matter during winter. A strong positive correlation was obtained between NO_2 and RH with PM in winter. Very high (>10) indoor toxicity potential (TP) values of $PM_{2.5}$ and PM_{10} were determined during winter. Extremely high TP values indicated potential severe health consequences of the healthcare professionals and patients in indoor hospitals environment.

Early Career Scientist

YES, I am an early career scientist.

MANGO-2B

Indoor Exposure of Particulate Matter and Association of $PM_{2.5}$ with Lung Function and Oxygen Saturation Level of the Residents in Dhaka, Bangladesh

Samiha Nahian[1], Farah Jeba[1], Tasrina Rabia Choudhury[2], Bilkis Ara Begum[2], Abdus Salam[1]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Real time concentration of indoor particulate matters ($PM_{1.0}$, $PM_{2.5}$ and PM_{10}) were measured at residential homes of six locations (Bashundhara, Cantonment, Chankharpul, Dhanmondi, Mirpur and Uttara) in Dhaka, Bangladesh between January and February, 2020. Indoor $PM_{2.5}$ samples were collected on quartz filters for 24 hours to quantify six metals (Fe, Cu, Pb, Zn, Cr, Mn). The average real time concentration of $PM_{1.0}$, $PM_{2.5}$ and PM_{10} for six sampling sites were 103.2 ± 58.1 μgm^{-3}, 136.4 ± 76.5 μgm^{-3} and 157.7 ± 88.4 μgm^{-3}, respectively. The nighttime concentration of $PM_{1.0}$, $PM_{2.5}$ and PM_{10} were 1.57 times higher than their corresponding daytime concentration. For Cantonment site, particulate matter concentration during haze was 1.68 times higher than that during usual weather. Mean I/O ratio (0.93) and positive correlation (R^2=0.85) between indoor and outdoor PM concentration confirmed significant impact of infiltration of outdoor air on indoor air quality. The 24-hour average $PM_{2.5}$ concentration for Dhanmondi, Mirpur, Cantonment, Chankharpul, Uttara and Bashundhara were 123.4 ± 39.3 μgm^{-3}, 123.3 ± 14.5 μgm^{-3}, 96.3 ± 14.5 μgm^{-3}, 96.3 ± 11.1 μgm^{-3}, 84.8 ± 5.4 μgm^{-3} and 77.1 ± 5.5 μgm^{-3}, respectively. Enrichment factor analysis revealed that, Pb and Zn had high enrichment, Cr and Cu had moderate enrichment and Mn was non-enriched. Moreover, Mn originated from crustal sources while other metals had non-crustal origin. The average peak flow rate and blood oxygen saturation of thirty inhabitants in six sampling locations were 360 L/min and 99%, respectively. Negative correlation (R^2 = 0.89) between peak flow rate and $PM_{2.5}$ concentration suggested that inhalation of elevated level of $PM_{2.5}$ is probably responsible for reduced lung efficiency. However, $PM_{2.5}$ concentration had no effect on the normal percentage of blood oxygen saturation. The average hazard ratio for indoor $PM_{2.5}$ was 4.23 and positive correlation (R^2 =1) between indoor $PM_{2.5}$ and hazard ratio indicated highly degraded indoor air quality across Dhaka, Bangladesh.

Early Career Scientist

YES, I am an early career scientist.

MANGO-3C

Fine particulate matter concentrations during 2020-2021 Lunar New Year holidays and the COVID-19 pandemic in Ho Chi Minh City, Vietnam

PhD student Cong-Thanh Tran[1,2], BSc. Anh-Ngan Tran[2], MPH Tzong-Gang Wu[1], Prof., PhD Chang-Fu Wu[1], Assoc. Prof., PhD Thi-Hien To[2], Prof., PhD Kuo-Liong Chien[1]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The Lunar New Year holidays period is usually an occasion that may observe significant downward trends of fine particulate matter ($PM_{2.5}$) concentrations in Ho Chi Minh City (HCMC), which is one of the most air-polluted cities in Vietnam. Furthermore, the coronavirus disease (COVID-19) pandemic that broke out during the 2020 Lunar New Year also may lead to abnormal variations of $PM_{2.5}$ concentrations in HCMC for this period. This study aimed to investigate the abnormal temporal variations of $PM_{2.5}$ concentrations in HCMC during these two special occasions by using low-cost particulate matter sensors. The ambient $PM_{2.5}$ concentrations were measured by the PurpleAir II-SD sensors and calibrated with the DustTrak II Aerosol Monitor 8530 Desktop. The $PM_{2.5}$ concentrations in the period after the Lunar New Year and in the period of the COVID-19 pandemic suddenly decreased compared to the concentrations in the previous period of the Lunar New Year, with the approximate decrements of 40%. During the study period, there were a peak of $PM_{2.5}$ concentrations in the morning rush hours (6-9 a.m.) and a low in the middle of the week. Our findings indicate that the massive decline in $PM_{2.5}$ concentrations during two special occasions may be considered as true background concentrations of $PM_{2.5}$ for future reference in HCMC, where concentrations frequently exceed the daily standard of Vietnam all year round. Moreover, using low-cost sensors might be a potential solution for HCMC to control disease risk contributed by $PM_{2.5}$.

Early Career Scientist

YES, I am an early career scientist.

MANGO-4A

Evolution of urban aerosols in warm and humid environment: Number concentrations & specific density

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group, China Working Group

Abstract

Effective density and number concentrations are important properties indicating physical and chemical aging processes of ambient aerosols and associated impacts. This study investigates how atmospheric mechanisms render unique features in the diurnal-nocturnal effective density (n>10000) and particle number size distribution (PNSD, n>20000) measured in a humid tropical urban environment (Singapore) during June–October 2019. Results of this study demonstrate the impacts of airborne water content, gaseous components, photooxidation and anthropogenic emissions on urban aerosols. Effects of formation and evolution (particle growth through condensation and agglomeration) on temporal characteristics of urban aerosols are also delineated. The first nucleation occurred together with >300 μg/m^3 increase in absolute humidity during 05:00–07:00. This was accompanied with 10–20% higher biogenic and anthropogenic VOCs (e.g., isoprene and benzene) and 16% more elemental carbon (EC) in $PM_{2.5}$. The increased emissions in primary aerosols could enlarge available surface for condensation, growing particles to 200 nm. From 09:00–12:00, since EC concentration remained similar with few particles <20 nm, particles could evolve mainly through gas-phase photooxidation and condensation, evidenced by substantial increase in SO_2 (~40%), sulfates (>35%) and tripled O_3 concentration under the strongest solar irradiation. Concurrent with more OC in $PM_{2.5}$, this also increased the effective density of 200-nm aerosols the most (by 35%) among all measured sizes, suggesting condensation-yielded particle growth. In addition to condensation, agglomeration of particles <30 nm could enhance the number concentrations of 50, 75 and 200 nm particles by factors of 1.2–3. Starting from 19:00–22:00, absolute humidity increased by >190 μg/m^3, cooccurring with an evening nucleation event. Opposite to higher amounts of anthropogenic VOCs (by 30–80%) and number concentrations, the effective density of measured aerosols decreased significantly, concluding the daily aerosol evolution in a warm humid urban environment.

Early Career Scientist

YES, I am an early career scientist.

MANGO-5B

Particulate Matter Pollution over North Western India using integrated modeling approach: Case Study of Pre-monsoon Event

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The impacts of a typical dust storm event during pre-monsoon season (April–June 2010) on regional air quality over northwestern India are analyzed. During the study period, Delhi and parts of Rajasthan (i.e. Jodhpur, Jaipur), daily averaged Particulate matter concentration (PM_{10}) were more than 300 $\mu g/m^3$, as seen from the Central Pollution control board observations. For this purpose, NASA Moderate Resolution Imaging Spectroradiometer (MODIS) and Aerosol Robotic Network (AERONET) observations are extensively used. During this pre-monsoon period, Northwest India has experienced consecutive dust storms. This effect can be seen in situ measurements (AERONET) as well as satellite observations of MODIS aerosol optical depth (AOD). To study in more detail WRF-Chem model was simulated to reproduce the transport of dust plumes with respect to time and space. The results were compared with in-situ and satellite data. Model results show that dust particles hinder the path of sunlight coming to surface so, in turn, cool the surface and the top of the atmosphere. This can be concluded from MODIS AOD images showing high AOD over parts of Rajasthan and Delhi as well as weather data. The results show that WRF-Chem output of PM_{10} and AOD is generally underestimated. So, model output is merged with satellite retrieved AOD for scaling purpose to better estimate the particulate pollution during the study period. Estimated PM_{10} was found close to hourly observations of the Delhi monitoring station. It has also successfully captured the trend and correlation (Correlation or R=0.83) during the satellite overpass time. Other stations like Jaipur, Jodhpur, Kota, and Delhi when compared daily also successfully captured the trend and had a better correlation of 0.81, 0.70, 0.77 and 0.78 respectively. So, this method can be used as to estimate particulate matter pollution in other parts of the world.

Keywords: MODIS, WRF-Chem, AOD, Particulate Matter, PM_{10}, AERONET

Early Career Scientist

YES, I am an early career scientist.

MANGO-6C

Investigating the performance of WRF-Chem in simulating the Indian Summer Monsoon and associated chemistry-feedback processes

Sreyashi Debnath[1,2], Dr. Chinmay Jena[3], Dr. Gaurav Govardhan[1], Dr. Rajesh Kumar[4], Dr. Mary Barth[4], Dr. Gabriele Pfister[4], Dr. Sachin Ghude[1]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The atmospheric chemical processes and their feedback on the meteorology in context of the Indian Summer Monsoon Rainfall (ISMR) demands much detailed exploration. Therefore, in the present study, an attempt has been made to investigate the performance of Weather Research and Forecasting Model coupled with advanced chemistry (WRF-Chem) in simulating the ISMR. Simulations for the Indian Monsoon season with detailed gas-phase chemistry and aerosol processes have been conducted over the Indian Subcontinent. In order to investigate the impact of chemistry and its feedback on the model's meteorology in simulating the ISMR, the model simulations has been carried out in two modes i.e. with and without the chemistry. It is noted from the simulations that though the models (in both modes) could simulate the mean rainfall over the entire Indian subcontinent reasonably well when compared to observations, they exhibit bias over various sub-regions with varying differences over the continental and oceanic regimes. The differences in the regional rainfall may be attributed to the local anthropogenic activities, changes in the land use land cover of those regions, long-range transport of aerosols and chemical compounds, etc. However, it is worth mentioning that inclusion of chemistry has resulted in the reduction of bias in the mean simulated rainfall over the entire sub-continent leading to the fact that chemistry does interact with the meteorology resulting in the changes in the simulated rainfall. The variations of different meteorological parameters and chemical species have also been investigated to have more detailed understanding about the interactive mechanisms that are important for the realistic simulation of the ISMR. It has been also observed from the simulations that changes in the dust concentration modulates the ISMR to a considerable extent.

Early Career Scientist

YES, I am an early career scientist.

MANGO-7A

A model- and observation-based approach to quantify trends and uncertainty of premature mortality due to $PM_{2.5}$ in China

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[2]National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Rome, Italy

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Assessing recent trends of premature mortality burden due to air pollution with chemical transport models (CTM) can be highly informative for policymakers but poses several challenges. In addition to large computational power, multi-year CTM simulations typically require annual up-to-date emission inventories which are often not available for continuous years as well as released belatedly.

Here, we present a novel methodology which combines model simulations and observed data of fine particulate matter ($PM_{2.5}$) to address the challenges outlined above and to accurately quantify the uncertainty of premature mortality estimates. We exemplify the methodology for the case of China, where recent studies have shown that air quality has improved over the last few years (2015-2018), but the impact in terms of avoided mortality has not been properly quantified. Our analysis is based on a one year-long WRF-Chem simulation at high-resolution (8km) for 2015 and observed hourly data from 1617 monitoring stations for the whole period of 2015-2018. The proposed statistical methodology nudges the model results towards the observed data, thus allowing for (i) a more accurate representation of $PM_{2.5}$ fields compared to model results only and (ii) the assessment of 2015-2018 premature mortality trend using only one year of computationally-expensive WRF-Chem simulation. Being a statistical methodology, uncertainty in the $PM_{2.5}$ fields can also be calculated accordingly, overcoming the limitations of deterministic CTM output in uncertainty quantification.

Key results show that confidence intervals in premature mortality estimates are considerably wider than previously reported, when propagating also $PM_{2.5}$ uncertainty via a Monte Carlo technique. Although the overall mortality burden remains vast in China (~1.6 million premature deaths), our results suggest that 200,000 premature deaths were avoided and 195 billion US dollars were saved in 2018 compared to 2015, bolstering the mounting evidence about the effectiveness of China's air quality policies.

Early Career Scientist

YES, I am an early career scientist.

MANGO-8B

Assessment of statistical models to improve performance of low-cost optical aerosol sensors in a warm and humid urban environment

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IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Low-cost (LC) optical sensors offer an economical approach for monitoring mass concentrations of airborne particulates with rapid time resolution. They can also offer in situ air quality data accessible to a wide range of users, bringing substantial advantages and applications to scientific communities and the public if the accuracy of sensor data can be enhanced and verified. In highly humid environment such as tropical regions, water uptake by hygroscopic particles can change the aerosol optical properties, compromising transmission of light signals in LC sensors and lowering the accuracy of sensor measurements. To enhance the usefulness of sensor data, this works constructs a statistical model to calibrate LC sensors by comparing co-located $PM_{2.5}$ measurements from optical-based LC sensors and Beta Attenuation Monitor (BAM) in a tropical urban environment. Under relative humidity (RH) ranging from 40% – 80%, the difference between LC sensor data and BAM $PM_{2.5}$ concentrations monotonically decreases as a function of increasing RH. At higher water content, the difference does not further decrease, exhibiting a non-linear response to RH over the range of RH studied. This indicates that for RH > 80%, the increase of water content no longer affects aerosol optical properties perceived by LC sensors. To account for non-linear behavior present in the data, LC sensor calibration model is constructed from a machine-learning-based method, support vector regression (SVR), predicting $PM_{2.5}$ concentrations from LC sensor readings and RH. SVR ability to handle data with non-linear nature, uncommon in conventional calibration models like multiple linear regression (MLR), enables us to estimate $PM_{2.5}$ levels more accurately, yielding mean absolute errors less than MLR by almost 15%. This implies that using non-linear prediction model is preferred to enhance the accuracy of LC sensor data, improving sensors applicability in real-time monitoring in changeable environments.

Early Career Scientist

YES, I am an early career scientist.

MANGO-9C

Effect of relative humidity on SOA formation from aromatic hydrocarbons: Implications from the evolution of gas- and particle-phase species

Dr. Tianzeng Chen
State Key Joint Laboratory of Environment Simulation and Pollution Control, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing, China

IGAC Regional Working Groups

China Working Group

Abstract

Relative humidity (RH) plays a significant role in secondary organic aerosol (SOA) formation, but the mechanisms remain uncertain. Using a 30 m^3 indoor smog chamber, the influences of RH on SOA formation from two conventional anthropogenic aromatics (toluene and *m*-xylene) were investigated from the perspective of both the gas- and particle- phases based on the analysis of multi-generation gas-phase products and the chemical composition of SOA, which clearly distinguishes from many previous works mainly focused on the particle-phase. Compared to experiments with RH of 2.0%, SOA yields increased by 11.1%–133.4% and 4.0%–64.5% with higher RH (30.0%–90.0%) for toluene and *m*-xylene, respectively. The maximum SOA concentration always appeared at 50.0% RH, which is consistent with the change trend of SOA concentration with RH in the summertime field observation. The most plausible reason is that the highest gas-phase OH concentration was observed at 50.0% RH, when the increases in gas-phase OH formation and OH uptake to aerosols and chamber walls with increasing RH reached a balance. The maximum OH concentration was accompanied by a notable decay of second-generation products and formation of third-generation products at 50.0% RH. With further increasing RH, more second-generation products with insufficient oxidation degree will be partitioned into the aerosol phase, and the aqueous-phase oxidation process will also be promoted due to the enhanced uptake of OH. These processes concurrently caused the O/C and oxidation state of carbon (OSc) to first increase and then slightly decrease. This work revealed the complex influence of RH on SOA formation from aromatic VOCs through affecting the OH concentration, partitioning of advanced gas-phase oxidation products as well as aqueous-phase oxidation processes. Quantitative studies to elucidate the role of RH in the partitioning of oxidation products should be conducted to further clarify the mechanism of the influence of RH on SOA formation.

Early Career Scientist

YES, I am an early career scientist.

MANGO-10A

Fungal spores as emission sources of 137Cs to ambient aerosols after a nuclear accident in Fukushima 2011

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Abstract

A nuclear accident occurred in March 2011 at Fukushima. Even after 7 years of the accident, ^{137}Cs levels are high in ambient aerosols from some areas of Fukushima. We presume that biological processes emit radionuclides deposited over soil to the atmosphere. Fungi can uptake various metal ions including potassium and ^{137}Cs from soil using the soil network system. To prove the hypothesis, we collected aerosol samples (day/night, n=40) from Namie-cho in Fukushima in August/October 2017. ^{137}Cs concentrations were measured using a Ge-semiconductor detector. Filter samples were extracted with dichloromethane/methanol mixture. After the concentration, the extracts were reacted with BSTFA to derive TMS derivatives of sugar compounds and then measured using GC/MS. High levels of fungal tracers (arabitol, mannitol and trehalose) were detected. Interestingly, nighttime samples showed a positive correlation between trehalose and ^{137}Cs. The results were discussed in terms of soil-to-air re-suspension of ^{137}Cs via biological and meteorological soil/air interaction.

Early Career Scientist

NO, I am not an early career scientist.

MANGO-11B

Personal $PM_{2.5}$ exposures of solid fuel users in rural China: *in vitro* toxicity and chemical composition

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IGAC Regional Working Groups

China Working Group

Abstract

Household air pollution, resulting from inefficient combustion of solid fuels for domestic cooking and heating, is a major environmental health risk factor worldwide. Understanding the underlying biological mechanisms and developing effective mitigation strategies require accurate exposure assessment, which is challenging in settings with complex mixtures of indoor and outdoor sources. Representative samples of fine particulate matter ($PM_{2.5}$) exposures can be collected using personal monitors, but these samples have rarely been employed in toxicological research investigating biological mechanisms.

We investigated the chemical composition and *in vitro* biological effects of personal $PM_{2.5}$ exposure samples from women in villages in three Chinese provinces (Beijing, Shanxi, and Sichuan) during summer and winter. Chemical characterization of water and organic $PM_{2.5}$ extracts included measurement of water-soluble organic carbon, ions, elements, and organic tracers such as levoglucosan and polycyclic aromatic hydrocarbons (PAHs). Human lung epithelial cells (A549) were exposed to the extracts. Following exposures, cell viability, reactive oxygen species (ROS) generation, and gene expression were measured.

PAH concentrations were higher in winter than in summer at the Shanxi and Beijing sites, but similar between seasons at the Sichuan site. Several biological endpoints followed a similar trend: cell death, ROS, and expression of pro-inflammatory cytokines (IL-6 and IL-8) were highest in winter in Beijing and Shanxi, but did not differ seasonally in Sichuan. Modulation of genes related to xenobiotic metabolism (cyp1a1, cyp1b1) and oxidative stress (HO-1, SOD1, SOD2, NQO-1, Catalase) was low or insignificant and did not exhibit clear differences between samples. Exposure to water extracts did not result in significant cell death or ROS, even at higher concentrations tested, among all sites and seasons. These results suggest that organic components, particularly PAHs, may play key roles in inflammation and other biological effects of $PM_{2.5}$ exposures, which is consistent with some other evidence from ambient $PM_{2.5}$.

Early Career Scientist

YES, I am an early career scientist.

MANGO-12C

Multi-drugs Resistant Bacteria Associated Particulate Matter in the Ambient Air over Dhaka, Bangladesh

Razia Sultana Ankhy[1], Shamma Jabeen Proma[2], Nazmul Ahsan[2], Farah Jeba[2], Md. Safiqul Islam[2], Abdus Abdus Salam1[2]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CATCH: the Cryosphere and Atmospheric Chemistry, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Americas Working Group, MANGO: Monsoon Asia and Oceania Networking Group, Southern Hemisphere Working Group, China Working Group, Japan National Committee

Abstract

Multi-drugs Resistant Bacteria Associated Particulate Matter in the Ambient Air over Dhaka, Bangladesh

Razia Sultana Ankhy[1], Shamma Jabeen Proma[1], Nazmul Ahsan[2], Farah Jeba[1], Md. Safiqul Islam[1] and Abdus Salam[1*]

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Abstract. Breathing the polluted air associated with multidrug-resistant bacteria drawing attention nowadays. The research aims to identify the bacteria associated suspended particulate matter of both indoor and outdoor air and characterize their antibiotic susceptibility pattern. The number of airborne bacteria was determined by culturing the sample in Nutrient Agar (NA) media at temperatures of 25 °C and 37 °C. The concentration of bacteria was 622±22 $CFUm^{-3}$ at 26.0 ± 2.0 °C and 11.0 ± 2.0 $CFUm^{-3}$ at 20.0 ± 2.0 °C in both outdoor and indoor air, respectively. Positive *Bacillus, Micrococcus luteus, Pseudomonas stutzeri, Brevundimonas diminuta* bacteria were identified. All the identified bacteria were found to be pathogenic. Moreover, some of the identified bacteria showed resistance to some commercially available antibiotics such as Cefixime, Ceftazimidine, Nalidixic acid, Ampicillin, Ciprofloxacin, and Gentamycin. The positive correlation between fine particles and the bacteria concentration (R^2 = 0.75 for indoor and R^2 = 0.68 for outdoor) revealed that the bacteria were highly associated with fine particulate matter.

Furthermore, meteorological parameters (temperature and relative humidity) affect the number and the growth of the bacteria. The rise in relative humidity favours the increase in bacterial concentration. Therefore, the risk of being affected by bio-aerosol is higher in the wet season than that of the dry season.

Keywords: Bioaerosol, airborne bacteria, particulate matter, fine particles, meteorological parameters

Early Career Scientist

YES, I am an early career scientist.

MANGO-13A

A ship-borne field campaign on ozone and precursors in Hong Kong waters

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

China Working Group

Abstract

Photochemical smog has long been the major air pollution issue in the Hong Kong and Greater Bay Area. To have a better understanding of the composition and distribution of ozone precursors above the sea, where no direct measurement data was available, several ship-borne measurement campaigns was conducted in Hong Kong waters in November 2020. A series of instruments were deployed on the ship to measure the trace gases, particles, and volatile organic compounds (VOCs). As guided by the weather and air quality forecasting, the ship-borne campaign successfully captured the spatial distribution and temporal variation of ozone and its precursors in the marine boundary layer over Hong Kong water for the first time. During the campaign, a high ozone episode (with concentration up to 132 ppb) was observed in the estuary of Pearl river in west of Hong Kong. Compared with Air Quality Monitor Station in Tung Chung, the O_3 concentrations at open sea were higher than the contemporaneous ground level at noontime. The transport pattern of ozone and its precursors was better characterized with the concurrent measurement over the sea and ground stations. This study provides a first insight into spatial distribution of O_3 and its precursors in Hong Kong waters, and the results will be helpful to better understand the formation mechanism of photochemical ozone episodes in Hong Kong.

Early Career Scientist

YES, I am an early career scientist.

MANGO-14B

Measurements of hydrogen peroxide and formaldehyde concentrations over Toyama Prefecture in central Japan

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CATCH: the Cryosphere and Atmospheric Chemistry, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

Japan National Committee

Abstract

Measurements of H_2O_2 and HCHO concentrations as well as aerosol number concentrations, SO_2 and O_3 concentrations were performed in the high-altitude atmosphere using a helicopter over Toyama Prefecture, central Japan. The concentrations of H_2O_2 and HCHO were analyzed by a HPLC system within about 10 minutes after the sampling. The H_2O_2 was lowest at the surface and highest H_2O_2 was usually detected at an altitude 8,000 ft (approximately 2400 m). On the other hand, the HCHO was highest at ground level. The concentrations of H_2O_2 were usually higher than those of SO_2 at high-altitudes during the summer. Especially, very high concentration of H_2O_2 was observed when air pollutants were transported from the industrial regions in China. Trans-boundary air pollution in the summer may significantly affect harmful influence on vegetation. H_2O_2 was lower than SO_2; this condition is called *oxidant limitation* during cold months. If H_2O_2 concentration rises in cold months, the acidification of cloud water may be accelerated over central Japan where air pollution is actively transported.

In early August 2020, the plume from Nishinoshima volcano in the Ogasawara Islands was transported to the Sea of Japan side of central Japan. High $PM_{2.5}$ and SO_2 values were detected in Toyama Prefecture. To elucidate the influence of the plume and SO_2 oxidation capacity in the high-altitude air, the helicopter observation was made over Toyama Prefecture, in the early afternoon on 5 August 2020. The concentrations of H_2O_2 were much lower than those during the previous helicopter observations in the summer and significantly lower than the SO_2 concentrations. The oxidation of SO_2 in the aqueous phase over Toyama Prefecture might have been suppressed in early August 2020.

Early Career Scientist

NO, I am not an early career scientist.

MANGO-15C

Formation and impacts of gaseous nitrated phenols at Hok Tsui during autumn and winter of 2018

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

China Working Group

Abstract

Nitrated-phenols (NPs) has been identified as key components of black carbon affecting the atmospheric visibility, oxidation capacity, and air quality. However, most of the measurements of NPs were in particle phase, gaseous measurement of NPs with high time resolution are limited, especially in China. In this study, gaseous NPs was detected continuously by HR-ToF-CIMS at Hok Tsui in the autumn and winter of 2018, including mono-nitrated phenols (mono-NPs), di-nitrated phenols (di-NPs) and chlorine-nitrated phenols (Cl-NPs). The concentrations of observed NPs varied between 1.04 to 122.11 pptv, with clear diurnal patterns for different NPs. The detected mono-NPs showed characteristics of photochemical products. The further oxidation of mono-NPs by OH and NO_3 radicals generated di-nitro phenols, which exhibited high peaks at nighttime due to the fast photolysis in the daytime. The formations of Cl-NPs were likely attributed to the nocturnal oxidation of Cl-aromatics. Photolysis was the primary degradation pathway for the detected NPs to generate HONO and OH, which could further affect the atmospheric oxidation capacity and nitrogen recycling.

Early Career Scientist

YES, I am an early career scientist.

MANGO-16A

MEASUREMENT OF BLACK CARBON MASS CONCENTRATION BY USING AETHALOMETER IN MEGACITY LAHORE, PAKISTAN

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IGAC Activities

IGAC Regional Working Groups

Abstract

Lahore is a megacity and capital of the Punjab province of Pakistan with 11.1 million occupants. The city is an industrial & commercial hub of the country and is being rapidly expanding. Lahore is bearing emissions of around 5 million vehicles (Punjab Bureau of Statistics, 2017) and thousands of industrial activities. Black Carbon (BC) is an important distinct atmospheric pollutant particulate matter that is produced during incomplete combustion of biomass and fossil fuel. The megacities like Lahore are thus a strong emission source of BC. We present long-term black carbon particle mass concentration measurements using aethalometer performed during 2019-2020. The measurements were performed with one-minute temporal resolution during the entire measurement period. We investigate the temporal variability of BC mass concentration by analyzing the diurnal, weekly and seasonal trends. We also investigate the effect of different meteorological parameters like precipitation, temperature, and relative humidity on BC mass concentration levels.

Early Career Scientist

YES, I am an early career scientist.

MANGO-17B

Integrated air quality forecasting system for Delhi and entire South Asia.

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IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Managing air quality levels in the big metro cities of South Asia has emerged as a complex task and is now a matter of top priority for the regulatory authorities as well as scientific and academic institutions. Short-term air quality forecasts can provide timely information about forthcoming air pollution episodes that the decision-makers can use to reduce public exposure to extreme air pollution events. In this perspective, first of its kind a very operational air quality prediction system was developed to predict extreme air pollution events over South Asia. This system was developed jointly by scientists of Ministry of Earth Sciences (MoES), Govt. of India and the National Centre for Atmospheric Research (NCAR), USA.

This modeling framework consists of a high-resolution fully coupled state-of-the-science Weather Research and Forecasting model coupled with Chemistry (WRF-Chem) and three-dimensional Variational (3DVAR) framework of the community Gridpoint Statistical Interpolation (GSI) system. The system assimilates satellite aerosol optical depth (AOD) retrievals at 3 km resolution, and surface data from 260 air quality monitoring stations in India and high-resolution emissions from various anthropogenic and natural sources including dust and stubble burning. The chemical data assimilation is further integrated with dynamical downscaling to obtain improved chemical conditions for Delhi and obtain high resolution air quality forecast at 400 m resolution domain.

The MoES has launched an Early Warning system (**https://ews.tropmet.res.in**)**.** The EWS provides (1) near real-time observations of air quality and visibility over Delhi region and details about natural aerosols like dust, fire information, satellite AOD, (2) Predictions of air pollutants based on state-of-the-art atmospheric chemistry transport models, (3) Warning Messages, Alerts, and Bulletins and (4) forecast of the contribution of non-local fire emissions to the air quality in Delhi. The warning system also provides an air quality forecast for a few more cities in the northern region of India at 10 km resolution. The website also shows forecast verification for Delhi on a daily and hourly basis.

Early Career Scientist

NO, I am not an early career scientist.

MANGO-18C

Recent Findings of "Health Investigation and Air Sensing for Asian Pollution (Hi-ASAP)" – a Project Endorsed by Future Earth in Asia

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[1]Research Center for Environmental Changes, Academia Sinica, Nankang, Taipei, Taiwan. [2]Department of Chemistry, University of Dhaka, Dhaka, Bangladesh. [3]3School of Science and Engineering, Ateneo de Manila University, Manila, Philippines. [4]4Environmental Health Consultant, Environmental Quality Management Co., Ltd, Myanmar. [5]School of Environmental and Natural Resource Sciences, Universiti, Kebangsaan, Malaysia

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

"Health Investigation and Air Sensing for Asian Pollution (Hi-ASAP)" was endorsed by Regional Centre of Future Earth in Asia as a regional activity in 2019. It was developed under the umbrella of IGAC - Monsoon Asia and Oceania Networking Group (IGAC-MANGO). The main goal is to provide scientific evidence to support effective policy actions to reduce air pollution levels, in particular $PM_{2.5}$, in this region by applying newly developed low-cost sensing (LCS) devices. Currently, research groups comprised of atmospheric chemists and public health professionals from 11 different areas in the Asia and the Pacific (AP) region have joined this Hi-ASAP project.

This project aims to conduct research providing policy-relevant findings to reduce $PM_{2.5}$-associated health risks at national levels. To tackle the health threats brought by severe $PM_{2.5}$ pollution in Asia, LCS devices are applied to evaluate $PM_{2.5}$ sources, exposures, and exposure-health relationships in high tempo-spatial resolution with much lower expenses. Three versions of LCS devices (namely AS-LUNG-O, AS-LUNG-I, and AS-LUNG-P) were validated to assess outdoor, indoor, and personal $PM_{2.5}$ levels. The application of these LCS devices in Bangladesh, Indonesia, Myanmar, Malaysia, Philippines, and Taiwan in assessing different sources and personal exposures will be introduced. Quantification of contribution of different sources in communities and indoor environments to personal $PM_{2.5}$ exposures will be presented; these evidences can be used in prioritizing source control strategies in different areas and settings. Moreover, in exposure-health evaluation with AS-LUNG and health sensors, it was found that heart-rate variability (one of the health indicators) would be affected immediately right after $PM_{2.5}$ exposures; the health impacts occurred at relative low $PM_{2.5}$ levels of 12.6 ± 8.9 μg/m^3 and lasted for 4-5 hours. Besides presenting the current findings, we will also report the future planning of Hi-ASAP.

Early Career Scientist

NO, I am not an early career scientist.

MANGO-19A

NOx and O3 Trends at U.S. Non-Attainment Areas for 1995–2020: Influence of COVID-19 Reductions and Wildland Fires

Dan Jaffe
University of Washington-Bothell, Bothell, WA, USA

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

We analyzed NO2 and O3 data from 32 U.S. non-attainment areas (NAAs) for 1995–2020. For O3, we use the annual fourth highest maximum daily 8-hour average (MDA8), and for NO2 we use the daily 1-hour maximum values. For 2016–2020, in nearly all regions, NO2 concentrations and the frequency of days with elevated O3 are lower on weekends during the O3 season (May-September), in contrast to the earlier part of the data record (1995–1999). This indicates that NO2 is now the limiting precursor in nearly all NAAs. Due to COVID-19 restrictions, NOx (NO + NO2) emissions were substantially reduced in 2020, starting in spring, extending into summer. In the eastern NAAs, we see a significant reduction in NO2 and O3. The decline in fourth highest MDA8 was larger than expected from the long-term linear relationship with NO2, indicating more efficient O3 production at low NOx concentrations. In the western U.S., we see variable reductions in NO2 but substantial increases in O3. This is attributed to O3 precursors emissions from huge wildland fires that burned in 2020. The recent pattern over the past 5 years suggest that the area burned now has a strong influence on the policy-relevant O3 metric in the western U.S. In the midwestern U.S., the fourth highest MDA8 O3 values were variable, with some enhanced in 2020 and some lower. We find that both higher temperatures and smoke from distant fires was responsible for elevating O3 in midwestern NAAs in 2020.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-1A

Linking land surface conditions with biogenic emissions, dry deposition and ozone in several latitude regions

Min Huang[1], James Crawford[2], Joshua DiGangi[2], Gregory Carmichael[3], Kevin Bowman[4], Sujay Kumar[5], Xiwu Zhan[6], Andrew Weinheimer[7], Yafang Cheng[8], Isabelle De Smedt[9], Rainer Steinbrecher[10], Yasin Elshorbany[11], Rodrigo Seguel[12]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report, GEIA: Global Emissions Initiative

Abstract

The land interacts with the atmosphere via exchanging water, energy, and chemical compounds. Soil moisture and vegetation dynamics, which are closely connected, play critical roles in impacting land-atmosphere interactions, weather and chemical composition. Satellite (e.g., SMAP, GPM, OCO-2, Aura and TROPOMI) and in-situ measurements (e.g., ground-based and aircraft data during field campaigns), along with regional-scale WRF-Chem simulations with suitable land inputs and initializations are being used to investigate the connections between land surface conditions and ozone related processes, particularly dry deposition and biogenic emissions of VOCs, NOx, and HONO, in different latitude regions (i.e., southeastern US, North China Plain-Korean Peninsula, and high-latitude European regions). The studies include updating default dry deposition and emission schemes towards realistically representing the indirect (i.e., via modifying the weather fields) and direct influences of land surface conditions on these ozone-related processes. Based on the default and updated model parameterizations, the benefits of assimilating satellite land products to modeling these processes and ozone are exploited. These efforts, together with our previous works focusing on articulating the changing impacts of transboundary pollution and anthropogenic emissions on western US ozone, aim to help better model and understand ozone trends, variability and impacts in the study regions as well as other regions with similar types of pollution sources, land cover and climate. They support or have important implications for multiple IGAC activities, particularly TOAR, GEIA, and MAP-AQ. Related citations: Huang et al. (doi: 10.5194/acp-2020-499; doi: 10.5194/egusphere-egu21-9002).

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-2B

Chemical characterization and source apportionment of PM2.5 in two West African cities (Korhogo and Abidjan in Cote d'Ivoire)

Sylvain Gnamien[1], Cathy Liousse[2], Véronique Yoboué[1], Sékou Keita[3], Siélé Silué[3], Julien Bahino[1], Eric Gardrat[2], Lamine Diaby[1]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

In order to understand atmospheric chemistry in West African urban environments, long-term urban-type sites have been installed and operated within the framework of the "Air Pollution and Health in Urban Areas" (PASMU). In that context, $PM_{2.5}$ aerosol samples (aerodynamic diameter < 2.5 µm) are collected weekly on a site in Abidjan and a site in Korhogo. Measurements took place from April 2018 to March 2020, and allow to cover two dry and two wet seasons. Both mass, EC, OC and soluble ions were analyzed for each $PM_{2.5}$ filters. From these data, chemical composition of $PM_{2.5}$ aerosol has been determined for the two studied sites as well as its seasonal and inter-annual variations. The first results show that the concentrations observed during the two dry seasons are more important than in the wet seasons, with inter-annual variations different in Abidjan than in Korhogo depending on meteorological factors and regional pollution. OC/EC ratios are generally higher in Korhogo than in Abidjan as well as relative importance of dust particles in $PM_{2.5}$ aerosol. Moreover, from these data and using the EPA PMF 5.0 software from the United States Environmental Protection Agency, five different sources that contribute to the $PM_{2.5}$ aerosols collected on the studied sites, have been identified both in Abidjan and in Korhogo. The contributions of such sources are very different from one site to another, with 40% for traffic and domestic and biomass fires in Abidjan, while in Korhogo domestic and biomass fires and traffic contribute to 70% and 16% respectively.

Finally, the analysis of the aerosol chemical composition including EC, OC, non-sea-salt ions, sea-salt and dust in parallel with $PM_{2.5}$ mass concentrations reveals the importance of a non-determined aerosol mass, higher in Korhogo than in Abidjan which could be due to undetermined sources (e.g. road dust).

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-3C

$PM_{2.5}$-bound silicon-containing secondary organic aerosols (Si-SOA) in Beijing ambient air

Dr Jingsha Xu[1,2], Professor Zongbo Shi[1], Professor Roy M. Harrison[1], Dr Congbo Song[1], Dr Siqi Hou[1], Dr Lianfang Wei[3], Professor Pingqing Fu[4], Professor Weijun Li[5]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CATCH: the Cryosphere and Atmospheric Chemistry, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Abstract

Volatile methyl siloxanes (VMS) have been widely used in personal care products and industrial applications, and are an important component of VOCs (volatile organic compounds) indoors. They have sufficiently long lifetimes to undergo long-range transport and to form secondary aerosols in the atmosphere through atmospheric oxidation. To investigate these silicon-containing secondary organic aerosols (Si-SOA), we collected $PM_{2.5}$ samples during 8th-21st August 2018 (summer) and 3rd-23rd January 2019 (winter) at an urban site of Beijing. As the oxidation of VMS mainly results in hydrophilic polar semi-volatile and non-volatile oxidation products, the differences between total water-soluble Si and total water-soluble inorganic Si were used to estimate water-soluble organic Si, considered to be secondary organic Si (SO-Si). The average concentrations of secondary organic Si during the summer and winter campaigns were 4.6±3.7 and 13.2±8.6 ng m^{-3}, accounting for approximately 80.1±10.1 % and 80.2±8.7 % of the total water-soluble Si, and 1.2±1.2 % and 5.0±6.9 % of total Si in $PM_{2.5}$, respectively. The estimated Si-SOA concentrations were 12.7±10.2 ng m^{-3} and 36.6±23.9 ng m^{-3} on average in summer and winter, which accounted for 0.06±0.07% and 0.16±0.22% of $PM_{2.5}$ mass, but the highest contribution to $PM_{2.5}$ mass can reach up to 0.26% and 0.92%, respectively. We found that net solar radiation is positively correlated with SO-Si levels in the summer but not in winter, suggesting seasonally different formation mechanisms.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-4A

Direct and indirect effects of aerosols on meteorology and air pollutant concentrations during dry and wet periods on Southeast Brazil

Dr Sergio Ibarra Espinosa[1], Dr. Gyrlene Aparecida Mendes da Silva[2], Dr Amanda Rehbein[1], Dr. Angel Vara Vela[1], Dr. Edmilson Dias De Freitas[1]
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IGAC Activities

GEIA: Global Emissions Initiative, AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

Air pollution concentrations remain high in South-East Brazil, being the most important source vehicular emissions. The representation of air pollutant concentrations and the direct and indirect aerosol fieedback were evaluated during a dry and wet periods. The emissions were generated using VEIN model and air quality concentrations with feedbacks using WRF-Chem with a grid-spacing of 3 km, to represent mesoscale circulations. The simulated meteorological parameters and air pollutants concentrations align with observations. It was found a reduction of 1.3% of downward solar radiation due to aerosol feedbacks during dry period, hiwch results in less 1.5% of surface O_3. It was found that precipitation is enhanced due to the aerosol indirect feedbacks resulting in higher planetary boundary layer and lower air pollutant concentrations in urban centers. Precipitation was the only parameter which presented significative difference due the activation of aerosol feedbacks.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-5B

The impact of large-scale circulation on daily $PM_{2.5}$ in major populated regions of China during winter

Miss Zixuan Jia[1], Prof Ruth Doherty[2], Prof Oliver Wild[3], Dr Chaofan Li[4], Dr Fiona O' Connor[5], Dr Carlos Ordóñez[6]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Since the beginning of the 21st century, rapid economic and industrial growth in China has led to extremely high pollution levels of suspended particulate matter ($PM_{2.5}$) which are associated with serious adverse health effects. Although emissions of pollutant precursors strongly influence air pollution levels, meteorology may also play a major role in producing air quality episodes, especially in winter. We examine the influence of the large-scale circulation and key regional meteorological features on $PM_{2.5}$ over three major regions of China: Beijing–Tianjin–Hebei (BTH), the Yangtze River Delta (YRD), and the Pearl River Delta (PRD). The East Asian winter monsoon (EAWM) is primarily studied, including some of its main large-scale components such as the East Asian trough and the Siberian high, as it influences $PM_{2.5}$ differently in different parts of China. In the BTH region, the shallow East Asian trough curbs the invasion of northerly cold and dry air from the Siberian high which induces high relative humidity and heavy pollution, possibly via relative humidity-promoted aerosol formation and growth. A weak southerly wind in Eastern and Southern China associated with a weakened Siberian high suppresses horizontal dispersion, contributing to pollution accumulation over YRD. In addition, the El Niño-Southern Oscillation (ENSO) as the dominant mode of global ocean-atmosphere interaction has a substantial modulation on precipitation over southern China. In the PRD, weak southerly winds and precipitation deficits over southern China are conducive to atmospheric pollution possibly via reduced wet deposition. Furthermore, we construct new circulation-based indices based on the dominant large-scale circulation, which can effectively distinguish different levels of pollution over BTH, YRD and PRD, respectively. We also show how additional regional meteorological variables can improve the prediction of regional $PM_{2.5}$ concentrations for these three regions.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-6C

Impact of aerosol chemical parameterization in a regional chemical transport model on PM distribution over Thailand.

Mr Sherin Hassan Bran[1,2], Dr Ronald Macatangay[1], Dr Vanisa Surapipith[1], Dr Chakrit Chotamonsak[2], Dr Somporn Chantara[2]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Atmospheric aerosol is a climate forcing agent that plays an important role in regional and global climate change. It is the current largest threat to the society in terms of health, regional climate change, biodiversity and the socio-economic state. Study on the discrete nature of aerosols limits the lack of sufficiently viable remote sensing and in-situ measurements. To overcome the limitations, regional chemical transport model such as weather research and forecasting model coupled with chemistry (WRF-Chem) has been used world widely. Though, there are measurable uncertainty's in aerosol mixing, aging process, meteorological and gas-phase interactions while using different aerosol chemistry. The present study aims to examine the sensitivity of two different aerosol chemistry schemes in WRF-Chem on aerosol distribution over Thailand during an intense pollution event.

Two parallel simulation has been made with different aerosol chemistry schemes, Goddard Chemistry Aerosol Radiation and Transport (GOCART) model and Model for Simulating Aerosol Interactions and Chemistry (MOSAIC) from 15th March to 15th April, 2019, using WRF-Chem v3.8.1. The simulated aerosol mass concentration were then compared with 61 stations over Thailand includes urban, semi-urban, remote, mountain and coastal locations from Pollution Control Department (PCD) of Thailand. The correlation coefficient between the simulated and the observed $PM_{2.5}$ mass concentration using GOCART and MOSAIC schemes found to be 0.51 and 0.46, associated root mean square error were 22.5 and 27.3 μg m^{-3}. In general, model underestimate the observation (10 – 60 %) in most part of Thailand during the study period. However, GOCART used simulation perform better when compared to MOSAIC scheme. The model could not able to capture the aerosol distribution over southern Thailand compared to other regions, the discrepancy maybe due to the inefficient distribution of aerosol emissions in the anthropogenic emission inventory, as well as from the weak chemical composition, strong wind speed and wet scavenging in the model.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-7A

Model evaluation of Zeppelin and surface observations of reactive compounds in the evolving Atmospheric Boundary Layer: Entrainment versus other ABL sources and sinks.

Dr Laurens Ganzeveld[1], Prof Maarten Krol[1,2], Prof Jordi Vila[1]
[1]Meteorology and Air Quality group, Wageningen University, Wageningen, Netherlands. [2]Institute for Marine and Atmospheric Research, Utrecht, Netherlands

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

In summer 2012 and 2013 a Zeppelin-NT airship was applied in three field studies of the EU project PEGASOS to provide detailed measurements of radicals, trace gases and aerosols during the early morning transition from nocturnal stable conditions into a convective atmospheric boundary layer (ABL). The measurements were motivated by previous studies indicating the importance of entrainment of residual layer air masses into the ABL for daytime chemistry. The Zeppelin was deployed around the supersites Cabauw (Netherlands), San Pietro Capofiume (Italy), and Hyytiälä (Finland) representing the contrasting meteorological and biogeochemical regimes of Europe. These airborne observations were complemented with ground-based measurements. We applied two different model approaches that both simulate explicitly land-atmosphere interactions and entrainment to evaluate these observations. One approach relies on application of the so-called slab mixed layer approach, with diurnal evolution of the ABL being represented by one bulk layer. We also applied a Single-Column Model with > 20 layers representing the forest canopy, overlaying ABL and entrainment zone. The model analysis aims to address 1) how the Zeppelin observations compare with the ground-based observations for this early morning transition? 2) how detailed we need to resolve ABL dynamics to simulate the observed temporal and vertical variability in tracer concentrations and 3) to determine the contribution by entrainment to the observed temporal variability in concentrations.

The presentation gives an overview of the main results for the evaluation for the three sites. This detailed evaluation combining these different measurements with the slab and 1-D model simulations provides an optimal approach to analyse in detail the processes that ultimately explain the observed morning transition e.g. at surface air quality network sites. The contribution by entrainment to ABL concentrations also stresses the need for evaluating carefully the representation of entrainment in large-scale atmospheric chemistry models.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-8B

The impact of climate change on winter haze over the North China Plain

Dr Shipra Jain[1], Prof Ruth Doherty[1], Dr. David Sexton[2], Dr Steven Turnock[2], Dr Chaofan Li[3], Dr Zongbo Shi[4], Ms. Zixuan Jia[1]
[1]University of Edinburgh, Edinburgh, United Kingdom. [2]UK Met Office, Exeter, United Kingdom. [3]Institute of Atmospheric Physics, Beijing, China. [4]University of Birmingham, Birmingham, United Kingdom

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

This study examines the past and future changes in winter haze ($PM_{2.5}$>150 μg m^{-3}) conducive weather conditions that lead to poor air quality over the North China Plain (NCP) using a meteorology-based Haze Weather Index (HWI). We find that the HWI can be used as an indicator of winter air quality across the NCP. We assess, for the first time, the impact of climate change, parameter uncertainty and internal variability on future haze and clear conditions under the RCP8.5 scenario over the NCP using the UK Met Office Perturbed Parameter Ensemble (PPE). Contrasting changes are found in the frequency of winter hazy and clear days in the future. Hazy days generally increase (+33%) whereas clear days decrease (-29%) in future (2060-2086) as compared to the historical (1979-2005) period. Whilst we find no consistent change in the interannual variance of hazy days for the future periods as compared to the historical period, the interannual variance of clear days reduces across the PPE. The future changes in the frequency of winter hazy and clear days in the PPE are largely driven by changes in zonal-mean mid-tropospheric winds and the vertical temperature gradient over the NCP. Finally, we find that whilst parameter uncertainty and internal variability can largely explain the extreme values and trends in the frequency of winter hazy and clear days for the historical and future periods in the PPE, the impact of climate change on trends in the frequency of clear days is more pronounced than for hazy days.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-9C

Association between pollution sources of ambient fine particulate and the changes in biomarkers of oxidative stress and inflammation: A case study in urban Beijing in 2016

Yidan Zhang[1], Yiqun Han[1,2], Wu Chen[1], Yuanyang Liu[1], Teng Wang[1], Jing Liu[3], Kelly Frank[2], Tong Zhu[1]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

China Working Group

Abstract

Fine particulate matter ($PM_{2.5}$) has significant impacts on human health, one mechanism is generating reactive oxygen species (ROS) and inducing oxidative stress associated with inflammation. The health effects may vary with different sources and chemical compositions of $PM_{2.5}$, however, the evidence remains limited. Aiming to a better understanding of the relationship between source contributions and adverse effects, chemical compositions were systematically analyzed for the $PM_{2.5}$ filter samples collected during the wintertime campaign of the AIR pollution on cardiopuLmonary disEaSe in urban & peri-urban reSidents in Beijing (AIRLESS) program in 2016. We used positive matrix factorization (PMF) to perform the source appointment. Four likely sources, including biomass burning and firework, secondary inorganic aerosols, coal combustion, industrial and traffic emissions, account for 5%, 37%, 23%, 35%, respectively. Linear mixed-effect models were applied to examine the associations between the components and sources of $PM_{2.5}$ with and changes in biomarkers of acute respiratory inflammation (FeNO) as well as oxidative stress (8-OHdG, MDA) in a panel of 120 individuals. Most detected constituents exhibited significantly positive correlations with biomarkers (p_{FDR} <0.05). As for pollution sources, the results showed that for each interquartile range (IQR) increases in coal combustion, secondary inorganic aerosols, and biomass burning source, there was a statistically significant increase of 31.2% (95% Cl:21.3-41.9%; p_{FDR}<0.001), 20.5% (95% Cl:12.6.-28.9%; p_{FDR}<0.001), 32.9% (95% Cl:21.4-45.6%; p_{FDR}<0.001) in FeNO, respectively. MDA was found to be associated with interquartile range (IQR) increases in secondary inorganic aerosols, industrial and traffic emissions source, with an increase of 14.4% (95% Cl:4.75-24.99%; p_{FDR}<0.05), 13.9% (95% Cl:5.10-23.33%; p_{FDR}<0.05), respectively, while no significant changes were observed in 8-OHdG. Our findings highlight the adverse health impact of certain $PM_{2.5}$ sources, namely coal combustion and biomass burning. We suggest targeted controlling measures for these two sources may lead to beneficial health effect in urban residents in Beijing.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-10A

Mountain-valley circulation in Santiago, Chile: consequences on Black Carbon deposition over glaciers and Ozone injection into the free troposphere

Rémy Lapere[1], Laurent Menut[1], Sylvain Mailler[1,2], Nicolás Huneeus[3]
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[3]Department of Geophysics, Universidad de Chile, Santiago, Chile

IGAC Activities

Abstract

The Santiago basin, Chile (33.5°S 70.65°W) combines very strong emissions of urban anthropogenic pollutants with the steep topography of the nearby Andes cordillera. Interactions between atmospheric pollution and mountain meteorology are thereby exacerbated. Based on chemistry-transport modeling with WRF-CHIMERE, we investigate (i) the pathways leading to deposition of black carbon (BC) from Santiago up to Andean glaciers and (ii) the effect of mountain-valley circulation on the vertical export of ozone precursors.

Ice and snow in the Central Andes contain significant amounts of BC often attributed to emissions from Santiago. However, given the usually stable conditions in wintertime and the height of the obstacle to overcome for urban air masses (Santiago is 500m a.s.l., summits are well above 4000m a.s.l.) the pathways for such deposition are not straightforward. We find that, for a typical winter month, up to 33% of BC dry deposition on glaciers in the Central Andes can indeed be attributed to emissions from Santiago. In summertime, although deposition is lesser, the share attributable to Santiago rises up to 90%. Statistical analysis shows that zonal wind speed in the urban area and vertical diffusion deep into the adjacent canyons account for most of the variance in wintertime BC deposition.

In summertime, we find that the strong mountain-valley circulation leads to the vertical export of ozone precursors such as NOx and VOC, but with consequences differing from the usual observations. Despite the surface urban environment featuring a NOx-rich regime unfavorable for ozone production, the heterogeneous lifetimes of species involved make for a more balanced regime higher up after export, combined with more intense photolysis conditions, leading to the formation of a persistent bubble-like ozone plume of more than 50ppb in average, detached from the surface, extending along 80km horizontally and 1.5km vertically, slightly North of Santiago.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-11B

TRACE METALS ASSOCIATED WITH ATMOSPHERIC FINE PARTICULATE MATTERS IN THE TWO MOST POPULOUS CITIES IN VIETNAM

Chi Doan Thien Nguyen[1], Hien Thi To[1], Huy Huu Duong[2], Le Anh Hoang[3], David Oram[4,5], Grant Forster[4,5], Graham Mills[4], Alex Baker[4]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Hanoi and Ho Chi Minh City (HCMC), the most populous cities in Vietnam, have received increasing global attention because of their poor air pollution status. As part of the recent UK-Vietnam 2-Cities project the concentration levels of trace metals in fine particulate matter has been characterized. 24-hour samples of PM_2 were collected on glass filters at 2 sites in Hanoi and 3 sites in HCMC during two periods of sampling. The first campaign was conducted from September to October 2018 and the second one was carried out in March 2019. The soluble fraction of trace metals (including fifteen elements: Fe, Al, Mn, Ti, Zn, V, Cu, Ni, Co, Cd, Pb, Th, Cr, As and Sb) bound to PM_2 were extracted with nitric acid at pH 2 and analyzed by ICP-MS. The results show that Zn was the most abundant metal in PM_2 in both cities. Fe and Al, derived from crustal sources, were the dominant metals after Zn. Most trace metals concentrations in Hanoi were higher than in HCMC, especially toxic metals such as Pb, Cd, Cr and As. V and Ni were the only two metals having concentration levels higher in HCMC than in Hanoi. The V/Ni ratios and the correlation between V and Ni together suggested shipping emissions strongly affect V and Ni levels in PM and, moreover, the air quality in HCMC.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-12C

Towards high resolution air quality modeling using large eddy simulation: a case study for Eindhoven, the Netherlands

Dr. Ruud H.H. Janssen, Dr. Martijn Schaap
TNO, Utrecht, Netherlands

Abstract

High levels of air pollutants have adverse impacts on the economy and quality of life worldwide. In the Netherlands, the government has committed itself to reduce the negative health impacts due to Dutch emissions by 30% in 2030. Since strong gradients in pollutant concentrations exist in cities that are caused by proximity to emissions sources (e.g. traffic) and by the limited atmospheric mixing that occurs in street canyons, levels of exposure to urban air pollution vary significantly in space and time. This poses an additional challenge on improving urban air quality. Therefore, to support health professionals and city planners in reducing the adverse effects of air pollution, understanding exposure at high resolution is essential.

Here, we present a study of the application of a large eddy simulation (LES) model in high resolution (25x25 m^2) air quality modeling. We aim to demonstrate the added value of LES modelling in terms of resolved turbulent dispersion. High-resolution emission data sets are developed that serve as input for the LES simulations. We compare results for stable aned unstable (convective) conditions, with a focus on the dispersion of passive tracers, and compare the LES results to those of the LOTOS-EUROS regional scale air quality model.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-13A

Assessing nitrogen dioxide intra-urban spatial variability in the West African city of Dakar, Senegal

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IGAC Activities

CCMi: Chemistry Climate Model Initiative, CATCH: the Cryosphere and Atmospheric Chemistry, ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Americas Working Group

Abstract

Increasing air pollution levels pose significant challenges for rapidly growing cities like Dakar, Senegal, which is one of the most urbanized and industrialized countries in West Africa. Because there are currently few studies and a lack of the surface measurements in the region, there are large uncertainties in sources, trends, and impacts of urban pollutants such as nitrogen dioxide (NO_2). In this context, we are investigating the drivers and impacts of intra-urban NO_2variability in Dakar. To do this, we are creating a land-use regression (LUR) model using an array of locally collected datasets, in particular NO_2mobile monitoring observations collected in February–March 2020. We are focusing our modeling on daytime workday conditions during the dry season. This study is producing the first LUR model for a West African city based on surface measurements collected in that city, and representing NO_2 spatial patterns in urban neighborhoods of Dakar at a resolution of 300 m x 300 m.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-14B

Investigation of the atmospheric chemistry of solid fuel burning tracers during a strong winter time particle pollution episode

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School of Chemistry and Environmental Research Institute, University College Cork, Cork, Ireland

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Solid fuel (e.g. wood, coal) burning is a well-known source of atmospheric particles and reactive organic gases (ROG) which strongly affect air quality and climate. These ROG can react with the main atmospheric oxidants (OH, O_3 and NO_3), leading to the formation of low volatile products and Secondary Organic Aerosols (SOA). Although SOA from solid fuel combustion is an important source of atmospheric particle pollution, information on the source strength and atmospheric impacts are still uncertain, due to the complexity of the ROG emitted.

In the present study, a Time-of-Flight Chemical Ionisation Mass Spectrometer (ToF-CIMS) was deployed for online measurements of organic compounds in Cork City, Ireland during winter 2019 (26th January - 8th February). The experimental set-up was completed by measurements of $PM_{2.5}$, O_3 and NO_x, meteorological parameters and air mass backward trajectories computed using the HYSPLIT model.

$PM_{2.5}$ exhibited a strong diurnal cycle with maximum concentrations at night, reaching concentrations up to 180 µg m^{-3} during a night-time air pollution episode. Several tracers of solid fuel burning were observed, such as catechol, levoglucosan, vanillin, etc. These compounds strongly correlated with the $PM_{2.5}$ concentration, showing that solid fuel burning is a major contributor to atmospheric particles in Cork. Oxygenated compounds such as dicarboxylic acids and quinones were observed together with a number of nitrogenated compounds. The evolution of the oxidised compounds in relation to their likely precursors and atmospheric conditions (NO_x, O_3, solar radiation, etc.) will be discussed here, highlighting the atmospheric chemistry of solid fuel burning emissions. In particular, ratios between nitrogenated compounds and their precursors during day and night is used to highlight differences between daytime photochemistry and nighttime chemistry initiated by NO_3 radicals.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-15C

Statistical and Machine Learning Methods for Evaluating Emissions Reduction Policies under Changing Meteorological Conditions

Minghao Qiu, Noelle E Selin
Massachusetts Institute of Technology, Cambridge, MA, USA

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

China Working Group, Americas Working Group

Abstract

Impacts of emissions reduction policy on air quality are potentially confounded by underlying meteorological variability, which need to be correctly adjusted for in order to attribute changes in air quality to policies. However, there is little consensus on what statistical methods should be used to correct for meteorological variability when estimating policy effects on air quality. Most previous studies use a multiple linear regression (MLR) model with basic meteorological variables (e.g., temperature, wind speed, precipitation) to correct for meteorological variability, but the ability of such models to assess policy impacts remains unknown.

Here, we quantify the performance of MLR and other regression models using the chemical transport model GEOS-Chem, and show that these methods do not perform well in correcting for the meteorological variability. To do this, we simulate the impacts of emissions control policies in the U.S. and China from 2011 to 2017 with GEOS-Chem and examine the 7-year trend in daily PM2.5 and O3. We simulate two sets of scenarios – "observed scenarios" with assimilated meteorological inputs (with interannual variability) and "counterfactual scenarios" with constant meteorological inputs. We then attempt to reproduce the policy-driven trends in the counterfactual scenarios, by using quantitative methods to remove meteorological variability in the observed scenarios. Compared with the counterfactual scenarios, trends estimated using MLR are biased by 40% (PM2.5) and 115% (O3). We then design a machine learning model that uses local and synoptic scale meteorological features which can significantly reduce the estimation bias (to 26% for PM2.5 and to 40% for O3). Our analysis suggests that the impacts of emissions reduction policies on PM2.5 and O3 in both US and China are largely overestimated using simple regression models. Furthermore, there is a minimum possible bias of 6-8% in the trend estimates without incorporating information on emissions changes, because of interactions between emissions changes and meteorology.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-16A

Modelling changes in secondary inorganic aerosol formation and nitrogen deposition in Europe from 2005 to 2030

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

In combination, secondary inorganic PM2.5 particles are formed from SOx, NOx and ammonia emissions, through the formation of either ammonium sulphate or ammonium nitrate. EU limits and WHO guidelines for PM2.5 levels are frequently exceeded in Europe, in particular in the winter months. In addition the critical loads for eutrophication are exceeded in most of the European continent. Further reductions in ammonia emissions and other PM precursors beyond the 2030 requirements could alleviate the health burden from fine particles, and reduce the deposition of nitrogen to vulnerable ecosystems.

Using the regional scale EMEP/MSC-W model, we have investigated the effects of year 2030 ammonia emissions on PM2.5 concentrations and on depositions of nitrogen in Europe under present (2017) and past (2005) conditions. In Europe the formation of PM2.5 from ammonia is largely limited by the ratio between the emissions of ammonia on one hand, and SOx and NOx on the other hand. As this ratio is increasing, the ability to curb PM2.5 levels through reductions in ammonia emissions is decreasing. We show that per gram of ammonia emissions mitigated in 2030 versus 2005 the resulting reductions in PM2.5 are reduced by about a factor of 2.6. However, the ratio is lower in winter, and further reductions in the ammonia emissions in winter may have similar potentials as SOx and NOx in curbing PM2.5 levels.

Following the expected emission reductions of ammonia, depositions of reduced nitrogen are decreasing in Europe. As the reductions in NOx emission are larger than for ammonia, the fraction of total nitrogen (reduced plus oxidized nitrogen) deposited as reduced nitrogen is increasing and exceed 60% in most of Europe by 2030. Thus the potential for future reductions in the exceedances of critical loads for eutrophication in Europe will mainly rely on the ability to reduce ammonia emissions.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-17B

Ultrafine Aerosol Particles in Merida, Yucatan (Mexico)

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Abstract

Air pollution is one of the biggest concerns of the World Health Organization as it can cause a variety of severe health problems and in extreme cases it can induce premature deaths. Aerosol particles can trigger cardiovascular and respiratory diseases on populations in polluted regions. Their adverse effects have been linked with their size and composition. The smaller the aerosol particles, the larger the likelihood of going deeper into the respiratory system. Although fine aerosol particles (i.e., with a diameter d<2.5 mm) have been found to reach the lungs and in some cases the blood stream, their acute effects are related to the fraction of ultrafine aerosol particles, UFPs (i.e., with d<0.1 mm). However, most countries do not monitor the UFPs as the local regulations focus of $PM_{2.5}$ only.

In the present work, the concentration of UFPs (d=0.02-0.1 mm) were monitored in Merida (Yucatan) between April-September 2017 and May-July 2018 using an UFP monitor (TSI, 3031). Moreover, the total aerosol particle concentration (d>0.30 mm), the concentration of particle-bound polycyclic aromatic hydrocarbons (pPAHs), PM_{10}, $PM_{2.5}$, criteria gases (i.e., CO, NOx, SO_2, and O_3), together with meteorological variables were also monitored. An average UFP concentration of 2,070±1,831 cm^{-3} was found for the entire sampling periods, with concentrations as high as 55,117 cm^{-3}. The average daily UFP profile showed a bimodal distribution with peak high concentrations observed at 07:00 and 20:00 h. The correlation of the UFP with the other measured variables indicate that the morning and night UFPs peaks are likely caused by primary vehicular combustion particles. Likewise, atypical high concentration of UFPs were observed at noon which are likely of secondary origin and the result of new particle formation promoted by photochemistry. Overall, UFPs seems to be an important contributor to the $PM_{2.5}$ in Merida with clear anthropogenic sources.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-18C

Black carbon dispersion in central and southern Chile in winter and summer 2016

Master's student Kevin Basoa[1,2], MSc Camilo Menares[1,2], PhD Laura Gallardo[1,2], PhD Nicolás Huneeus[1,2], PhD Mauricio Osses[1,3], PhD Peter Wind[4], PhD Alvaro Valdebenito[4]
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IGAC Activities

GEIA: Global Emissions Initiative, ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

Chile's latest Nationally Determined Contribution (NDC) to the Paris Agreement, considers the mitigation of black carbon (BC) by at least 25% in 2030 respect to levels in 2016. Current BC emission estimates show important contributions from the residential (38%), off-road machinery (27%) and industrial (16%) activities according to the NDC associated BC national emissions. This and other estimates show large uncertainties, particularly in connection with residential wood burning, which dominate over central and southern Chile. In this work we aim at constraining BC for the base year 2016, through simulations of aerosol and BC dispersion tested against available observations. To this end, we use a ca. 1x1 km^2 national emission inventory to distribute NDC emissions of BC as an input to the EMEP/MSC-W model, which is fed with WRF meteorological at 10x10 km^2 horizontal resolution and 45 vertical levels over the domain 30- 50°S, 65 -77°W, for a winter and a summer month. We evaluate model outputs for CO, NO_x, PM_{10}, $PM_{2.5}$ and BC against in situ air quality data collected in several Chilean cities. Also, Aerosol Optical Depth (AOD) and Absorbing Aerosol Optical Depth (AAOD), from the AErosol RObotic NETwork (AERONET) and satellite products, are going to be compared against corresponding model outputs.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-19A

An Update on Low-cost Sensors for the Measurement of Atmospheric Composition

Richard Peltier
University of Massachusetts, Amherst, MA, USA

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CATCH: the Cryosphere and Atmospheric Chemistry, ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

Abstract

Following an initial 2018 report on the use of lower cost sensors for atmospheric chemistry, the World Meteorological Organization, along with a team of more than a two dozen experts, present a new synthesis of its view on low cost sensing (LCS) techniques that have grown in increasing popularity. The report significantly expands beyond the scope of the original charge and evaluates new technologies, as well as new analytical methods, that meet the definition of 'low cost'. The revision also provides context for policy makers who are considering the use of LCS as a means to build capacity, both in terms of improving spatial and temporal resolution of existing monitoring networks, but also for communities with emerging networks. The aim of this report is to inform policymakers and other stakeholders on the relative strengths and weaknesses of different LCS approaches, and to update previous consensus findings from the panel of experts. We provide a summary of conclusions, and directly seeks feedback from the broader IGAC community on best practices, case studies, and in informing on areas of relative strengths and weaknesses with low cost sensors in projects across the globe.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-20B

Increasing trends in secondary aerosols in Santiago: empirical analysis and modeling approach

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Hereby we report on the increasingly important role played by secondary aerosols in explaining observed concentrations of fully inhalable particles (PM2.5) in Santiago, Chile. In lack of long-term measurements of aerosol speciation studies, to this end we use a simple empirical approach that infers the secondary fraction based on observed daily maxima of ozone, and hourly carbon monoxide mixing ratios. The former is used indicator of photochemical activity, and the latter, as proxy for primary particles. This approach is compared with available speciation data, and with model simulations using the EMEP MSC-W chemistry transport model. These approaches indicate that in fact, the fraction of secondary aerosols has been increasing over the period between 2001 and 2018, particularly in Eastern Santiago where ozone mixing ratios are highest. We attribute this trend to the observed growth in Ox=O3+NO2, which appears to be driven by increasing NO2 partly linked to growing motorization rates in Santiago.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-21C

Comparison of ground-based aerosol data, satellite observation and dust forecast models in African dust and high convective events over the Greater Caribbean Basin

PhD student Josele Rosas Nava[1], Dr Peter R Colarco[2], Dr Andrea M Sealy[3], Dr Ashford Reyes[3], Dr Hongbin Yu[2], Dr Brent Holben[2], PhD Dan B Otis[4], Dr Paquita Zuidema[5], Dr Olga L Mayol-Bracero[1], PhD Bighnaraj Sarangi[1], Undergraduate student Bianca L Martinez-Huertas[1]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report, CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Americas Working Group, MANGO: Monsoon Asia and Oceania Networking Group, Southern Hemisphere Working Group

Abstract

Over 40 million tons of mineral dust from Northern Africa are transported every year by the trade winds to the Greater Caribbean Basin (GCB). This African dust (AD) has shown to affect human health, weather, climate, visibility, and ecosystems. Many aspects of those effects remain poorly understood showing the need for more research. In this study, we characterize and quantify African Dust plumes using synoptic Earth observations (i.e., from the Moderate Resolution Imaging Spectroradiometer (MODIS), the Visible infrared Imaging Radiometer Suite (VIIRS), and the Cloud- Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIOP)) and ground-based data from several stations located at several locations in the GCB (Miami-USA, Merida-MX, Cape San Juan-PR, Martinique-MAR, Guadeloupe-GUA, Ragged-point-BAR, Cayenne-FG). This regional approach is needed to increase spatial and temporal coverage of AD plumes. The ground-based data include PM_{10}, $PM_{2.5}$, dust surface concentrations, aerosol optical properties (scattering, absorption), and data from NASA's Aerosol robotic Networks (AERONET) and Micro-Pulse Lidar Network (MPLNET). In addition, we compared ground-based and satellite observations with outputs of dust forecast models (i.e., the Goddard Earth Observing System-5 (GEOS-5) and the regional dust forecast model Weather Research and Forecasting model coupled with Chemistry (WRF-Chem)) in African dust events and which happened in parallel with large convective systems as tropical storm Cristobal, Gonzalo, and Hurricane Isaias during June-July 2020. This comparison was done to better understand how these data could improve dust forecasts in the GCB. Results show that the dust forecast models were not always in agreement with the observations. This was the particular case during the presence of tropical storms Cristobal and Gonzalo. We will show the differences between the forecast provided by both models, reanalysis data, and the result of another run after ingesting the models with aerosol data available in near real time.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-22A

Modeling the combined impacts of changing human activity and a changing climate on air quality

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University of Illinois at Urbana-Champaign, Urbana, IL, USA

IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CCMi: Chemistry Climate Model Initiative, CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Our research group aims to develop modeling tools, informed by analysis of observations, to address how the combined effects of changes in human activity and climate impact air quality on scales relevant to human health. This includes effects of policies, population growth and development, and land use/land cover change on emissions that impact both air pollution formation and climate. For example, in countries like the US, emissions from agriculture are becoming more important to air quality as other sources like cars and power plants are more regulated. Increasing temperatures from climate change will also increase temperature-dependent emissions from land and vegetation. Moreover, changes in agricultural activity can affect regional-scale heat and humidity. What will potential futures look like depending on air pollution policies, and how will this interact with a changing climate to ultimately affect air quality? We examine these and other related questions by developing emissions inventories for different scenarios which we implement in a coupled 3-D model of atmospheric chemistry and climate. We develop the models for specific regions of interest by evaluating against ground-based and satellite observations.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-23B

From Low-Cost Sensors to High-Quality Data: the Importance of Collocated Calibration Model Development

Michael R Giordano, R Subramanian
CNRS, Paris, Creteil, France

Abstract

Attaining high-quality data from low-cost sensors requires the construction of calibration models for each species the sensors measure. One way to build such calibration models is by collocating reference-grade monitors with the sensors for a set amount of time then deploying the sensors to their desired locations. One outstanding question that arises from this methodology is how applicable are models developed in one location to another location as differing pollutant source profiles may greatly impact calibration models. Here we examine this question using data from 4 sets of RAMP (Real-time, Affordable, Multi-Pollutant) air quality monitors deployed at 4 locations in Africa – South Africa, Cote d'Ivoire, Kenya, and Egypt. Calibration models for each location,as well as a "generalized" calibration model from Pittsburgh, PA USA, are developed and applied to the measurements at all the locations and their accuracy versus the reference monitors assessed. Results show that while the specific models for each location generally perform the best other models, including the generalized calibration model from Pittsburgh, do fairly well at reproducing reference-grade measurements from the low-cost sensors.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-24C

Assessment of Atmospheric Particulate Matter (PM2.5 and PM2.5-10) and Source Apportionment in the Ambient Air of Kenitra City, Morocco

Dr. Mounia TAHRI[1], Dr. Abdelfettah BENCHRIF[1], Dr. Moussa BOUNAKHLA[1], Pr. Fouad BENYAICH[2], Pr. Yves NOACK[3], Dr. Fatiha ZAHRY[1]
[1]National Centre for Energy, Sciences and Nuclear Techniques (CNESTEN), Rabat, Morocco. [2]University of Moulay Ismaïl, Faculty of Sciences, Department of Physics, Meknes, Morocco. [3]European Center for Research and Education in Environmental Geosciences, Aix en Provence, France

Abstract

In Morocco, air protection activities lack a comprehensive strategic vision. Therefore, despite a number of significant positive changes such as the introduction of cleaner fuels or halving SO2 emissions by the country's only refinery, air quality, in particular in urban areas, remains a challenge. In addition, no detailed anthropogenic inventories are available for Moroccan cities. In the present study, the seasonal and spatial variations of particulate matter and its chemical composition have been studied over a one-year period in Kenitra city (2007-2008). The samples were collected using Gent sampler. The chemical compositions of collected filters were evaluated by using Total X-Ray Fluorescence and Atomic Absorption Spectroscopy. The influence of the atmospheric transport scenarios on the levels of PM was elaborated by means of air mass back-trajectories, using HYSPLIT™ model. This study allowed identifying four main transport patterns: Short local flows over Kenitra region, Northwesterly flows over Atlantic Ocean, Northerly flows, and Southern flows. The highest PM2.5-10 concentrations were observed in the summer and the lowest in the winter. However, no significant seasonal were discerned for PM2.5 particles. The enrichment factor was calculated to distinguish between anthropogenic influences and the natural background levels of metals in PM2.5-10 and PM2.5 particles. The source apportionment in the studied areas was conducted using the positive matrix factorization method. Four sources and their contributions to PM mass were identified and quantified. These include metal smelting, road dust, soil dust and motor vehicles for PM2.5; and two stroke engines, road dust, soil dust and motor vehicle for PM2.5-10.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-25A

Formaldehyde column density as an indicator for elevated surface ozone

Laura Judd[1], Katherine Travis[1], James Crawford[1], Alan Fried[2], James Walega[2], Elena Spinei[3], Scott Janz[4], Andrew Whitehill[5], Lukas Valin[5], James Szykman[6], Caroline Nowlan[7], Hyeong-Ahn Kwon[7], Gangwoong Lee[8], Seong-Jee Kim[9], Gao Chen[1]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Efforts to observe near-surface ozone directly from space are hindered by the limited sensitivity of ozone satellite retrievals to the lower troposphere. Formaldehyde (HCHO) column observations from the NASA DISCOVER-AQ campaign showed a strong relationship with surface ozone, particularly when biogenic volatile organic compounds (VOCs) were the dominant ozone precursor due to their strong temperature-driven variability. Both tropospheric ozone and HCHO are secondarily produced through the oxidation of VOCs and in regions where the main fate of RO_2 is reaction with NO, thus formaldehyde and ozone are generally co-produced. This work explores the relationship between column formaldehyde and surface ozone using data from two air quality research campaigns, the Long Island Sound Tropospheric Ozone Study (LISTOS) in 2018 and the Korea U.S. - Air Quality (KORUS-AQ) campaign in 2016. These campaigns included HCHO column information from airborne in-situ profiling and remote sensing and ground-based Pandora spectrometers in combination with surface ozone monitors in each region. These data are used to further explore the HCHO-ozone relationship and its potential for identifying areas of elevated ozone using remote sensing or satellite observations of column HCHO alone. These two regions offer a valuable comparison given their different VOC mixtures and the higher NO_x levels in Seoul that result in ozone titration effects. This work will also address the potential for this application with future geostationary satellite observations.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-26B

Combining light-absorption observation and source-oriented modelling for characterization and source apportionment of black carbon aerosol pollution in a typical Mediterranean coastal area

Andrea Milinković[1], Asta Gregorič[2,3], Vedrana Džaja Grgičin[4], Sonja Vidič[4], Abra Penezić[1], Saranda Bakija Alempijević[1], Anne Kasper-Giebl[5], Sanja Frka[1]
[1]Division for Marine and Environmental Research, Ruđer Bošković Institute, Zagreb, Croatia. [2]Aerosol, Ljubljana, Slovenia. [3]Center for Atmospheric Research, University of Nova Gorica, Nova Gorica, Slovenia. [4]Croatian Meteorological and Hydrological Service, Zagreb, Croatia. [5]TU-Wien, Wien, Austria

IGAC Activities

Abstract

Black carbon (BC) is recognized as the primary pollutant resulting from incomplete combustion of mostly fossil fuels and biomass. It is the most light-absorbing fraction of fine particulate matter (PM) and a major contributor to climate change. Studies of BC temporal variations and sources are so far predominantly limited to winter campaigns performed at highly polluted urban sites, while significantly less data are present for areas with lower population density and less polluted coastal environments.

In order to study the temporal variation of the aerosol optical properties and to evaluate major BC emission sources in a typical coastal Mediterranean environment, a field campaign during February–July 2019 at the Central Adriatic area was conducted. Real-time continuous BC measurements were performed, while Aethalometer model source apportionment, optimized by using levoglucosan measurements, was evaluated against modelling results obtained by LOTOS-EUROS chemical transport model. The measured mean BC concentration of 0.57 μg m^{-3} was the lowest among others observed in the Mediterranean area. Daily, monthly and seasonal variations in BC concentrations are significantly affected by domestic heating, local traffic as well as by local meteorological conditions and long-range air-mass impacts. The BC from fossil fuel (BC_{ff}) dominated the area throughout the studied period with maximum in the winter and increased levels by the approaching summer. European emission sectors contributed to BC concentrations up to 88% with stationary source combustion, transportation, shipping and agriculture sectors as the most influential contributors. This study highlighted that in addition to biomass burning, the small combustion fossil fuel sources, including land traffic and shipping sources should be much more strictly controlled to limit the BC pollution at pristine Mediterranean areas.

This work has been supported by Croatian Science Foundation under the IP-2018-01-3105 BiREADI project.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-27C

Diagnosis and prognosis of air quality in South Korea using the UKESM1 modeling

Taegyung Lee[1], Ja-Ho Koo[1], Sungbo Shim[2]
[1]Yonsei University, Seoul, Korea, Republic of. [2]National Institute of Meteorological Sciences, Jeju, Korea, Republic of

Abstract

Prediction of the future air quality is the useful information for alleviating the damage by air pollution. Since the atmospheric situation in the future will be different according to the pattern of climate change, the usage of climate modeling can suggest the benefit for the diagnosis and prognosis of air quality in the future. United Kingdom Earth System Model (UKESM1), participating Coupled Model Inter-comparison Project 6 (CMIP6), can simulate the amount of multiple air pollutants by combining atmospheric chemistry processes and reflecting the scenarios of Shared Socioeconomic pathways (SSP). In this study, we compared the UKESM1 model outputs to the ground observations ($PM_{2.5}$, O_3, NO_2, SO2, CO) in South Korea, and examined the difference of future in terms of SSP scenarios: SSP1-2.6, SSP3-7.0, and SSP5-8.5) scenarios. While the UKESM1 output tends to underestimate the amount of air pollutants in South Korea, it well captures the seasonality of air pollutants. An exception is the case of PM2.5. Both model and observations consistently show the decreasing trend of air pollutants in South Korea at this present moment, except ozone; ozone shows increasing trend. Future trend of air pollutants, however, can be different according to the SSP scenarios. UKESM1 shows that decreasing trend will be continuous with the SSP1-2.6 scenario, which relates to the sustainable development, but weaker with the SSP3-7.0 scenario, which does not actively perform the social effort to resolve the climate change. Moreover, the model result revealed that the ozone in South Korea will not be diminished even with the SSP1-2.6 scenario, meaning that the stronger effort will be required to improve the future air quality in Korea. We expect that this study is helpful to understand the interaction between air quality and climate change, therefore can be used as the basic reference to prepare policies for local air pollution.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-28A

Polycyclic Aromatic Hydrocarbons (PAHs) in the Atmospheric Suspended Particulate Matter from Fertilizer Industries in Bangladesh

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University of Dhaka, Dhaka, Bangladesh

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CATCH: the Cryosphere and Atmospheric Chemistry, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Americas Working Group, MANGO: Monsoon Asia and Oceania Networking Group, Southern Hemisphere Working Group, China Working Group, Japan National Committee

Abstract

The variation of 16 US-EPA priority Polycyclic Aromatic Hydrocarbons (PAHs) were observed in total suspended particulate matter (TSP) collected from two fertilizer industries (National Agricultural Fertilizer Company (NAAFCO), and Jamuna Fertilizer Company Ltd. (JFCL)) in Bangladesh from July to November 2019. Total 12 TSP samples was collected using a low-volume sampler on quartz filter paper for 24 hours. PAHs from filters were extracted with two different solvents: Dichloromethane (DCM) and n-hexane to predict their PAH extraction efficiency. Extraction was done by solid-phase extraction method using an ultrasonic centrifuge machine and analyzed by gas chromatography coupled with two different detector systems - Mass Spectroscopy (MS) and Flame Ionization Detector (FID). The average mass concentrations of TSP were 232.8 ± 219.7 μgm^{-3} at NAAFCO and 103.1 ± 27.7 μgm^{-3} at JFCL. The result showed that the average concentrations of 13 PAHs were 69.0 ± 14.9 ngm^{-3} for NAAFCO and 62.8 ± 12.7 ngm^{-3} for JFCL. The other 3 PAHs namely: Acenaphthene, Fluorene, Anthracene were below the detection limit at both fertilizer industries. The influence of wind direction on the PAHs concentrations has also been analyzed using backward air mass trajectory analysis (HYSPLIT, NOAA USA). The health risk assessment was done utilizing the lifetime lung cancer risk (LLCR), which were 1.21×10^{-3} for NAAFCO and 1.08×10^{-3} for JFCL. LLCR values were higher than European Union guideline value indicating potential health risks at these two fertilizer industries areas.

Keywords: Total Suspended Particulate matter (TSP); Polycyclic Aromatic Hydrocarbons (PAHs); Low-Volume Sampler; Gas Chromatography; Air mass backward trajectory analysis; Health risk assessment.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-29B

Effect of Global Atmospheric Datasets in Modeling Meteorology and Air Quality in the Andean Region of Ecuador

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

Numerical atmospheric models require resolutions of a few km for mesoscale studies, using outputs from global atmospheric datasets to define nested domains' initial and boundary conditions. GFS and FNL are analysis datasets prepared from current observations for weather forecasting. Reanalysis datasets as NCEPR2, ERA-Interim, and ERA5 incorporate more observations than analysis products. Therefore, it is expected that reanalysis datasets will improve modeling performance compared to analysis products. We used the GFS, FNL, NCEPR2, ERA-Interim, and ERA5 datasets to generate the initial and boundary conditions for the city of Cuenca (Andean region of Ecuador, 2500 masl), for simulating meteorological variables and air quality during September 2014, with the online chemical transport Weather Research & Forecasting with Chemistry (WRF-Chem V3.2) model. Unexpectedly, when using the reanalysis datasets, modeling performances did not improve or even were worse. Results suggested using currently GFS or FNL rather than reanalysis products for modeling at mesoscale ranges in the Andean region of Ecuador. One reason behind the performances when using reanalysis datasets could be the scarcity of records from the Andean region when building these datasets. It is necessary to review the processes for generating reanalysis products to improve atmospheric modeling performances over this region.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-30C

Efficient vertical transport of black carbon in the planetary boundary layer

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

China Working Group

Abstract

Vertical distribution of black carbon (BC) determines the layer where its heating impacts exert. This study presents continuous and simultaneous measurements at surface, and on a mountain site above the wintertime planetary boundary layer influenced by uplifted surface anthropogenic emissions. BC was observed efficiently transported upwards by daytime convective mixing. However, this vertical transport was less for other particulate masses. An about two-folds higher BC mass fraction was thus present at mountain than surface, hereby a lowered single-scattering albedo (SSA) by 0.06. This may be caused by the evaporative loss of condensed semi-volatile materials, prevailing the secondary particulate formation, in a cleaner environment containing less precursors. The elevated BC mass corresponded with the most intensive solar radiation at midday, wielding more heating impacts over the PBL. This phenomenon may apply to other remote regions where a reduced SSA will introduce more positive radiative effects.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-31A

Quality Assurance in the WMO-Global Atmosphere Watch (GAW) Program: A New Expert Team on Measurement Quality for More Standardization and Evaluation

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Abstract

The Global Atmosphere Watch (GAW) Program of the World Meteorological Organization (WMO) was established more than thirty years ago in recognition of the need for improved scientific understanding of the increasing influence of human activities on atmospheric composition and subsequent environmental impacts. To detect and document changes in atmospheric composition and understand the underlying processes and their causes GAW maintains a global network of long-term observing stations. A set of Central Facilities supports the Quality Assurance (QA) infrastructure to maintain the long-term stability and traceability of those observations. In this context, worldwide recognized experts and laboratories has been providing longstanding support and has been leading the quality assurance activities relevant to the global observations of atmospheric constituents which are most relevant in air quality and climate. Delivery of quality products and services relies on the quality of the underlying observation data which can be only achieved through sustainable operation and long-term commitment of laboratories established in GAW.

More than three decades of QA experience in GAW have shown that between the different classes of GAW measurements there exist quite different methodologies of QA to follow. Therefore, within GAW-QA-infrastructure a new Expert Team on Atmospheric Composition Measurement Quality (ET-ACMQ) has been established to evaluate the existing QA-procedures and to facilitate and guide the standardization of the QA-methodologies. We will present the role of the ET-ACMQ in GAW in bridging different QA-efforts through standardization and harmonization. We will present a new concept of regular documentation and evaluation of the QA protocols of the GAW Central Facilities on calibrations and intercomparisons that would result in improved traceability and long-term stability of the observations. Adding to those advancements of increased transparency for data users, a harmonized terminology on traceability of calibration, precision, uncertainty and QA flagging of the measured data.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-32B

Sensitivity of Air Pollution in Quebec to Regional Emissions

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Particulate matter, NO_X (nitrogen oxide (NO) + nitrogen dioxide (NO_2)), and ozone (O_3) are known to be associated with adverse health outcomes in humans (Crouse et al. 2015; Laden et al. 2006; Pope and Dockery 2006; Stieb et al. 2002). It is important to better understand the sources of air pollution in order to craft policies that allow for economic growth while also reducing the impacts on populations of poor air quality.

We perform simulations using the GEOS-Chem chemical transport model (version 12.9.1, doi:10.5281/zenodo.3950473; Bey et al. 2001; Park et al. 2004) with 0.5° x 0.625° resolution to determine the regional contributions to air pollution with the Canadian province of Quebec. Specifically, we perform sensitivity studies to determine the contributions due to anthropogenic emissions from three different regions: from within Quebec, from the rest of Canada (excluding Quebec), and from the United States.

We find that anthropogenic emissions from each of these three source regions are responsible for a significant fraction of the air pollution in Quebec, with variations depending on season and location.

This work was supported by Le ministre de l'Environnement et de la Lutte contre les changements climatiques de Québec.

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Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-33C

Quantifying Linear and Non-Linear Influences of Aerosol Precursor Emissions on Pollutant Concentrations Using CMAQ-hyd

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Chemical transport models (CTMs) are essential assets to understand complex physico-chemical reactions in the atmosphere. They provide estimates of concentrations of air pollutants based on emissions and meteorological parameters. Sensitivity analysis in CTMs has helped researchers determine the uncertainty in the CTMs and make policy recommendations. The simplest method to compute sensitivity coefficients is the finite difference method (FDM). The sensitivity coefficients are calculated by running the model multiple times with incremental values for the input variable of interest. However, this method suffers from truncation (i.e., ignoring higher-order terms) and cancellation errors (i.e., numerical issues caused by subtracting two very close numbers). The truncation error can be minimized by taking smaller perturbation step, thus eliminating the impact of higher-order sensitivity terms on the first-order result. However, the cancellation error will dominate if the perturbation step is too small. Other methods, including the direct decoupled method (DDM) and the adjoint method, involve formulating new forward sensitivity or adjoint equations to the CTM. When the CTM is updated, new equations must be modified manually, thus reducing their applicability in various complex CTMs. Here, we propose an alternate approach for sensitivity coefficient calculations in CTMs: the hyperdual number approach (Fike et al., 2011). Instead of a real number perturbation in the FDM, we applied a hyperdual perturbation to the emission variable of interest. The method is more accurate and does not depend on the perturbation step size. The method is also easier to implement compared to the DDM and the adjoint method. We applied this method in the Community Multiscale Air Quality (CMAQ) model v.5.3 to formulate the CMAQ-hyd model. We have calculated the exact first- and second-order sensitivities of aerosol and gas concentrations to select aerosol precursor emissions based on this new method.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-34A

The influence of chemical compositions to the sensitivity of visibility on the PM2.5 and relative humidity

Jiao Wang[1], Jianhui Wu[2], Baoshuang Liu[2], Xiaohuan Liu[3], Huiwang Gao[3], Yufen Zhang[2], Yinchang Feng[4], Suqin Han[5], Xiang Gong[6]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

The atmosphere visibility is mainly influenced by the concentration of fine particles ($PM_{2.5}$) and relative humidity (RH). However, the sensitivity of visibility on the $PM_{2.5}$ and RH is hard to be quantified, especially under different aerosol compositions. In this study, a relative sensitivity index function of visibility variation to $PM_{2.5}$ concentration or RH was established based on the quantitative relationship between visibility, $PM_{2.5}$ and RH. The visibility sensitive area is divided into $PM_{2.5}$-limited regime or RH-limited regime based on change regular of the ratio. The influence of chemical compositions to the sensitivity of visibility on $PM_{2.5}$ concentration or RH was investigated based on the content of total extinction and hygroscopic components in $PM_{2.5}$. The correlation coefficient of visibility and $PM_{2.5}$ varied from -0.48 to -0.76, and the correlation coefficient between visibility and RH varied from -0.17 to -0.73 for different aerosol types. Fitting equation between visibility, PM concentration and RH in most types increase the accuracy of the parameterization scheme for visibility calculation (R=0.78-0.90) except lower-hygroscopic components type. There were several times difference for the $PM_{2.5}$ and RH threshold values of varied visibility sensitive area under different aerosol types.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-35B

Constructing a spatiotemporally coherent long-term PM2.5 concentration dataset over China during 1980–2019 using a machine learning approach

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

The lack of long-term observations and satellite retrievals of health-damaging fine particulate matter in China has demanded the estimates of historical $PM_{2.5}$ (particulate matter less than 2.5 μm in diameter) concentrations. This study constructs a gridded near-surface $PM_{2.5}$ concentration dataset across China covering 1980–2019 using the space-time random forest model with atmospheric visibility observations and other auxiliary data. The modeled daily $PM_{2.5}$ concentrations are in excellent agreement with ground measurements, with a coefficient of determination of 0.95 and mean relative error of 12%. Besides the atmospheric visibility which explains 30% of total importance of variables in the model, emissions and meteorological conditions are also key factors affecting $PM_{2.5}$ predictions. From 1980 to 2014, the model-predicted $PM_{2.5}$ concentrations increased constantly with the maximum growth rate of 5–10 $\mu g/m^3$/decade over eastern China. Due to the clean air actions, $PM_{2.5}$ concentrations have decreased effectively at a rate over 50 $\mu g/m^3$/decade in the North China Plain and 20–50 $\mu g/m^3$/decade over many regions of China during 2014–2019. The newly generated dataset of 1-degree gridded $PM_{2.5}$ concentrations for the past 40 years across China provides a useful means for investigating interannual and decadal environmental and climate impacts related to aerosols.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-36C

Contribution of brown carbon to the light absorption and radiative effect of carbonaceous aerosols from biomass burning emissions in Chiang Mai, Thailand

Miss Ying Zhang[1], Dr. Yiran Peng[1], Mr. Wenhuai Song[2], Dr. Yan-Lin Zhang[2], Mr. Pitakchon Ponsawansong[3], Dr. Tippawan Prapamontol[3], Dr. Yuxuan Wang[4]
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IGAC Regional Working Groups

China Working Group

Abstract

Chiang Mai, the largest city in North Thailand, suffers from adverse haze associated with heavy biomass burning (BB) during almost every dry season (February to April). Substantial amount of black carbon (BC) and brown carbon (BrC) from BB can have strong radiative effects on local and regional climate, due to their absorption of solar radiation. However, studies that characterize the radiative effects of BB-associated BC and BrC in Chiang Mai are quite limited. In this study, we use a global chemical transport model (GEOS-Chem) coupled with the rapid radiative transfer model for GCMs (RRTMG) to estimate the radiative forcing (RF) of BB-associated carbonaceous aerosols (CAs including BC, BrC,and non-absorbing organic aerosols) in Chiang Mai. BrC is treated as an individual tracer in the model. Due to the high variability of BrC imaginary refractive index (k_{BrC}), three sets of k_{BrC} (low-, medium- and high-absorbing) obtained from previous literature and experiments are used in our simulations. Results show that BrC accounts for 33 – 40% of total CAs absorption at 440 nm during dry season, and BC accounts for 60 – 67%. As estimated, BrC contributes 14 ± 3% to the instantaneous RF of total CAs (IRF_{CAs}) at the top of atmosphere (TOA), and 16 ± 3% to IRF_{CAs} at surface. Moreover, including BrC in model strengthens 9 ± 5% of surface cooling effect of organic aerosols and reduces the cooling effect at TOA by 9 ± 3%, indicating that BrC helps to maintain more energy and warm in the atmosphere in Chiang Mai.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-37A

Air Quality Modeling with Urban WRF-Chem system over a high altitude tropical City: Implementation and evaluation.

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National Autonomous University of Mexico, CDMX, Mexico

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group, Japan National Committee

Abstract

Urban WRF-Chem modeling system has been implemented to study air quality problems of highly urbanized cities. An urban canopy model BEP (Building Energy Parameterization)[1] has also been included so that the roughness of the city is taken into a count. BEP includes radiation effects of buildings and fabrics as well as energy due to human activities.

For urban modeling BEP model allows a direct interaction with the PBL and recognizes three-dimensional nature of urban surfaces that substantially impacts the thermodynamic structure of the urban roughness sub-layer and hence the lower part of the urban boundary layer. BEP also takes into account effects of vertical and horizontal (streets and roofs) surfaces on momentum (drag force approach), turbulent kinetic energy (TKE), and potential temperature (Chen, et al. 2011)[2]. This scheme is operational with Noah land surface model (LSM) and has been coupled with two turbulence schemes: Bougeault and Lacarrère (1989)[3] and Mellor–Yamada–Janjic (Janjic, 1994)[4]. The BEP system represents the most sophisticated urban modeling scheme in WRF (Chen, et al. 2011)[2].

To input urban parameters for BEP in the WRF model a Local Climate Zone (LCZ) classification scheme by Stewart and Oke, (2012)[5] and & Stewart, Oke and Krayenhoff (2014) is used, which extend the number of urban classes from 3 to 10 (the 10 Local (Urban Climate Zones of Stewart and Oke 2012)[1].

Study case corresponds to México City, February 2014. Simulation results show that WRFu overestimate maximum values of Temperature and Wind Speed as compared against observations and WRF, which likely depends on LCZ classification and UHI effect seen by the WRFu. Urban Land Use categories used in this modeling system, modify surface roughness length, having a direct effect over the urban canopy that can improve local meteorology simulations hence photochemical description of pollutants over urbanized zones.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-38B

Trace Elements From Ocean-Going Vessels in East Asia:Vanadium and Nickel Emissions and Their Impacts on Air Quality

Junri Zhao, Yan Zhang
Fudan University, Shanghai, China

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

Vanadium (V) and nickel (Ni) are considered the most abundant trace metals in ship exhaust burning heavy fuel oils. This study is the first attempt to estimate the impact of V and Ni from shipping on air quality in East Asia for the year 2015. In this study, emission inventories of V and Ni from shipping and land-based sources were constructed and implemented into the revised aerosol module to simulate ambient V and Ni concentrations. Our results showed that ship emissions contributed the majority of vanadium and were important to nickel emissions in most coastal regions in East Asia, with the contributions exceeding 60% and approximately 40% in some regions, respectively. The simulated ambient V and Ni concentrations has been validated by the measurements, and the comparison revealed there was an obvious improvement (reducing the mean bias by 32%–63%) in the model performance o the V and Ni predictions after including shipping emissions. Our study filled the gaps of trace element contributions in coastal regions and implied that the impact of metals from shipping traffic on regional air quality is worthy of attention in East Asia. Although the International Maritime Organization (IMO) low sulfur fuel policy has been implemented since 2020, the impact of shipping traffic on trace metals with respect to regional air quality is still important given heavy fuel oils being in use.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-39C

Insights into future spatial and temporal variability of $PM_{2.5}$ and O_3 in Xiamen, South China

Qixian Liu
Fudan University, Shanghai, China

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

China Working Group

Abstract

With the acceleration of industrialization and urbanization, air pollution incidents occur frequently in China. The air quality problem has attracted extensive attention from the government and the public, especially in the urban areas in China. In this study, we investigated the future air quality during the "14th Five-Year Plan" (2021-2015) in Xiamen, one of the most prosperous cities in South China. A non-emission reduction scenario and two emission control cases (reduced the anthropogenic emissions 20% and 40% respectively) were simulated in this study using the Community Multi-scale Air Quality (CMAQ) model under the Representative Concentration Pathway (RCP) 4.5 and 8.5 conditions. The result shows that compared with the non-emission reduction scenario, the $PM_{2.5}$ concentration in Xiamen decreases significantly in the next five years after emission reduction, with an average reduction rate of about 30% to 40%. In contrast, the concentration of O_3 keeps the same level compared to year 2020, with an average reduction rate less than 15%. Thus, during the "14th Five-Year Plan", O_3 is still a big challenge to Xiamen's air quality management. More strident emission control strategies are required in Xiamen to meet the air quality standard in the "14th Five-Year Plan".

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-40A

Modelling the impact of urban traffic management strategies on emissions and air quality levels in Barcelona (Spain)

Mr Daniel Rodriguez-Rey[1], Dr. Marc Guevara[1], Dra. Mª Paz Linares[2], Dr. Josep Casanovas[2,3], Dr. Jan Mateu[3], Dr. Jaime Benavides[4], Dr. Carlos Perez García-Pando[1], Dr. Oriol Jorba[1], Dr. Albert Soret[1]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Persistent high levels of NO_2 have severe health effects on population. These are often found in large urban conurbations with high vehicle densities. In Barcelona, with one of the highest vehicle densities in Europe, the two traffic air quality monitoring stations are continuously exceeding the limit values established by the 2008/50/EC Ambient Air Quality Directive. To reduce traffic emissions and associated air pollution levels, Barcelona is applying a series of traffic restrictions that attempt to renew and reduce the amount of circulating vehicles within the city. These include the reduction of private vehicle space in specific areas or urban corridors of the city (superblocks and tactical urbanism) and the implementation of a Low Emission Zone (LEZ) that restricts the entrance of polluting vehicles in the city.

We quantify the impact of the applied traffic restrictions in Barcelona with a tailored multi-scale air quality modelling exercise composed of a traffic, emission and photochemical dispersion models which allows to estimate the induced effect of different traffic restrictions on emissions and air quality at high resolution (i.e. 20 meters). The system combines the CALIOPE mesoscopic air quality model, and a street-scale air quality model composed of the dynamic traffic-emission model VML – HERMESv3 and the CALIOPE-Urban dispersion model.

Results show how the unique application of measures focused on the reduction of vehicle space had no impact on the overall NOx emissions, although street-level NOx gradients of +/- 17% were observed as a consequence of traffic re-routing and the generation of new bottlenecks. When these measures are combined with the LEZ and traffic demand reduction, overall emission reductions are observed (-13% and -30% in NOx, respectively). The study also shows the fit-for-purpose street-scale tool used, since the computed NOx emissions and the NO2 generated street gradients could not be reproduced by the mesoscale approach.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-41B

A cross-model examination of the impact of orography and model resolution on pollutant transport

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IGAC Activities

Abstract

Pollutant transport modelling is widely used to recreate specific pollution events, study emission transport in future scenarios and, in general, to inform mitigation strategies. As such, gaining a concrete understanding of how modelling strategies affect accuracy is essential for choosing appropriate models depending on the application. Transport modelling is commonly based on atmospheric reanalysis data: relatively coarse resolution (>10km) global products based on the consistent assimilation of observational data. This approach is necessitated due to the typical spatial and temporal requirements; however, reanalysis data are generally too coarse to resolve local meteorological effects, such as orographic phenomena, that can have an impact in the overall transport of the pollutants.

In this study, we use aircraft observations obtained as part of the "Effect of Megacities on the transport and transformation of pollutants on the regional to global scales" (EMeRGe) project after releasing an inert tracer gas at three megacities in Asia: Manilla in Philippines, Nanjing in China, and Taipei in Taiwan. The transport of the tracer gas was computed using a number of different models and approaches to assess how the representation of the topography in the different model setups affects the accuracy of the simulation. A Lagrangian model (FLEXPART) was initialised using the European Centre for Medium-Range Weather Forecasts (ECMWF) ReAnalysis 5 (ERA5) data. In addition, a Lagrangian and an Eulerian model (FLEXPART-WRF and FALL3D respectively) were initialised over dynamically downscaled ERA5 data from 31 down to a 1 km grid using the WRF model. This multi-model approach allowed us to cross-examine simulation results and assess: (i) the impact the topography around each location had on the actual transport, as well as (ii) the impact of the representation of the topography in each model has on the simulated transport.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-42C

RWANDA AIR POLLUTION ASSESSMENT AND FORECASTING.

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

Rwanda is among the most population density in Africa and one of the NST1 target is to accelerate urbanization from 17.3% by 2014 to 35% by 2024 and this will accelerate also air pollution. The air pollutant sources in Rwanda include transport emission, agriculture burning, charcoal making, cook fires, industrial emission. There is a need to quantify, forecast and identify the air pollutants sources in Rwanda not only for providing data for academician but also for government and NGOs to determine the efficiency of the policy developed and implemented. During this project, the lower cost air quality monitors will be used to determine the pollutant concentration near different sources. The implementation will be done in three phases (ten RAMPS installation across Rwanda based on the most vulnerable region in a spatial distribution way where at least two instrument will be installed in a province or Kigali City, data collection period and data analysis together with final report), each phases will have a detailed report before starting the next phase. Different pollutants will be measured and analyzed including CO, NO, NO_2, NO_X, SO_2, VOC, O_3, particulates maters (PM2.5, PM10 and PM1) Using optical particulate matter detectors. The calibration of RAMPS before installation will be done based on RCO reference station located in Kigali City for the accuracy of the data. The RAMPs will be installed at maximum height of twenty meters from the ground for being able to relate the finding to the health effect on the population exposed. The exact cases of health effect related to air pollution exposure will be obtained under collaboration with the district hospital near the lower cost air quality instrument data station based on patient diagnosis and consultation.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-43A

Characteristics and Source Apportionment of Trace Metals in PM_{10} and $PM_{2.5}$ at a Traffic Site in Agra, India.

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Dayalbagh Educational Institute, Agra,UP, India

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Air pollution is one of the leading causes of death and in low-income countries it tops the list. Many trace metals in air pose health hazard to people and ecosystems. This study was conducted to investigate trace element pollution in PM_{10} and $PM_{2.5}$ at a traffic site in Agra, India. In this work a four-step extraction procedure was adopted to fractionate particulate matter bound trace metals into four fractions and then determine the bio accessible and mineralised residual fractions. Mass concentrations of trace metals were determined in the samples using inductively coupled plasma optical emission spectroscopy (ICP-OES). The mass concentration of PM_{10} varied from 134.4 to 217.5μg m^{-3} with a mean value of 179.3μg m^{-3} while the $PM_{2.5}$ concentration varied from 54.8 to 169.2 μg m^{-3} with a mean value of 112.1μg m^{-3}. These are respectively 1.8 and 1.9 times higher than Indian National Ambient Air Quality Standards. The mean metal content in PM_{10} samples was of the following order Fe>Si>Zn>Pb>Cu>Cr>Mn>V>Ni>As>Cd and in $PM_{2.5}$ samples was Fe> Si>Zn>Pb>Cu>Ni>Mn>Cr>As>V>Cd. The influence of anthropogenic sources on the concentrations of elements contained in $PM_{2.5}$ and PM_{10} was calculated on the basis of enrichment factor (EF). Zn, Cd, As and Pb had high EF indicating that they were largely derived from anthropogenic activities. The source apportionment analysis was done using Principal Component Analysis (PCA) and Positive Matrix Factorisation (PMF). Percentage contributions of each metal to the sources were identified. Data processed indicated that industry and road traffic were major contributors followed by soil dust and fossil fuel burning.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-44B

Exploring strategies to improve source apportionment in urban areas: Combination and cross-validation of traditional (EPA-PMF) and new (Multi-Isotopic Fingerprint) models.

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

Urban air pollution is considered the major environmental threat to public health in the world, considering that more than 55% of the world population live in urban areas. Identification\quantification of the main pollutant sources in these areas is essential to guide pollution control policies aimed at public health protection and the UN's Sustainable Development Goals 3 (human health) and 13 (climate change). Traditional models employed to source apportionment estimations in particulate material (PM), based on multivariate analysis, have achieved important advances, like U.S. Environmental Protection Agency's - Positive Matrix Factorization (EPA-PMF), employed as a reference model. However, EPA-PMF presents issues associated to source identification and discrimination due to the collinearities among the source tracers. Currently, Multi-Isotopic Fingerprints (MIF) model have demonstrated good resolution for source discrimination, since urban sources are characterized by specific isotopic signatures. But the main limitation of MIF is associated with quantification of sources based on few elements, being little representative of the total PM mass. In order to improve these issues, this study reports strategies for EPA-PMF and MIF combination to improve source identification/discrimination and its quantification in urban areas. We performed EPA-PMF analysis, assessing uncertainties and employing the elemental concentrations and Pb and Zn isotopic signatures measured in PM2.5 from São Paulo City. We have achieved three main findings: 1) cross-validation of PMF source identification based on isotopic fingerprints, (2) source quantification based on the combination of MIF and PMF models for total PM mass, and (3) new insights into potential Zn isotopic signatures of biomass burning and secondary aerosol. Therefore, our findings demonstrated the great potential of the MIF model to provide a step-forward in the source apportionment research. In this line we support future studies on the improvement of isotopic fingerprints databases of sources based on isotopes of diverse elements.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-45C

The study of atmospheric nitrous acid in the North China Plain

Postdoctor Wenqian Zhang, Professor Shengrui Tong, Professor Maofa Ge
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CATCH: the Cryosphere and Atmospheric Chemistry, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Americas Working Group, MANGO: Monsoon Asia and Oceania Networking Group, Southern Hemisphere Working Group, China Working Group, Japan National Committee

Abstract

Gaseous nitrous acid (HONO) as an important precursor of the hydroxyl (OH) radical, plays a significant role in initiating atmospheric chemistry. We have studied HONO formation mechanisms in the North China Plain from 2016 to 2018. For instant, during a period of heavy pollution in winter 2016 at an urban area of Beijing, the maximum of HONO was up to 10.7 ppbv. Vehicle emissions contributed more than 40% to nocturnal HONO. Moreover, homogeneous reaction of NO and OH was found as a main source of HONO due to the high level of NO[1]. Additionally, a vertical measurement about HONO at 8 m, 120 m and 240 m in spring 2018 was conducted. The level of HONO concentration and sources were different from that in the haze event in winter 2016, the average HONO concentration was the highest at 120 m, followed by that at 8 m and 240 m. Heterogeneous reaction of NO_2 is the dominant source of HONO at three measurement heights, especially during the nighttime. Ground surfaces were more important for NO_2 conversion into HONO during this whole spring measurement while aerosol surfaces played the more crucial role when $PM_{2.5}$ concentrations increased. Note that we found a strong HONO formation pathway consuming OH and positively related to solar radiation at upper heights, which could result in different photochemical processes from that at the ground layer[2]. In summary, concentration levels and sources of HONO varied from seasons and heights.

[1] Zhang WQ, Tong SR, Ge MF, et al. Sci Total Environ 2019; 648: 253-262.

[2] Zhang WQ, Tong SR, Jia CH, et al. Environ Sci Technol 2020; 54: 12870-12880.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-46A

An Overview of long-term monitoring efforts of Persistent Organic Pollutants and pesticides in Africa

PhD John K Mwangi
RECETOX, Masaryk University, Brno, Czech Republic

Abstract

Following the Stockholm Convention on Persistent Organic Pollutants (POPs) being entered into force in 2004, the Global Monitoring Plan was put into place to provide long-term data that could be used to evaluate the effectiveness of the recommended regulations.

Within this scheme, the monitoring network in Africa (MONET Africa) was established and through passive sampling, long term data on POPs and pesticides has been collected across many sites in the continent for a decade since 2008. This was possible through supplementary and collaborative approach with other networks such as GAPS network (Environment and Climate Change Canada), pesticide use in tropical settings project (PESTROP), child health and agriculture pesticide study in South Africa (CapSA) and so on.

The Research Centre for Toxic Compounds in the Environment, RECETOX, has been instrumental within these strategic partnerships and networks to realize these results. The contributions and published works from these efforts will be discussed herein.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-47B

Modeling diurnal variation of surface PM2.5 concentrations over East China with WRF-Chem: impacts from boundary-layer mixing and anthropogenic emission

Qiuyan Du[1], Chun Zhao[1], Mingshuai Zhang[1], Xue Dong[2], Yu Chen[1], Z Liu[1], Zhiyuan Hu[3], Yubin Li[4], Renmin Yuan[1], Shiguang Miao[5]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

China Working Group

Abstract

Diurnal variation of surface $PM_{2.5}$ concentration (diurnal $PM_{2.5}$) could dramatically affect aerosol radiative and healthy impact, and can also well reflect the physical and chemical mechanisms of air pollution formation and evolution. Based on the observations, the normalized diurnal amplitude of surface $PM_{2.5}$ concentrations averaged over East China is the weakest (~1.2) in winter, and reaches ~1.5 in other seasons. The diurnal $PM_{2.5}$ shows the peak concentration during the night in spring and fall and during the daytime in summer. The simulated diurnal $PM_{2.5}$ with WRF-Chem and its contributions from multiple physical and chemical processes are examined in the four seasons. The simulated diurnal $PM_{2.5}$ with WRF-Chem is primarily controlled by planetary boundary layer (PBL) mixing and emission variations, and is significantly overestimated against the observation during the night. This modeling bias is likely primarily due to the inefficient PBL mixing of primary $PM_{2.5}$ during the night. The simulated diurnal $PM_{2.5}$ is sensitive to the PBL schemes and vertical layer configurations with WRF-Chem. Besides the PBL height, the PBL mixing coefficient is also found as the critical factor determining the PBL mixing of pollutants in WRF-Chem. With reasonable PBL height, the increase of lower limit of PBL mixing coefficient during the night can significantly reduce the modeling biases in diurnal $PM_{2.5}$ and also the mean concentrations. It can also reduce the modeling sensitivity to the PBL vertical layer configurations. The diurnal variation and injection height of anthropogenic emissions also play roles on simulating diurnal $PM_{2.5}$, but the impact is relatively smaller than that from the PBL mixing. This study underscores that more efforts are needed to improve the boundary mixing process of pollutants in models with observations of PBL structure and mixing fluxes in addition to PBL height, in order to simulate reasonably the diurnal $PM_{2.5}$ over East China.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-48C

Uncertainties propagated from optical properties in aerosol classification schemes

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

Aerosol Optical Depth (AOD) is an integrated measurement of light extinction in the atmospheric column due to the presence of aerosols. Surface sun photometers, such as those managed by the AERONET network (AErosol RObotic NETwork), measure AOD and other aerosols optical properties. Continuous observations of AOD at different wavelengths can be used to derive other products, but the uncertainties associated with the instrument and the acquisition and control algorithms are then propagated affecting these products such as the Ångstrom coefficient. This parameter is of special importance as it is used for aerosol classification, whose results are usually reported without considering the uncertainty propagation impacts. In terms of relative errors, the impact is greater when the absolute value of AOD is lower. Furthermore, if it is also taken into account that the limits proposed by various authors for aerosol classification are usually vague, the conclusions that can be extracted from must be observed with extreme caution. This work aims to characterize the effect of such uncertainties on the aerosol classification schemes using as a study case the Metropolitan Area of Buenos Aires in Argentina, where relatively low AOD values are observed during the year. In this work it was possible to determine that the Ångstrom coefficient calculated as the slope of the spectral dependence of the AOD in a logarithmic space has a mean propagated relative uncertainty of around 30% and that the classifications made with the different schemes are highly affected by this uncertainty.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-49A

Evaluating the impact of dust events on Cloud Condensation Nuclei (CCN) and Aerosol Load levels over the East Mediterranean using satellite observations

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

The Mediterranean Basin is a climatically sensitive region as it becomes subject to water and temperature stresses while it is at a crossroad of air masses originating from Northern Europe, Asia and Africa, carrying pollutants of different chemical composition and origin. The warm and dry air masses from Africa, rich in dust aerosols, can act as Cloud Condensation Nuclei or Ice Nuclei and affect climate.

Aerosol remote sensing techniques provide a great tool for the observation and understanding of aerosols behavior since they allow systematic and extended spatial and temporal sampling of the atmosphere.

During the last decade, several intensive dust outbreaks, originating in the Saharan desert and transporting dust over the East Mediterranean Sea, have occurred and have been observed from space.

In the present study we use satellite observations, aiming to detect the impact of dust transport to Aerosol Load (expressed in terms of optical depth) and Cloud Condensation Nuclei (expressed in number of CCN in the atmospheric column) over the Mediterranean, during major dust events. For this purpose, Cloud Condensation Nuclei and Aerosol Optical Depth Level-3 daily products from Moderate Resolution Imaging Spectroradiometer (MODIS), collected from the Aqua platform and gridded into 1 by 1 degree grids, for the years 2011-2021, have been acquired and analyzed. The results indicate that during mineral dust episodes values of CCN and Aerosol Load can be up to 10 times higher on a daily basis compared to what is observed under background conditions.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-50B

Assessing the role on two anthropogenic emission inventories on the outcomes of air quality simulations for the metropolitan area of Buenos Aires

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group

Abstract

Anthropogenic emission inventories are one of the most critical inputs for air quality models. Consequently, the development of representative regional inventories is always required to improve the results in high resolution simulations. This study aimed to assess the performance of an emission inventory based on local information (PAPILA) in comparison with a global dataset (CAMS-4.1) for the Metropolitan Area of Buenos Aires (MABA). Simulations were run for summer (January) and winter (August) 2015 using WRF-Chem with three nested domains. The high-resolution domain (3km x 3km) is centered in the MABA. Model-predicted surface meteorological fields are overall in good agreement with surface observations, although the model tends to overestimate the maximum values of surface wind speed which may be related to the need to improve the roughness parameters of the model for that region. The outputs were evaluated against CO and NOx ground-based observations from available monitoring stations in MABA. Simulated concentrations using the PAPILA inventory exhibited in general better statistical metrics. Differences in the concentrations resulting from both runs were consistent with those exhibited between the inventories: : CO emissions are 12% higher in the PAPILA dataset than in CAMS being road transportation the main responsible while those of NO_x are 46% higher in PAPILA, with significant discrepancies in emissions from thermal power, road transportation and industrial combustion. For winter, PAPILA-based results had lower gross error than CAMS-based results and the negative bias is larger for the CAMS emission run and exceeds 12% for both CO and NOx. Contrariwise, as emissions during summer are lower because of decreasing use of liquid fuels by vehicles and stationary combustion sources, PAPILA's improvements are not as clear as in winter. Therefore, this work highlights the importance of having accurate inventories especially for winter when the highest emissions and worst dispersion conditions occur.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-51C

MAIAC algorithm calibration uncertainties for sites with low AOD values. Case study: Metropolitan Area of Buenos Aires

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IGAC Activities

Abstract

Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithm has been developed from the MODIS sensor measurements (on-board Terra and Aqua satellite), and combines a time series approach and image processing to derive atmospheric aerosols products. The dataset obtained includes Aerosol Optical Depth (AOD) at 470 nm and 550 nm with high spatial resolution (1 km), which for example could be useful for studying the aerosol variability at the urban-scale. This product is generally calibrated with help of ground-based AOD measurements from solar photometers, being the AERONET network a common method to validate satellite AOD retrievals. Even though the AERONET network provides AOD measurements at various wavelengths, they are not at the same MAIAC wavelength. In order to validate MAIAC, it is used the closest AERONET wavelength or an interpolation is introduced in order to match it up (i.e. to 550 nm and 470 nm). Furthermore, the MAIAC calibration is a complex task since the ground-truth data corresponds to a specific location and 15-min time resolution, while the satellite product provides data few times a day for a wider area. As the whole procedure has associated errors that will impact on the calibrated data they must be considered and propagated when analyzing the data. This work aims to study the MAIAC calibration uncertainties using as a case study the Metropolitan Area of Buenos Aires, Argentina, where relatively low AOD values are observed. The results showed that for low AOD values (0.05 - 0.15), the MAIAC relative expanded uncertainty (REU) is always greater than 20% while for higher AOD values, the REU decreases, observing similar patterns for the considered wavelengths.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-52A

Importance of model complexity on modeling ambient air quality and the resulting health impacts

Forrest Lacey[1,2], Rebecca Schwantes[3,4,5], Louisa Emmons[1], Simone Tilmes[1], Mary Barth[1], Patrick Callaghan[6], Andrew Conley[1], Duseong Jo[1], Peter Lauritzen[6], Gabriele Pfister[1], Francis Vitt[1]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Models are often used to predict ambient air quality and the burden of disease associated with exposure to trace pollutants in the atmosphere. Over time these models have become increasingly complex both in terms of improved horizontal resolution and through the use of more complex chemical mechanisms. While the changes in model parameterizations are often evaluated using available observations, there has been less work done in quantifying the impact on the burden of disease associated with these changes and uncertainties that can be tied to model complexity.

This study uses the newly-developed Multi-Scale Infrastructure for Chemistry and Aerosols (MUSICA version 0), a model framework based on the Community Atmosphere Model with chemistry (CAM-chem), to independently adjust horizontal resolution and chemical complexity in model configurations for CONUS during 2013 and estimate the health impacts from $PM_{2.5}$ and ozone using exposure response functions. Throughout the US increasing horizontal resolution by a factor of eight increases the estimated number of annual deaths by 23% for $PM_{2.5}$ and reduces the burden of disease by 15% for ozone. Conversely increased chemical complexity reduces estimated health impacts by 17% for $PM_{2.5}$ and increases the estimated deaths by 5% for ozone. These results highlight the importance of both chemical complexity and resolution for modeling of health-relevant pollutants and their impacts. Further aggregation of these results to the ten EPA regions highlights the importance of regional changes in model parameterizations and provides additional insight of importance for policy and mitigation strategies within the US and that can help inform uncertainty in other prediction frameworks.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-53B

Towards an automated algorithm for surface PM2.5 estimation using stacked machine learning

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Texas A&M University, College Station, Texas, USA

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Particulates with a diameter less than 2.5 micrometers (PM2.5) are known to have adverse effects on public health. PM2.5 can be measured at ground monitoring stations that are often geographically sparse and thus cannot faithfully document long-term exposure to PM2.5 nationwide. Historically, numerical modeling has filled in the data gap. More recently, a zoo of machine learning (ML) methods have been proposed to estimate surface PM2.5 concentration from satellite observation (notably the aerosol optical depth (AOD)), ground-based measurement of meteorological factors, and other miscellaneous data sources such as proximity to major roads and power plants. However, which variables and ML methods are best suited for this purpose has not been systematically examined.

Here, we estimate PM2.5 concentration from meteorological and AOD data in NASA's MERRA-2 reanalysis spanning 2015-2020. From a pool of 22 candidate variables such as wind speed and direction, humidity, etc., a subset of 10 variables are automatically and objectively selected based on the mutual information criterion. The algorithms under consideration are based on linear regression (Ordinary Least Squares Regression, Elastic Net, Polynomial Regression, Bayesian Ridge, Support Vector Regression using a Radial Basis Function, and Multivariate Adaptive Regression Splines), a Multi-layer Perceptron, or decision trees (Ada Boost, Random Forest, Extra Trees, Gradient Boost, and XGBoost).

The models with the three lowest cross-validated root mean squared error (RMSE) are combined via stacking, which can create a more powerful (i.e., lower RMSE) estimator than the conventional approach of selecting and adopting any single model.

Texas serves as a testbed in this pilot study, but the automated package developed here can be easily adopted elsewhere. In open collaborative efforts with the international community, we aim to deliver this satellite data-driven product to assess the health risk from long-term exposure to PM2.5 beyond the urban environment.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-54C

Aerosol Optical Depth, decadal (2007-2018) scenario over four megacities of India: An Assessment using Gridded MODIS Satellite Observations

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[1]IESD, Banaras Hindu University, Varanasi, Uttar Pradesh, India. [2]Department of Physics, Birla Institute of Technology Mesra, Jaipur, Uttar Pradesh, India. [3]Banaras Hindu University, Varanasi, Uttar Pradesh, India

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Aerosol Optical Depth (AOD) over four metropolitan cities of India i.e. Delhi, Kolkata, Chennai and Jaipur have been analyzed for period 2007-2018. Moderate Resolution Imaging Spectroradiometer (MODIS) onboard NASA's Aqua and Terra platform AOD datasets used for monthly, seasonal and annual variations. Annual mean analysis reveals highest aerosol loading in Indo Gangetic Plains and significant increasing trends from earlier to present year. Delhi recorded maximum AOD during monsoon season (0.95-1.05), whereas Kolkata shows maximum AOD during winter season (0.95-1.05). Chennai reveals low to moderate mean AOD for all the seasons. Annual and Seasonal mean AOD tendencies have been analyzed to know the prominent changes in average aerosol loading during first or last half of the past twelve year (2007-2018). Maximum increase in AOD percentage from 2007-2018 is obtained for Kolkata (39%), followed by Delhi (27.34%), Chennai (26.30%) and Jaipur (16.53%). Further, cumulative effects of different meteorological parameters i.e. temperature, wind speed and relative humidity along with AOD have been studied over all metropolitan cities.

Overall, twelve years mean AOD reflects, Delhi was in the peak of aerosol loading (0.82 ± 0.06), followed by Kolkata (0.82 ± 0.08), Chennai (0.43 ± 0.028) and Jaipur (0.43 ± 0.03).

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-55A

The Observation of particulate matters in a research vessel: indoor concentrations and size distributions

Observation of particulate matter in a research vessel: indoor concentrations and size distributions wu xudong
University of Science and Technology of China, Hefei.Anhui, China

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

There are no reports on the characteristics and exposure risks of airborne particulates in the indoor air of ships. During the period from Shanghai to Antarctica, Lighthouse Handheld 3016 IAQ was used to measure the PM2.5 content in the indoor air of the RV *Xuelong*. This article mainly discusses the characteristics and impact factors of indoor particulate matter in RV *Xuelong*. Characteristics about indoor particles: (1) The indoor PM2.5 concentration of RV *Xuelong* is lower than the indoor concentration standards of different countries. (2) The unsynchronized changes of the number concentration and mass concentration of PM2.5 reveal that there may be new particle generation and growth up events in the indoor environment. (3) The fluctuation of coarse particles over time is obviously stronger than that of fine particles. (4) The number concentration spectrum distribution of indoor particulate matter satisfies the power function trend, and the mass concentration spectrum distribution shows that the maximum mass concentration distribution is at 2~4mm. Impact factors: (1) Some rooms in 31 Antarctic Routes were discussed. Temperature had little effect on particles larger than 0.3 mm in diameter, but the relative humidity had a certain influence on the concentration of particles through moisture absorption and growth; (2) Three rooms in 34 Antarctic Routes were discussed, and the rooms are less affected by the outdoor. This study is the first to study the characteristics of indoor particulate matter in ships and analyze its impact factors, which provides valuable information for crew exposure risk assessment.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-56B

Characterization, oxidative potential (OP) and health risk analysis of PM2.5 bound trace metals during foggy and non-foggy episodes at a site in the Indo-Gangetic Plain

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Dayalbagh Educational Institute, Agra, Uttar Pradesh, India

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, ACAM: Atmospheric Chemistry and the Asian Monsoon

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

This study assesses the acellular technique (Dithiothreitol, DTT Assay) for measuring oxidative potential (OP) of $PM_{2.5}$, metals (Fe, Cu, Mn, Cr, Zn, Cd, Ni, K, Mg, Na, Ca, Pb, Ba and Al) and health risk associated with trace metals (Ba, Cu, Mn, Pb, Zn, Ni, Cr and Cd) during foggy and non-foggy episode in the year 2019 at a rural site in the Indo-Gangetic plain, India. The mean concentration of $PM_{2.5}$ during foggy and non-foggy episode was found to be 134.9 ± 52.8 and 98.2 ± 57.4 μg m^{-3} respectively and higher than WHO and NAAQS limit. The results showed mean value of trace metals followed the order: Fe > Zn > Pb > Mn > Cu > Cr > Ni > Cd. The volume- and mass- normalized DTT activities (DTTv and DTTm) of $PM_{2.5}$ were higher in foggy episode (2.6 ± 2.4 $nmolmin^{-1}m^{-3}$ and 27.6 ± 13.3 $pmolmin^{-1}\mu g^{-1}$) than non-foggy episode (1.0 ± 0.7 $nmolmin^{-1}m^{-3}$ and 19.9 ± 24.2 $pmolmin^{-1}\mu g^{-1}$). Strong correlations (r > 0.7) were found between DTT activity and trace metals like Cu, Mn, Cd, Ni and Cr in both the episode. Cr and Mn showed the highest carcinogenic and non-carcinogenic risks. Cumulated non-carcinogenic risk in children (HI: 6. 01 for foggy days; HI: 3.23 for non-foggy days) was higher compared to the adults (HI: 2.60 for foggy days; HI: 1.40 for non-foggy days) during both episodes while the cumulated carcinogenic risk was higher for adults (ILCR: 5.12E-05) than for children (ILCR: 2.98E-05) during foggy than non-foggy episode via inhalation. Enrichment factor (EF) calculations showed that Cd, Pb, Zn, and Cr were enriched being contributed by anthropogenic activities carried out in the industrial sectors of the city.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-57C

Characteristics of Volatile Organic Compounds over Hong Kong Waters in a Pilot Ship Measurement Campaign During Ozone Episode

Ho Wun Lee[1], Dasa Gu[1], Ka Fung Leung[1], Hao Sun[1], Yuchen Mai[1], Penggang Zheng[1], Zhe Wang[1], Zhi Ning[1], Jian Zhen Yu[1], Jimmy Fung[1], Alexis Lau[1], Peter Louie[1,2], Kenneth Leung[2], Cathy Lee[2], Hilda Huang[2], Claudie Wong[2]
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Abstract

Since the mid-1990s, the rapid economic growth in the Pearl River Delta (PRD) led to significant increasing nitrogen oxides and volatile organic compounds (VOCs) emissions and caused severe photochemical ozone pollution. Despite local and regional efforts on reducing ozone precursor emissions, increasing ozone concentration is still observed in Hong Kong due to the regional transportation of both ozone and its precursors. Albeit being well researched on land, patterns of ozone and its precursors were not well understood over PRD waters. To investigate the characteristics of ozone precursors over Hong Kong waters, hourly whole air canister sampling was performed during the ozone episode during Nov 23~27, 2020, near the western sea boundary of Hong Kong (WSB) and at HKUST Air Quality Research Supersite. 86 VOC species were quantified by the HKUST VOC Lab's GC-FID/ECD/MSD system. A higher ozone formation potential was observed in WSB due to substantial contributions from aromatics. In contrast, the comparable contributions between aromatics and alkenes were observed at HKUST alongside their lower concentrations. Estimating maximum air mass age via alkyl nitrate to parent alkane ratio yielded an age of up to 4.7 hours at HKUST and below 3 hours for WSB. By comparing samples collected at the same time, HKUST samples had higher air mass age (0.5~1 hour) than WSB samples on Nov 24 and 26. It suggests eastward regional transport of VOCs from the Pearl River Estuary significantly contributed to local ozone formation during the episode. Further shipborne measurements are therefore warranted for understanding the transportation pattern of photochemical ozone and its precursors over Hong Kong.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-58A

The aggravated short-term PM2.5-related health risk due to atmospheric transport in the Yangtze River Delta

Dr Peng Wang[1], Dr Juanyong Shen[2], Mr Shengqiang Zhu[1], Dr Meng Gao[3], Mr Jinlong Ma[1], Mr Jie Liu[2], Dr Jingsi Gao[4], Prof Hongliang Zhang[1]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

Severe fine particulate matter (PM2.5) pollution and the associated health risks remain pressing issues in the Yangtze River Delta (YRD), although significant efforts have been made locally, such as the Clean Air Action since 2013. Regional transport is an important contributor to high PM2.5 levels during haze episodes in the YRD, but its impact on human health is rarely analyzed. In this study, we evaluate the short-term PM2.5-related health risks and associated economic losses due to different source regions by estimating daily mortality based on model results in the YRD. The results show that regional transport induces significant health risks in the YRD during haze days, contributing over 60% of daily premature mortality in Shanghai and Nanjing (major cities in the YRD). Moreover, in Hangzhou and Jiaxing, regional transport's contribution can be as high as 70%. The total daily mean economic loss in the YRD is estimated as 526.8 million Chinese Yuan (approximately 81.4 million U.S. dollar) in winter of 2015 and 2016, accounting for 1.4% of the daily averaged gross domestic product (GDP) of the YRD. Emission control (in accordance with the 13th Five-year Energy Conservation and Emission Reduction Plan) is an effective way to reduce health risks in the YRD, reducing premature deaths during haze days by 12-33%. More stringent emission control measures are suggested for further reduce PM2.5-related health risks.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-59B

Long-term fog variation and its impact factors over East China

Dr Shuqi Yan, Prof Bin Zhu
Nanjing University of Information Science & Technology, Nanjing, China

Abstract

The long-term variation of fog includes two aspects, fog frequency (fog days) and fog lifetime (fog duration). Previous studies have demonstrated that long-term fog variation is controlled by three impact factors, climate change, urbanization and aerosols. However, few studies have disentangled their complex influences on fog variation.

The long-term variation of fog days over major city clusters of East China are revealed by ground meteorological observation data from 1960 to 2012. Fog days increase first and then decrease, and the turning point occurs 5~15 years earlier in large cities than in small cities. Furthermore, the respective contributions of climate change, urbanization and aerosols are quantitatively calculated. During the initial urban development stage (1960-1985), the increase in fog days is dominantly contributed by the promoting effects of increasing aerosols (45~85%). During the fast urban development stage (1986-2012), the promoting effect of aerosols weakens, while the inhibiting effect of urbanization becomes the dominant factor (53~60%). During the overall period (1960-2012), aerosols have positive effects on fog (20~40%).

The trend of fog duration is analyzed by using manually-recorded weather phenomenon data from 1960 to 2010. More than 90% of stations witness an increase in fog duration, and this trend is caused by the increase in aerosol pollution. The promoting effect of aerosols is contributed by aerosol-radiation interaction (ARI; also aerosol direct effect) and aerosol-cloud interaction (ACI; also aerosol indirect effect). Therefore, the separate effects of ARI and ACI on fog lifetime are quantitatively revealed by WRF-Chem simulations. ACI advances fog formation, delays fog dissipation and increases fog duration by about one hour. In contrast, ARI effect is quite weak, which increases fog duration only by 3 min. Further experiments show that ACI effect on fog duration overweighs ARI effect under different moisture conditions, pollution levels and sensitive experiment settings.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-60C

A new air quality index to measure the impact of urban trees on air quality, human health and secondary pollutant formation

Mrs Savita Datta, Mrs Anita Sharma, Mr Vidit Parkar, Mr Haseeb Hakkim, Mr Ashish Kumar, Mrs Astha Chauhan, Mr Shubham Singh Tomar, Mrs Baerbel Sinha
Indian institute of science education and research, Mohali, Punjab, India

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

At present, urban planners select tree species for urban plantation based on criteria which are heavily biased towards the aesthetics and economic value of trees and the tree's air pollution tolerance and summarized in an anticipated performance index (API). While it is important to select trees that can survive in a polluted environment, it is equally important to consider whether the chosen species will aggravate the pollution by emitting highly reactive ozone or secondary aerosol precursors. Pollen allergy potential, too, has a significant impact on human well-being.

In this study, we contrast the impact of two species with a high API rating, namely *mangifera indica* and *Polyalthia longifolia,* with an API of 5.9±0.9 and 4.8±1.0, respectively. The former is a high isoprene and moderate monoterpene emitter, while the latter is a non-isoprene emitter and a low monoterpene emitter. After investigating their net impact on summertime secondary pollution formation using VOC flux measurements, leaf porometer measurements, and the DO3SE model we propose a new Air Quality Impact Index AQII, which allows to evaluate the impact of planned tree plantation drives in the urban environment in a holistic manner, by taking take aerodynamic properties, leaf structure, pollution uptake potential, pollution tolerance, ozone and SOA precursor emissions, and the pollen allergy impact into account.

We conduct a literature review and compile a list of 121 species out of approximately 250 tree species which are commonly considered for urban plantation in India for which VOC emissions have been reported prior (114) or are reported for the first time in the current study (7). We also compile the pollen allergy potential (79) and air pollution tolerance (76) and calculate the air quality impact index AQII for 74 species for which sufficient data is available.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-61A

Spatial bias-correction method for street-scale air quality models

Dr. Jan Mateu Armengol[1], Dr. Marc Guevara[1], Dr Herve Petetin[1], Alvaro Criado[1], Dr Jaime Benavides[1], Daniel Rodriguez-Rey[1], Dr Carlos Perez Garcia-Pando[1,2], Dr Albert Soret[1], Dr Oriol Jorba[1]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Urban dispersion models are designed to capture the spatial variability that pollutants exhibit at the street scale. However, they are afflicted by strong uncertainties. Major challenges include accounting for the multiscale nature of the phenomenon, constraining emissions at such scales, and downscaling the turbulent wind flow within street canyons. In order to minimize these uncertainties, spatial bias-correction methodologies aim at correcting the systematic errors of the model at the entire computational grid using observations. In this work, we derive a method that preserves the spatial variability estimated by the urban model while robustly improving the model output. This method is based on linear regressions for the daily mean concentration and the daily variability, which are fitted using the available data pairs of model-observation. Using these regressions, hourly results are corrected based on their daily mean and daily variability, relying solely on the model output. The post-processing models are refitted every day to account for the dependency of the systematic errors on the meteorological conditions.

To assess the capabilities of this spatial bias-correction method, we examine two full years (2017 and 2019) of NO_2 model results over the city of Barcelona, Spain, using the dispersion model CALIOPE-Urban. Observations are obtained from nine urban monitoring sites in Barcelona within the official Catalan network (XVPCA). Cross-validation results show that locations where observations are unavailable have a correlation coefficient of 0.62 and a fraction of predictions within a factor of two of 0.80 on average. A reliable characterization of spatiotemporal maps of air quality is key to design effective traffic restrictions to meet the regulated air-quality limits all over Barcelona city. In addition, bias-corrected NO_2 concentrations with full spatial coverage are an essential input for epidemiological studies assessing the pollution impact on public health.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-62B

Simultaneous observations of NO2 and HCHO from three different locations in India

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Formaldehyde (HCHO) and nitrogen dioxide (NO2) are important atmospheric pollutants and key ingredients for tropospheric ozone (O3) production. Here we present Multi Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) observations of HCHO and NO2 over three different locations in India. Measurements were made at Mirzapur, a rural location in India during monsoon 2014; followed by observations at Mahabaleshwar, a high-altitude station in India during the pre-monsoon period of 2018; and a year-long campaign in Pune City, an urban location in western India. Due to higher anthropogenic emissions, Pune City showed the highest average NO2 mixing ratio (1.62 ± 1.24 ppb) among the three observation sites, followed by Mirzapur (0.81 ± 0.20 ppb). Mahabaleshwar showed the lowest average NO2 mixing ratios (0.19 ± 0.06 ppb) as it has the least anthropogenic activities in its vicinity. This indicates that anthropogenic emissions are mainly responsible for observed differences in NO2 between the three sites. The average HCHO mixing ratios were highest in Pune (2.64 ± 1.43 ppb) followed by Mirzapur (1.93 ± 0.60 ppb) and Mahabaleshwar (1.6 ± 0.61 ppb). The difference in HCHO mixing ratios between Mahabaleshwar and Mirzapur was smaller compared to that of NO2, indicating that the background HCHO over both the places were controlled by the biogenic HCHO. The higher average HCHO mixing ratio over Pune was probably due higher anthropogenic emissions of precursors from automobiles. Diurnal profiles of these two trace gases in Mirzapur and Pune were dominated by photochemistry, with Pune showing a distinguished morning traffic-related peak. At Mahabaleshwar, the trace gas mixing ratios were dominated by boundary layer evolution. Mixing of trace gases emitted from the mountain bases due to boundary layer evolution is the main source of HCHO and NO2 in Mahabaleshwar.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-63C

Predicting future changes of soil selenium based on Se atmospheric deposition.

Yutao Chen, Yang Gao
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IGAC Activities

GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, TOAR: Tropospheric Ozone Assessment Report, ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CATCH: the Cryosphere and Atmospheric Chemistry, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

China Working Group

Abstract

Selenium (Se) is one of the essential dietary elements of human beings which can improve immunity, help anti-aging and prevent from cancer. Further research has found moderate Se intake can counteract the toxicity of arsenic and improve the cure rate of COVID-19. The dietary availability of Se is determined largely by their soil concentrations. In previous studies, atmospheric deposition was verified to dominate surface soil distribution by collecting precipitation and aerosol samplings. In this study, we construct an Se emission inventory and add Se chemistry reactions based on GEOS-Chem. The model result suggests that the distribution of soil selenium concentration and Se deposition have a good consistency in mainland of China, with R = 0.65. The distribution of soil Se is found more similar to that of precipitation rather than to emissions in China, which support that atmospheric wet deposition is the main contributor of soil Se content due to high solubility of Se. In terms of the future precipitation variation, the future soil Se content may increase in northern China and decrease in southern China.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-64A

Simulated fine particulate air pollution attributable to coal-fired power in the Highveld

Ms. Patricia-Ann van der Walt[1], Mr. Mogesh Naidoo[2], Dr. Roelof Burger[1], Dr. Rebecca Garland[2]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

South Africa, a developing country, is continuously challenged with keeping a balance between competing economic-, social- and environmental factors. Coal-fired power dominates the energy supply sector, with the majority of the coal-fired power plants concentrated in the coalfields of the eastern inland plateau known as the Highveld. The Highveld Priority Area Air Quality Management Plan sees the power generation sector as the highest contributor of sulphur dioxide and oxides of nitrogen in this region. These emissions are known precursors for secondary fine particulate air pollution (PM2.5). A photochemical grid model, the Comprehensive Air Quality Model with Extensions (CAMx), was used to explore the relationship between emissions from coal-fired power plants and PM2.5 air pollution in the Highveld. The source contribution to PM2.5 was estimated through the difference between a baseline simulation of the Highveld atmosphere and a control simulation, which excluded coal-fired power plant emissions. The study was able to isolate the full impact of the coal-fired power plants on the concentration and distribution of PM2.5 over the Highveld and found that the noticeable change in the simulated PM2.5 was due to secondary PM2.5. The presentation will show the changes in the simulated mass concentration and composition of the PM2.5 air pollution over the Highveld and that attributable to the coal-fired power plants.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-65B

Mixing Height Simulations over the Chiang Mai Valley Atmosphere in Northern Thailand

Ronald Macatangay, Sherin Hassan Bran
Atmospheric Research Unit, National Astronomical Research Institute of Thailand, Chiang Mai, Thailand

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The mixing height, sometimes also referred to as the mixing layer height, the atmospheric boundary layer (ABL) height or the planetary boundary layer (PBL) height, is one of the meteorological parameters that affect particulate matter concentrations on the surface. Its accurate simulation implies lesser uncertainty in forecasting air pollutant concentrations. In this study, the Weather Research and Forecasting (WRF) model was utilized to simulate the mixing height over the Chiang Mai valley atmosphere in northern Thailand from December 2020 to March 2021 using the standard MODIS terrestrial dataset and the USGS (with updated Thailand) terrestrial data. Atmospheric LiDAR observations were used for validating the simulations. Results showed that the modeled hourly and diurnal average mixing height only had a slight sensitivity to the terrestrial datasets used and that the greatest discrepancy with observations occured during periods with high aerosol loading (March). This suggests aerosol-PBL interactions occuring and further model simulations will be undertaken by coupling the model to chemistry and enabling aerosol feedbacks.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-66C

Decision support system for air-quality management in Delhi and the surrounding region

Gaurav Govardhan[1,2], Preeti Gunwani[1], Chinmay Jena[1], Rajesh Kumar[3], Sumit Sharma[4], Sreyashi Debnath[1], Sachin Ghude[1], Ravi Nanjundiah[1,5], M Rajeevan[6]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Delhi, the capital city of India, has been witnessing polluted autumns and winters during the recent decade. The Indian Institute of Tropical Meteorology has led the development of an 'Air Quality Early Warning System' (AQEWS) to alert the citizens and the policymakers about the potential severe air-quality events. However the policy makers need more precise information on the possible sources responsible for the degraded air-quality during a forecast air-quality event. We have now extended the AQEWS with a 'Decision Support System' (DSS) for air-quality management in Delhi. DSS is designed to deliver quantitative information about the contribution of a). the emissions from Delhi and the surrounding 19 districts to the air-quality in Delhi b). the emissions from 8 different sectors in Delhi to the air-quality Delhi c). the biomass-burning activities in the neighboring states to the degradation of air-quality in Delhi. This information would clearly highlight the most important emission sources responsible for the degraded air-quality in Delhi. Additionally, DSS also gives an information about the quantitative effects of possible emission source-level interventions on the forecast air-quality event in Delhi. Here, we show implementation of DSS for a). an air-quality event that occurred in Delhi during the winter month of January 2021 and b). a biomass-burning event that occurred in the states surrounding Delhi during the month of October 2020. In addition to the region-wise and Delhi's sector-wise source apportionment, we also show the impacts of possible source-level intervention on the air-quality in Delhi especially during such severe air quality events. With a plethora of quantitative information, the AQEWS integrated with DSS is likely to be a very important tool for air-quality management in Delhi and the surrounding region.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-67A

Fog-forecast over the northern region of India employing realistic aerosol

Gaurav Govardhan[1,2], Avinash N. Parde[1,3], Sachin D. Ghude[1], Bernard Claxton[4]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

One of the major environmental issues that the northern part of India faces during winters is frequent occurrence of fog and the associated reduction in visibility. Several flights get delayed or cancelled due to such low visibilities, which results in tremendous monetary losses. Moreover, the reduced visual range also affects the rail and road transport causing severe accidents and resulting in casualties. All these factors underscore the importance of fog-forecast for the entire northern region of India. The existing algorithms for visibility predictions employ empirical relationship between visibility and liquid water content, with no or a constant aerosol number concentration. This assumption may not hold good especially over a region like Delhi, where aerosol concentration during the winter months are the highest. In this study we aim to couple real-time simulated aerosols and fog-prediction. For this, we make use of the simulated aerosols (PM2.5) and meteorological parameters (pressure, temperature, liquid water content, specific humidity) from the WRF-Chem model simulations run for the 'Air Quality Early Warning System' for Delhi. The model results are fed to the 'Visibility Employing Realistic Aerosol' (VERA) scheme of the United Kingdom Met Office to predict visibility. VERA employs log-normally distributed aerosol species with varying hygroscopicity and allows them to participate in the cloud/dew droplet formation processes. The resulting microphysical properties of the droplets in turn decide the visibility. Such framework has been utilized to compute visibility over Delhi during 8 fog-event that occurred in the month of December 2020. The comparison of VERA computed visibility with the traditional visibility-computing algorithms will be shown with the background of observed visibility.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-68B

Biogenic Volatile Organic Compounds (BVOCs) and roles on Air Quality (Ozone and PM2.5) over Northern Thailand

Dr. Vanisa Surapipith[1], Dr. Saran Poshyachinda[1], Dr. Pornpun Uttamang[2], Dr. Teerachai Amnuaylojaroen[3], Ms. Angkhana Ketjalan[1], Dr. Radshadaporn Janta[1], Prof. Alex Guenther[4]
[1]National Astronomical Research Institute of Thailand, Chiang Mai, Thailand. [2]Maejo University, Chiang Mai, Thailand. [3]University of Payao, Payao, Thailand. [4]University of California at Irvine, Irvine, USA

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, ACAM: Atmospheric Chemistry and the Asian Monsoon, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Air pollution has drawn increasing attention from the government as well as the general public of Northern Thailand, particularly that of Chiang Mai, as various negative impacts of poor air quality have been recognized, ranging from increased incidents of pulmonary diseases in the population, to its adverse effects on economy and tourism. Despite not well-known among the pubic, Volatile Organic Compounds (VOCs) play an important role in fine particulates, so called PM2.5, formation both anthropogenic sources (AVOCs), such as road traffic, and VOC emissions from biogenic sources of which vegetation is the primary source. BVOCs include terpenoids (e.g., isoprene and monoterpenes), hexenal family compounds (hexenals, hexenols, and hexenyl esters), methanol, and acetone. In the presence of sunlight and nitrogen oxides (NOx), reaction of VOCs contributes to the formation of ozone (O3) and PM2.5 prominently in summer, when both photochemical activity and BVOC emissions reach the peak. Reactivity of BVOCs has been estimated to be two to three times that of their counterparts from gasoline combustion, and so resulting in background concentration of PM2.5 contributing to what is called Blue Haze. At NARIT, Weather Research and Forecasting with Chemistry (WRF- Chem) model has been set up on High Performance Computing (HPC) environments with the attempt to understand atmospheric processes and eventually forecast the air pollution episodes. Field observation from air sampling on flux towers above plant canopy in Payao, Lampang and Chiang Mai, during 2020-2021 are generating new emission factors of BVOCs to be used in WRF-Chem, which considers the best fit microphysics, short and long-wave radiation parameterization and boundary layer schemes. Preliminary finding is that WRF-Chem with improvement on BVOCs emission inventory capture the actual activities, such that the modelling system will be useful for supplying the necessary information to decision makers in controlling air quality in Northern Thailand.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-69C

Rainwater Chemistry during the GoAmazon2014/5: the multiple influence of biogenic, biomass burning and urban pollution on the compostion of precipitation in Central Amazonia

Professor Theotonio Pauliquevis[1], Ricardo H. M. Godoi[2], Glauber Cirino da Silva[3], Cybelli Barbosa[2], Priscila Kurzlop[2], Paulo Artaxo[4], Scot T Martin[5], Henrique M. J. Barbosa[4]
[1]UNIFESP, Diadema, SP, Brazil. [2]UFPR, Curitiba, PR, Brazil. [3]UFPA, Belem, PA, Brazil. [4]USP, Sao Paulo, SP, Brazil. [5]Harvard University, Cambridge, MA, USA

Abstract

Daily rainwater was sampled from August/2014 to March/2015 in Central Amazonia during the GoAmazon2014/5 Experiment, in a site subject to a mix of natural biogenic emissions, large-scale transport of biomass burning during the dry season, urban emissions from Manaus (~100 km upwind), and a minor influence of small brick factories. Three distinct scenarios could be distinguished: 1) Aug-Oct/2014, with higher influence of biomass-burning plumes; 2) Nov-Dec/2014, a transitional period, and 3) Jan-Mar/2015, clean atmosphere, due to the enhanced precipitation of the wet season. Samples were analyzed by ion chromatography, and the results show that during period (3) the Volume Weighted Mean (VWM) concentrations are comparable to previous measurements in pristine amazonian areas. The pH was ~5.0, typical of the clean atmospherem, acidity was mainly associated to weak organic acids such as acetic and formic acids from natural origin. These facts indicate that either the impact of the Manaus plume on the rainwater chemical composition is small or that episodes of urban plumes are less frequent during wet season. In the dry period, and under the strong influence of biomass burning the average pH dropped to ~3.5, which is very low and a consistent indicator of degradation of the atmospheric state. The concentrations of Chlorine, Potassium, Sulfate and Nitrate ions increased by a factor of 7.5, 4.7, 3.6 and 2.5, respectively, compared to the wet period. The dry period was also characterized by an excess of ammonium, and the ratio NH4:SO4 was up to 10:1 in some specific days (1:1 during the wet season). Potassium and Chloride were correlated ($r = 0.64$, $p < 0.01$), an indication of the presence of the biomass burning tracer KCl. The result shows clearly that biomass-burning impacts the composition of rainwater significantly even far from sources (at least ~ 1000 km).

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-70A

Development of a regional air quality reanalysis over the contiguous United States

Dr. Rajesh Kumar, Dr. Cenlin He, Dr. Piyush Bhardwaj, Dr. Stefano Alessandrini
NCAR, Boulder, Colorado, USA

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations

Abstract

Air quality simulations suffer from errors and biases due to errors in initial conditions, uncertainties in input emissions, and poor understanding of some of the air quality processes. These errors and biases can be partially addressed via assimilation of space-borne observations of atmospheric composition available from the National Aeronautics and Space Administration (NASA) satellites. With the objective of improving long-term air quality simulations for use in the trend analysis in unmonitored areas and studies linking air quality to human health, we have developed a chemical data assimilation system to simultaneously assimilate aerosol optical depth (AOD) retrievals from the Moderate Resolution Imaging Spectroradiometer (MODIS), and carbon monoxide (CO) retrievals from the Measurement of Pollution in the Troposphere (MOPITT) in the Community Multiscale Air Quality (CMAQ) model. The Weather Research and Forecasting (WRF) is used to simulate the meteorological input for CMAQ air quality simulations over the contiguous United States (CONUS) at 12 x 12 km^2. WRF simulations have been performed for 2005-2018 and evaluated against the ground-based and satellite observations. The WRF model has been found to capture the seasonal, interannual, and regional variability of key meteorological parameters very well. CMAQ air quality simulations with assimilation of MODIS AOD and MOPITT CO have been completed for 2005-2007 and are being run for 2008-2018 currently. A preliminary evaluation of the first three years of CMAQ simulations shows good performance in capturing the seasonal cycle of ozone and fine particulate matter at state-level in the U.S. This presentation will discuss the design of the chemical data assimilation system and its impact on air quality simulations. The presentation will also evaluate the trends in surface ozone and fine particulate matter from the chemical reanalysis against the observations.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-71B

Forecasting of $PM_{2.5}$ Concentration under Climate Change over Thailand

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

The atmosphere's unusual variations directly affect meteorological parameters such as temperature, pressure, and humidity. Several studies show that the relationship between meteorological factors (temperature and pressure) can significantly impact most air pollutants [1]. In addition, research in the Pearl River Delta region reveals that increases in surface temperature under the RCP8.5 scenario is critical in the accretion of future air quality. Severe climate change has direct effects in the vertical atmosphere [2].

The air pollution situation has been studied as an important environmental problem in Thailand for a long time. The air pollutants that usually appear in Thai national journals are particulate matter with a diameter of less than 10 μm (PM10) and 2.5 μm (PM2.5), ozone (O3), carbon monoxide (CO), and nitrogen oxide (NOx). Nowadays, the PM2.5 and O3 have become the harmful air pollutants because of the rapid increase of their level against the standard according to the Annual Report of Air Quality and Noise Management Bureau 2018 of the Pollution Control Department (PDC), which is under the Ministry of Natural Resources and Environment of Thailand [3].

This study aims to investigate the impacts of climate change on future $PM_{2.5}$ concentration in 2022 to 2026 under different RCP (4.5 and 8.5) [4] by using the WRF-Chem model Weather Research and Forecasting model coupled with Chemistry (WRF-Chem).

Keyword: Weather Research and Forecasting model coupled with Chemistry (WRF- Chem)

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-72C

Levels of PM2.5 in Great Mendoza (Argentina) and its impact on bicyclists

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations

Abstract

Particulate matter (PM) is one of the main air pollutants in cities being its primary source the vehicular traffic emission. Many cities are promoting the use of bicycles as a decarbonized transportation mode, motivated by a range of environmental, economic, health, and social benefits. But cyclists are exposed to air pollutants. The purpose of this study is to evaluate PM2.5 concentrations in Great Mendoza to determine the health impact on bicyclists, using low-cost PM2.5 sensors and WRF-CALPUFF modeling. University student volunteers belonging to UTN-FRM carried OpenSeneca equipment on their bicycles, mounted with SPS30 sensors and GPS, during their rides in Great Mendoza during August and September 2019, thus collecting geolocated PM concentration data in the city. The information was organized with a GIS system and modeled with WRF-CALPUFF, in a 23 km x 30 km modelling domain, with 350 resolution grid. The PM2.5 Inhaled Dose in real time was calculated, for each lap of the route discriminating city zones. The results show an hourly profile in the city, with PM2.5 levels higher in the midday hours and in the evening at sunset, and higher PM2.5 levels on main streets, to which cyclists are exposed. These findings provide valuable information for deciding the design of future bikeways.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-73A

Effects of Land Use and Land Cover pattern on Meteorology and Air Quality over Delhi

Dr. Preeti Gunwani[1], Dr. Chinmay Jena[1,2], Mr. Prafull Yadav[1], Dr. Gaurav Govardhan[1,3], Ms Sreyashi Debnath[1], Dr. Sachin Ghude[1], Dr. Manoj Khare[4], Ms Akshara Kaginalkar[4]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

National Capital Region, Delhi has witnessed rapid changes in Land Use Land Cover (LULC) due to anthropogenic and economic developmental activities. Albedo, emissivity and surface roughness are important parameters influenced by the LULC. The physical characteristics of LULC further govern the moisture and energy fluxes between the land and the atmosphere. Dynamically changing land cover is a key factor in modulating meteorology and air quality of an area. Thus, it is important to have an understanding of these land surface effect and land-atmosphere interaction on near surface meteorological fields and atmospheric boundary layer structure. In this study, Weather Research and Forecasting model with Chemistry (WRF/Chem) and single layer Urban Canopy Model (UCM) is used to simulate meteorology and air quality over Delhi during winter period using MODIS and Sentinel LULC data. The urban category in the Sentinel data has been reclassified into three categories (High-rise, Mid-rise and Low-rise building), which allows for a realistic representation of urban land use area. It is seen that the LULC changes have caused distinct differences in simulated temperature, humidity, height of the planetary boundary layer and concentration of particulate matter. The model simulation results show that land-use change from MODIS to Sentinel reduced the averaged 2 m temperature by up to 2K, decreased the average planetary boundary layer height by 100m and increased the particulate matter concentration by up to 50 ug/m^3. The overall analysis indicates how that the atmospheric environment is sensitive to land-use changes.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-74B

Modeling secondary organic aerosol formation from volatile chemical products in Los Angeles

Elyse A Pennington[1,2], Dr. Karl M Seltzer[2], Dr. Benjamin N Murphy[3], Dr. Momei Qin[4,2], Dr. Yuan Wang[1,5], Dr. John H Seinfeld[1], Dr. Havala O.T. Pye[3]
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Abstract

Volatile chemical products (VCPs) are commonly-used consumer and industrial items that are an important source of anthropogenic emissions. Organic compounds from VCPs evaporate on atmospherically relevant time scales and include many species that are secondary organic aerosol (SOA) precursors. However, the chemistry leading to SOA, particularly that of intermediate volatility organic compounds (IVOCs), has not been fully represented in regional-scale models such as the Community Multiscale Air Quality (CMAQ) model, which tend to underpredict SOA concentrations in urban areas. Here we develop a model to represent SOA formation from VCP emissions. The model incorporates a new VCP emissions inventory and categorizes new SOA precursor emissions into three classes: siloxanes, oxygenated IVOCs, and nonoxygenated IVOCs. VCPs are estimated to produce 1.67 μg m^{-3} of noontime SOA, doubling the current model predictions and reducing the SOA mass concentration bias from -75% to -58% when compared to observations in Los Angeles in 2010. While oxygenated and nonoxygenated VCP species are emitted in similar quantities, SOA formation is dominated by the nonoxygenated IVOCs. This work suggests that VCPs contribute up to half of anthropogenic SOA and it is necessary to better represent SOA precursors from VCPs in CMAQ algorithms to predict the urban enhancement of SOA.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-75C

Understanding NO_2 concentrations on the South African Highveld using a ground-based monitoring system

Ms Refilwe Faith Kai[1], Professor Mary Scholes[1], Professor Robert Scholes[2]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

We will present the Highveld nitrogen dioxide concentration data obtained using the ground-based Pandora-2s monitoring system. The quasi-continuous data will be used to investigate the seasonal and daily cycles of near-ground and tropospheric column nitrogen dioxide concentrations over the Highveld atmosphere.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-76A

Understanding aerosol composition in an inter-Andean valley impacted by sugarcane- intensive agriculture and urban emissions.

MSc student Angela C Vargas[1], PhD student Lady Mateus Fontecha[1], PhD Rodrigo Jimenez Pizarro[1], PhD Nestor Y Rojas Roa[1], PhD Germán H Rueda Saa[2]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Agro-industrial areas are usually affected by various sources of atmospheric pollutants with impacts on public health and ecosystems. However, air quality monitoring in these areas is infrequent because of their lower population density when compared to large cities, especially in developing countries. The Cauca River Valley (CRV) region is an agro-industrial zone in Colombia, focused on the production of sugarcane derivatives. Also, the area is affected by traffic emissions. This study aims to unravel the chemical composition of PM2.5 and to identify the main sources that impact the air quality in the CRV. For this, a sampling campaign was carried out in a representative site of the region, measuring daily mass concentrations of PM2.5 and the concentrations of water-soluble ions, trace metals, organic and elemental carbon, and the organic compounds: carbohydrates, n-alkanes, and polycyclic aromatic hydrocarbons (PAHs). The sampled mean concentration of PM2.5 was 14.6 ± 4.6 mg m-3, and the most abundant constituent was organic material (55.4% ± 6.56), followed by ammonium sulfate (18.9 ± 5.6%), and elemental carbon (7.2 ± 2.3%), showing the formation of secondary aerosols and the impact of an incomplete combustion process. Levoglucosan was present in all samples with a mean concentration of (113.8 ± 147.2 ng m-3) revealing biomass burning as a persistent source. The diagnostic ratios applied to organic compounds revealed the influence of petrogenic and pyrogenic sources. Principal component analysis identified the influence of road dust derived from road traffic, the formation of secondary aerosol particles, petroleum combustion associated with vehicle exhaust, the presence of vegetative detritus and agriculture soil resuspended by wind erosion. While sugarcane burning as a frequent activity in the area was not directly identified as an independent component, its contribution was continuous and could influence the formation of secondary aerosols.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-77B

THE DIURNAL EVOLUTION OF AIR POLLUTANTS IN NAIROBI CITY, KENYA

Mr Constance Okuku
Kenya Meteorological Department, Nairobi, Kenya

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences

Abstract

THE DIURNAL EVOLUTION OF AIR POLLUTANTS IN NAIROBI CITY, KENYA

By

C. C. Okuku[1] and K. K. Thiongo[1]

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Adequate understanding of air quality parameters, their diurnal ambient levels, including spatial and temporal evolutions and appropriate field data are necessary in evaluating the exposure of population in urban area and strategic sound management of the urban environment. Stationery and mobile criteria air pollutants measurements were performed at main up-country bus station and busy roads in Nairobi city during the Months of January 2016 and July, 2017. Four sites were sampled using a mobile air pollution measurement van for two consecutive days at each site. Muthurwa, Industrial Area, Pumwani and Nakumatt-junction. One-minute mean values of pollutants were calculated and plotted against time. Meteorological parameters were measured concurrently. The main objective of the campaign was to understand the diurnal evolution of criteria pollutants in Nairobi City.

PM10, PM2.5, CO and BC showed a similar diurnal trend. High values in the morning and evening corresponding to heavy traffic jams hours. PM10 and PM2.5 peak values were 30.74 and 69.64µg/m^3 exceeding WHO limits of 25 and 50.64µg/m^3 respectively. At Muthurwa, PM10 and PM2.5 sometimes exceeded the instrument measurement scale and difficult to determine maximum values. Surface O^3 had pick values around noon, i.e 12.00 and 1.00 pm. CO and BC values exhibited two peaks, one in the morning and evening. Nakumatt Junction had a third peak at around noon. PM10, Pm2.5, O3, CO, SO2 and Black Carbon values over Nairobi city, Kenya, during the months of January and July were found to exceed National and WHO standards during hours of heavy traffic jams. These are episodes of bad air quality in the city

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-78C

EC/OC content in PM2.5 in five Latin American cities and megacities: air quality and radiative forcing

Jorge Herrera Murillo[1], Julian Gelman Constantin[2,3], Julio Murillo Hernandez[1], Miryam Gomez Marin[4], Thiago Nogueira[5], Maria Fatima Andrade[5], Djacinto A. Monteiro dos Santos[6], Valeria Diaz[7], Laura Dawidowski[2]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

The relevance of atmospheric Black Carbon (BC) has been on focus in the last decades due to its impact on human health (*1*) and climate change (*2*, *3*). The warming effect of BC on the atmosphere and the cryosphere is currently accepted, but the quantification of the effect still presents a high degree of uncertainty, due to known biases in estimations (*2*). Biases in aerosol models (BC atmospheric concentrations and mass absorption cross-section) and methodological difficulties in BC absorption retrieval from measured AOD are the major sources of uncertainty (*3*).

We present preliminary results from a 1-year field campaign in Buenos Aires (Argentina), Medellín (Colombia), Quito (Ecuador), San José (Costa Rica) and São Paulo (Brazil). The campaign is part of a wider ARCAL project, funded by the International Atomic Energy Agency (IAEA), that involves monitoring and source apportionment of PM2.5 in thirteen Latin American cities.

EC/OC content in PM2.5 samples was measured by a thermal-optical method (NIOSH-870 protocol). Seasonal variations for the six different cities were assessed, as well as the incidence of biomass burning events. Measured EC/OC content was used together with other relevant input (total ozone and water column, surface albedo, etc.) to estimate carbonaceous aerosols' direct radiative forcing over the six cities under study. We used the Atmospheric Look-up table Generator (ALG) toolbox (*4*) to perform radiative forcing estimations with several radiative transfer models.

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4. J. Vicent *et al.*, *Geosci. Model Dev.* **13**, 1945–1957 (2020).

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-79A

Experimental air quality forecasting with the Rapid-Refresh model coupled to chemistry (RAP-Chem)

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Experimental air quality forecasts with the Rapid-Refresh model coupled to chemistry (RAP- Chem) at NOAA ESRL began in July 2020 in an effort to capture changing atmospheric composition due to the emissions reductions associated with the COVID-19 lockdowns. The full gas-phase and aerosol chemistry mechanism used in the RAP-Chem and proposed for transition into the Unified Forecast System (UFS) offers a potential lower computational cost alternative compared to mechanisms used in similarly capable operational models. Additionally, the RAP-Chem includes wildfire emissions of gases and aerosols, natural emissions of biogenic gases, dust, and sea salt, and simulates aerosol feedback to atmospheric physics allowing evaluation of the impact of changes in atmospheric composition on atmospheric conditions. Here we will show results over the August-September 2020 wildfire season and introduce key model features and developments in the RAP-chem slated for potential implementation into the UFS; specifically, we will demonstrate the suitability of a reduced complexity gas-phase chemical mechanism, the improvements associated with the use of the MYNN PBL scheme to perform non-local mixing of chemical species, as well as the use of the full TUV photolysis model with aerosol feedback combined with assimilated ozone from the Global Forecast System to more accurately capture the impacts of variable total column ozone on surface photochemistry.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-80B

Size-segregated ions and carbonaceous fractions of ambient aerosol in Bogotá

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Universidad Nacional de Colombia, Bogotá, Colombia

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Size-segregated chemical characterization of ambient aerosol is useful to understand its sources and formation mechanisms, and complements information obtained from bulk aerosol composition. Elemental and Organic Carbon (EC/OC) make up a significant fraction of matter particulate emitted by combustion processes, and water-soluble ions provide an important information about the origin of ambient aerosols. Previous studies have determined the chemical composition and source contribution of PM_{10} and the temporal and spatial variability of polycyclic aromatic hydrocarbons (PAH) in Bogotá, one of the main megacities of Latin America. However, the size-segregated chemical composition of ambient aerosol has not been studied. This work aims to better understand the size-segregated variability of the aerosol chemical composition in this city. A Tisch® 8-Stage Cascade Andersen Impactor was used to collect the samples of ambient aerosol in the southwest area of the city, which usually show the highest concentrations of $PM_{2.5}$. Eight sets of size-segregated ambient aerosol samples were collected over two periods in 2018 to quantify the concentration of OC/EC and water-soluble ions (ammonium, sodium, potassium, magnesium, calcium, chloride, nitrate, sulfate and oxalate). The average PM_1 concentration during the sampling campaign was 20.8 $\pm$12.5 mg/m^3 (70.8 $\pm$ 10.7 % of $PM_{2.5}$). The mass size distribution was bimodal, with a coarse mode between 5.8 and 4.7 mm, and an accumulation mode between 0.43 and 0.65 mm. The carbonaceous fraction constituted over 75 % of PM_1 mass. The main component of the finest particles was EC, which can penetrate and deposit on alveolar sacs of people exposed to air pollution in this area of the city. The main inorganic ions were sulfate, nitrate, and ammonium, which had the maximum concentration on the range of 0.65 - 1.1 mm. The PM_1 concentration showed a moderate correlation with the concentrations of OC, EC, nitrate, calcium, and ammonium.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-81C

Effects of grid resolution on urban air quality simulation with MUSICAv0

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Abstract

Both global and regional scale three-dimensional chemistry models have been used for air quality simulations. While global models can be useful to evaluate the chemistry mechanism in different chemical regimes and to investigate the implications of gases and aerosols for air pollution and climate in general, coarse resolution can impact the accuracy of simulated gases and aerosols especially over urban areas with point emission sources. Regional models with finer horizontal resolution can resolve urban scale chemistry but need lateral boundary conditions, which can introduce another source of error by using a fixed profile or chemical fields from global models. Isolating the effects of grid resolution on chemistry simulation is even more difficult because dynamic, physical, and chemical processes are different between global and regional models. The Multi-Scale Infrastructure for Chemistry and Aerosols (MUSICA) has been developed at NCAR to enable a computationally feasible global modeling framework while still resolving chemistry at urban scales. Here we use the MUSICAv0 with four different grid configurations to investigate the effects of grid resolution on chemistry while keeping dynamics, physics, and chemistry the same. We construct two global grids (ne30 (~100 km) and ne60 (~50 km)) and two regional refinement grids over Korea (ne30x8 (~14 km) and ne30x16 (~7 km)) and perform simulations for the KORUS-AQ campaign. The model simulations compared with aircraft measurements demonstrate the changes of chemical concentrations due to different resolutions. However, the impact of using finer resolution substantially varies across different species due to several factors such as gas/aerosol, lifetime, emission source, and multi-generation chemistry. Detailed methodology and simulation results by species and regions will be presented.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-82A

Impact of air quality management programs on non-criteria and criteria primary atmospheric pollutants in the Metropolitan Zone of Mexico Valley

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UNAM, Mexico City, Mexico

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Air pollution is a worldwide public health problem. In 2019, contributed with 6.7 million death, being particles with diameter < 2.5 µm ($PM_{2.5}$) the main driver of air pollution´s burden of disease worldwide with 4 million of deaths in the same year (https://www.stateofglobalair.org/). Environmental management impacts air quality. The combination of good decisions and actions carried out between different sectors improves it, otherwise it has no effect or even worsen it.

We analyze the trend of a class of non-criteria pollutants called polycyclic aromatic hydrocarbons (PAHs) in particulate matter ≤2.5 mm ($PM_{2.5}$), whose importance lies in their toxicity. Criteria atmospheric pollutants (CAPs) were also analyzed. The study was carried out in the Metropolitan Zone of Mexico Valley (MZMV) (~22 million inhabitants) during 2006-2017. A decrease in carcinogenic PAHs (25%, 10%-40%) was observed, as well as benzo[*ghi*]perylene (54%) that is a non-carcinogenic PAH and a marker of vehicular gasoline combustion. The behavior was consistent with the negative trend of the CAPs: CO (50%), NO_2 (16%), SO_2 (29%) and PM_{10} (8%).

CAPs and PAHs declined despite urban population growth (~10%) and increase in vehicle fleet size (more than double) in the same period. Various air quality management programs have been designed and implemented over the years, such as relocation of industries outside the Valley, diesel with lower sulfur content, use of gas as fuel instead of fuel oil in industry and power plants, mandatory use of catalytic converters, removal of lead from gasoline, frequent rotation and retrofit of vehicles, efficient public transportation, vehicle maintenance programs and mandatory no driving day rule.

The actions have been effective in reducing the primary CAPs and PAH concentrations. However, a greater effort is currently required to reduce $PM_{2.5}$ and O_3, which have remained constant and even increased in recent years.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-83B

Air quality modeling with WRF-Chem / DART system for Central Mexico

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National Autonomous University of Mexico, Mexico City, Mexico

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

We use the Weather Research and Forecasting Model with the chemistry/Data Assimilation Research Testbed (WRF-Chem/DART) chemical weather forecasting/data assimilation system to show the influence of join meteorological and chemical data assimilation into air quality modeling in Central Mexico. The capability to assimilate surface in situ observations from the Mexico City Ambient Air Monitoring Network (RAMA) was added to DART module. The related experiments show sulfur dioxide (SO2), nitrogen dioxide (NO2), ozone (O3), carbon monoxide (CO) data assimilation from RAMA. WRF-Chem/DART is also applied to the assimilation of Terra/Measurement of Pollution in the Troposphere (MOPITT) carbon monoxide (CO) trace gas retrieval profiles. Meteorological data assimilation was conducted through PREBUFR data from National Centers for Environmental Prediction (NCEP). We check the validity of the results by comparison outputs with and without data assimilation with the in-situ observations. Results show that updated initial conditions improve the model performance between 10% and 45% root mean square error reduction for the assimilated species except NO2. It is also shown how the process itself has a certain influence in variables such as temperature, CO and O3. In addition, a better correspondence is observed between the modeled values and those measured in the monitoring stations, for all cases with assimilation compared to those without assimilation. The influence to assimilate in situ observation is less remarkable than satellite-derived atmospheric composition products like MOPITT CO, obtaining metrics closer to the desired value in the second case. The results demonstrate the importance of applying data assimilation for air quality studies in the Mexico City basin.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-84C

The AQ-WATCH Project - Worldwide Analysis and Forecasting of Atmospheric Composition for Health

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Abstract

Air pollution is the main environmental hazard worldwide and ambient air pollution is responsible for 4.2 million premature deaths every year. Many authorities and small and medium enterprises (SMEs) however miss the tools to monitor and forecast air quality and assess the potential and impact of air pollution reduction measures. AQ-WATCH is an international Horizon 2020 funded project that addresses this need. It builds on scientific knowledge on air quality to form new environmental technologies that will help decision-makers in government, municipalities and in the private sector to address air pollution issues in the region of the world where they operate. The consortium supporting the project includes knowledge institutes, applied science organizations and business-oriented partners, to support the world-wide effort to improve air quality. In this project we are developing a supply chain leading to the generation of seven downstream products and services that are innovative for improving air quality forecasts and attribution. These prototypes are based on existing models as well as space-borne and in situ observations of air quality and tailored to the identified needs of international users. The project will allow SMEs to integrate a very large number of datasets from earth observations, advanced predictive models and Copernicus-associated ones. These innovative products and services are aimed at improving public health and optimizing service provided by the energy sector in different regions of the world. Here we will present the project and its first results as well as our user interface platform.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-85A

Stable and transport indices applied to winter air pollution over the Yangtze River Delta China

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Abstract

Previous studies have developed a stable weather index (SWI) based on meteorological elements that adequately represent PM2.5 pollution over the North China Plain (NCP). However, the SWI performs poorly over the Yangtze River Delta (YRD) region because air pollution over this region is affected not only by stagnant weather (STAG) but also by transport (TRANS). For example, air pollutants can be transported from the NCP to the YRD by cold fronts. In this study, an obliquely rotated principal component analysis in the T-model is applied to classify the synoptic patterns of winter weather over the YRD region from 2013 to 2018. Among the four identified synoptic patterns, two of which cause TRANS, one pattern is most likely to cause STAG, and one pattern may lead to either STAG or TRANS depending on the location of high pressure at around Shandong province. Due to the large contribution (63%) of TRANS to the total PM2.5 pollution events, a transport pollution index (TPI) is constructed to describe the transport features of PM2.5 pollution over the YRD region. Our results show that, when considering the SWI alone, the correlation coefficients between the SWI and ln(PM2.5) range from 0.50 to 0.57 in the main cities of the YRD. Excitingly, when considering both the TPI and SWI (TPI+SWI), the correlation coefficients increase significantly to 0.63~0.74, suggesting that TPI+SWI better reflects the wintertime PM2.5 pollution level over the YRD region. In addition, the satisfactory performance on the validation also suggests that TPI+SWI can increase the accuracy of evaluating and forecasting of PM2.5 pollution episodes over downstream regions of source emissions.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-86B

Development and adaptation of sensors and samplers for vertical profiling using fixed-wing drones in the context of the Cooperation to Unravel the RolE of Atmospheric Aerosols over the Amazonian Basin (CURE-3AB).

Dr Maximilien Desservettaz[1], Dr Christos Keleshis[1], Mrs Panayiota Antoniou[1], Mr Panagiotis Vouterakos[1], Mrs Yunsong Liu[1], Mr Roland Sarda[2], Mrs Dominique Baisne[2], Mr Greg Kok[3], Mr Jonathan Harnetiaux[3], Prof Jean Sciare[1]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

The Cooperation to Unravel the Role of the Atmospheric Aerosol over the Amazon Basin using drones (CURE-3AB) project has yielded new technical solutions to perform high quality in-situ atmospheric observations in the lower troposphere (0-2 km) with Unmanned Aerial Vehicles (UAVs). An Ozonesonde (EN-SCI ECC, Model 2Z), designed for regular O_3 radio sounding, has been adapted to perform on-line measurements of Ozone onboard the drone. A 3D printed low-cost pollen/spore collector has been developed to replicate reference instruments (VPPS2000) and adapted to perform onboard our UAV. Finally, an optical particle counter (AlphaSense) and a custom-made drying system have been fitted on a third drone. The three vehicle/instrument tandems will be deployed in the proximity of the Amazonian Tall Tower Observatory during the CURE-3AB campaign (delayed due to pandemic). We present the instrumental developments, setups, and preliminary test results performed with our UAVs at the Cyprus Institute private airspace.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-87C

GEOS Simulations of Dust Deposition into Tropical Atlantic Ocean: Underestimate of Dust Emissions Compensated by Efficient Removals

Dr. Hongbin Yu[1], Dr. Huisheng Bian[2], Dr. Qian Tan[3], Dr. Mian Chin[1], Dr. Dongchul Kim[4], Dr. Zhibo Zhang[5], Dr. Paul Ginoux[6]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group

Abstract

Massive dust emitted from North Africa can transport long distances across the tropical Atlantic Ocean, reaching the Americas. Dust deposition along the transit adds microorganisms and essential nutrients to marine ecosystem, which has important implications for biogeochemical cycle and climate. However, assessing the dust-ecosystem–climate interactions has been hindered in part by the paucity of dust deposition measurements and large uncertainties associated with oversimplified representations of dust processes in current models. We have recently produced a unique dataset of dust optical depth, deposition flux, and loss frequency over the tropical Atlantic Ocean by using the decade-long (2007-2016) record of aerosol three-dimensional distribution from four satellite sensors, namely CALIOP, MODIS, MISR, and IASI. In particular, the dust loss frequency, a useful diagnostic measuring the removal efficiency, makes it possible to disentangle the dust transport and removal processes from the dust emissions when identifying the major factors contributing to the uncertainties in the model simulated dust deposition. In this study, we use the satellite-based datasets of dust and rainfall along with in situ observations of dust deposition and particle size distribution to assess how well NASA GEOS model performs in simulating trans-Atlantic dust transport and deposition. We found that the GEOS modeling of dust deposition falls within the range of satellite-based estimates. However, this reasonable agreement in dust deposition is a compensation of the model's underestimate of dust emissions and overestimate of dust removal efficiency. Furthermore, the overestimate of dust removal efficiency results largely from the model's overestimate of rainfall rate. Our results provide insights into the model's deficiencies at process level, which could better guide model improvement.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-88A

How Does Indoor Air Chemistry Affect Outdoor Air Pollution?

Dr Freja F. Oesterstroem, Professor Nicola Carslaw
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report

Abstract

Despite the fact that more than 90% of our time is spent indoors, most atmospheric chemistry research is focused on outdoor air. Indoor air chemistry is different from outdoors, particularly the sources of pollutants, the relative importance of key oxidants, and the surface area to volume ratios can be significantly different between outdoor and indoor regimes. Whilst an increasing number of indoor air studies have been performed recently, the complexity of indoor environments makes it a challenging system to describe. Indoor air chemistry models are good tools to understand the chemistry in the absence of observational data or to provide further insight when used alongside measurements. This project is part of the modelling consortium for chemistry of indoor environments that connect models over a large range of time and space in the indoor environment, investigating the gas phase chemistry of indoor air during specific activities and the impact these have on outdoor air pollution.

The Indoor Detailed Chemical Model (INDCM) developed at University of York is used to describe the impact of indoor cooking and cleaning on outdoor air. The INDCM uses the chemical scheme of the Master Chemical Mechanism v. 3.3.1 comprising of ~17,000 reactions and 6700 species. The model was initialised using data from the HOMEChem field campaign, where air composition was measured while different activities were carried out in a test house. The indoor activities are simulated in the INDCM and then the 'aged' air is released outdoors following indoor activities, calculating emission factors for different species emitted during different indoor activities. The results are used to show the proportion of various outdoor species that can be assumed to have originated indoors in an urban area, allowing us to assess the impact of indoor activities on both indoor and outdoor air quality.

Early Career Scientist

YES, I am an early career scientist.

MAPAQ-89B

What's really in the air? A season of pollen counts with novel real-time instruments

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Aeroallergens, such as pollen and fungal spores, cause allergic responses in a growing proportion of the population, currently affecting 20-30% of those living in developed countries. This has significant impact on quality of life as well as large direct and indirect health costs, which, for Europe, are estimated between €50-150 billion per year. Reducing these costs by even just 0.1% equates to a saving of up to €150 million per year.

Routine pollen monitoring is carried out across the world, however, monitoring networks currently rely almost exclusively on instruments developed in the 1950s. These samplers continuously collect airborne particles on a rotating drum, which is removed from the instrument usually once a week. The tape is then disassembled from the drum and particles manually identified and counted using optical microscopy. The time-consuming nature and expertise required for this method restricts both the possible number of stations and the time-resolution of data provided to end users.

New technologies developed over the past few years now mean that real-time monitoring is becoming a reality. Several instruments based on different techniques exist but, given their novelty, little is known about how each instrument performs in situ over an entire pollen season. This study provides the first analysis of several automatic devices run in parallel for the 2019 pollen season. Seven different automatic instruments were used: a DMT WIBS-Neo, a Helmut Hund BAA500, a Plair Rapid-E, two Swisens Polenos and two Yamatronics KH3000s. In addition, data from two manual Hirst-type monitors were also analysed and compared as reference.

Three instruments were further tested at the Swiss Federal Institute for Metrology (METAS). A range of different polystyrene latex spheres were used to compare the measured particle number concentrations and fluorescent signals with reference standards produced in the METAS experimental chamber.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-90C

Development of an Aerosol and Cloud Analysis System in the Caribbean

Dr. Bighnaraj Sarangi[1], Mr. Lemanuel Colon Resto[1,2], Dr. Darrel Baumgardner[3], Miss Jessica Colon Gonzalez[1], Miss Isis A Guadalupe-diaz[1], Dr. John A Ogren[4], Professor Olga L Mayol-Bracero[1]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group

Abstract

The role of aerosol-cloud interactions continue to be a major source of uncertainty in climate forcing and hence in future climate projections. Investigation of the physico-chemical mechanisms of aerosol-cloud interactions, especially in tropical regions such as the Caribbean, is important because these regions are susceptible to frequent and intense precipitation events. Furthermore, during the summer, transported dust from northern Africa affects the regional air quality and local weather in the Caribbean. This project will help to reduce uncertainties in climate forcing through the development of sensor suite, the Aerosol Cloud Analysis System (ACAS), which is focused on the study of the multiple interactions that occur between aerosols and clouds. The ACAS is a tightly integrated set of sensors sampling from three custom aerosol inlets (counterflow virtual impactor, interstitial and total) that extracts air from specific subsets of the population of aerosol particles and cloud droplets and measures their physical and chemical properties. ACAS will have a broad variety of research applications, e.g. cloud processing of aerosols, cloud condensation nuclei closure studies, cloud chemistry, and cloud model validation. It will be available to the international community through both on-site and remote access. ACAS is installed at the mountaintop research site (1051 a.m.s.l.) of Pico Del Este located in a tropical montane cloud forest of Puerto Rico. The research site is frequently above the cloud base and is influenced by both local and transported aerosols from clearly identifiable air mass sources year-round. Here we will discuss the recent developments made to the site after the devastating impact of Hurricane Maria (Sept 2017), development of the ACAS, some preliminary measurements, and future development plans.

Early Career Scientist

NO, I am not an early career scientist.

MAPAQ-91A

Development of a MUlti-Scale Infrastructure for Chemistry and Aerosols – MUSICA

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

To explore the various couplings across space, time and between ecosystems in a consistent manner, atmospheric modeling is moving away from the fractured limited-scale modeling strategy of the past towards a unification of the range of scales inherent in the Earth System. The MUlti-Scale Infrastructure for Chemistry and Aerosols (MUSICA) is intended to become the next generation community infrastructure for research involving atmospheric chemistry and aerosols. MUSICA is being developed collaboratively by the National Center for Atmospheric Research (NCAR) and university and government researchers, with the goal of serving the international research and applications communities. The capability of unifying various spatio-temporal scales, coupling to other Earth System components and process-level modularization will allow advances on topics ranging from fundamental research to air quality to climate and is also envisioned to become a platform that addresses the needs of policy makers and stakeholders. The overall design of MUSICA and some first results will be presented. The community is invited to participate in MUSICA development and the opportunities for collaboration will be described.

Early Career Scientist

NO, I am not an early career scientist.

PACES-1A

FUTURE AEROSOL RADIATIVE FORCING OVER THE ARCTIC

Dr Ulas Im[1,2], Dr Kostas Tsigaridis[3,4], Dr Cynthia H Whaley[5], Dr Gregory S Faluvegi[6,4], Dr Zig Klimont[7], Dr Knut VonSalzen[5]
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, CCMi: Chemistry Climate Model Initiative

Abstract

The Arctic Monitoring and Assessment Programme (AMAP) is currently assessing the impacts of Short-Lived Climate Forcers (SLCF) on Arctic climate and air quality. Among a number of sub-topics, the report will have focus on the future air quality and climate over the Arctic using fully-coupled Earth System Models (ESM). In support of this task for the assessment, we used the NASA Goddard Institute of Space Sciences (GISS) Earth System Model version 2.1.1 (modelE2.1.1), with fully coupled dynamic ocean, to simulate SLCF concentrations and their radiative forcing globally between 2015 and 2050. The simulations were conducted over a 2° ´ 2.5° spatial resolution

Anthropogenic emissions from the ECLIPSE V6b emissions database were used, along with aircraft and open biomass burning from the Coupled Model Intercomparison Project Phase 6 (CMIP6), while the natural emissions of sea salt, DMS, isoprene and dust are calculated interactively. We conducted historical (1990-2014) and future simulations, using two different future scenarios developed within the Eclipse database; Current Legislation (CLE) and Maximum Feasible Reductions (MFR). Both periods were simulated using three ensembles.

The simulated monthly surface concentrations of sulfate (SO_4), black carbon (BC), organic carbon (OA), and ozone (O_3) are compared with observations from a set of Arctic stations, extracted from the EBAS and IMPROVE databases. Simulated aerosol optical depths (AOD) are also compared with Advanced Very-High Resolution Radiometer (AVHRR). Monthly mean BC and SO_4 concentrations are underestimated by 60% and 42%, respectively, while O_3 concentrations are overestimated by 14%. Results show that the top of the atmosphere (TOA) radiative forcing over the Arctic (> 60°) will be slightly more negative in 2035 compared to 2015, due to a decrease in warming by BC, along with an increase in cooling by NO_3, while cooling by SO_4 slightly decreases.

Early Career Scientist

NO, I am not an early career scientist.

PACES-2B

Isotopic composition of atmospheric nitrate in Fairbanks, Alaska: results from the pre-ALPACA campaign 2019

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Urban polar areas can be subject to severe pollution in winter, linked to sharp temperature inversions that trap pollutants near to the surface. However, the formation of secondary aerosols (sulphates, nitrates, organics) in these cold and dark conditions and the role of the Arctic boundary layer are still poorly understood. To address this issue, an intensive international measurement campaign, called ALPACA (ALaskan Pollution And Chemical Analysis), will be conducted in January/February 2021 in and around Fairbanks, Alaska. Among the various atmospheric chemical and physical measurements, gas and particles collections will be carried out for multiple isotopic analyses.

The use of stable isotopes over the past decades has demonstrated its ability to provide information relevant for tracing emission sources, individual chemical processes and budgets of atmospheric trace gases. Of particular interest is the propagation of the ozone distinctive oxygen-17 anomaly ($\Delta^{17}O$) into the reactive nitrogen cycle which has led to a better understanding of nitrate formation pathways in various environments.

During this presentation, we will report the preliminary results of the $\Delta^{17}O$ and $\delta^{15}N$ in atmospheric nitrate collected during the 2019 pre-ALPACA campaign, which took place in downtown Fairbanks from November 21 to December 13 and, and investigate the source and fate of atmospheric nitrate.

Early Career Scientist

YES, I am an early career scientist.

PACES-3C

Ozone and carbon monoxide observations over open oceans on R/V Mirai from 67° S to 75° N during 2012 to 2017: Testing global chemical reanalysis TCR-2 in terms of Arctic processes and low ozone levels at low latitudes

Dr. Yugo Kanaya[1], Dr. Kazuyuki Miyazaki[2,1], Dr. Fumikazu Taketani[1], Dr. Takuma Miyakawa[1], Dr. Hisahiro Takashima[3,1], Dr. Xiaole Pan[4,1], Ms. Saki Kato[3], Dr. Kengo Sudo[5,1], Dr. Takashi Sekiya[1], Dr. Jun Inoue[6], Dr. Kazutoshi Sato[7], Dr. Kazuhiro Oshima[8]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Japan National Committee

Abstract

Constraints from ozone (O_3) observations over oceans are needed in addition to those from terrestrial regions to fully understand global tropospheric chemistry and its impact on the climate. Here, our original observational data set of ozone and CO levels derived from 24 research cruise legs of R/V *Mirai* during 2012 to 2017, in the Southern, Indian, Pacific, and Arctic Oceans, covering the region from 67° S to 75° N were used to evaluate the Tropospheric Chemistry Reanalysis version 2 (TCR-2), produced by assimilating a suite of satellite observations of multiple species into a global atmospheric chemistry model CHASER. For clean marine conditions, two focused analyses were performed. The first was in the Arctic (>70° N) in September every year from 2013 to 2016; TCR-2 underpredicted O_3 levels by 6.7 ppbv (21 %) on average, suggesting the possibility of more efficient descent of the O_3-rich air from above than assumed in the models. For TCR-2 (CHASER), dry deposition on the Arctic ocean surface might also have been overestimated. In the second analysis, over the western Pacific equatorial region (125–165° E, 10° S to 25° N), the observed O_3 level more frequently decreased to less than 10 ppbv in comparison to that obtained with TCR-2, and also those obtained in most of the ACCMIP model runs for the decade from 2000. These results imply loss processes that are unaccounted for in the models. We found that the model's positive bias positively correlated with the daytime residence times of air masses over a particular grid, namely 165–180° E and 15–30° N; an additional loss rate of 0.25 ppbv h^{-1} in the grid best explained the gap. Halogen chemistry, commonly omitted from currently used models, might be active in this region and could have contributed to additional losses.

Early Career Scientist

NO, I am not an early career scientist.

PACES-4A

WRF-Chem numerical analysis of YAK-AEROSIB aircraft data with BC emissions from Russian oil/gas flarings evaluated by satellite data

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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

Abstract

Arctic air pollution originates mainly from long-range transport of short-lived climate forcers (SLCFs), including black carbon (BC), ozone, and their precursors, from mid-latitudes and, also from important local anthropogenic emissions from activities such as resource extraction, shipping and domestic combustion. Russia's location closer to the Arctic leads to more significant contributions from local anthropogenic emissions to levels of Arctic air pollution, especially BC from oil/gas extraction activities. However, large uncertainties exist about the magnitude and temporal/spatial variations of BC emissions and their contribution to Arctic BC loading. In this study, we focus on a better understanding of BC emissions from gas flaring hot spots in the Yamal-Nenets regions of northern Russia by using WRF-Chem simulations with improved BC emissions estimated from radiometer scanning night-light imaging from satellite data. For this study, we convert VIIRS (Visible Infrared Imaging Radiometer Suite) 12-hourly heat radiances (Elvidge et al. 2016) from Russian gas/oil flaring hot spots into daily BC emission, by using correlations with 0.025 degree annual BC emissions derived from Sea and Land Surface Temperature Radiometer (SLSTR) GFlaringS3 data (Caseiro et al. 2020). We analyze the origins of polluted air masses sampled during French (CNRS)-Russian YAK-AEROSIB flights over the Ob Valley, Yamal and Kara Sea regions during October 2014 using BC tracers run in WRF-Chem. Full chemistry-aerosol simulations of WRF-Chem, run with SAPRC-MOSAIC and ECLIPSE-v6b anthropogenic emissions, are used to examine the sensitivity of simulated BC to gas flaring emissions. BC emissions from the flaring sector are replaced with emissions derived from VIIRS data. Sensitivity runs with daily varying and annual average BC are also performed to examine the impacts of temporal variations in flaring activities on Arctic BC.

Early Career Scientist

NO, I am not an early career scientist.

PACES-5B

Model simulations of short-lived climate forcers in the Arctic

Dr Cynthia H Whaley[1], Dr Rashed Mahmood[2], Dr Knut von Salzen[1], Dr Barbara Winter[3], Dr Sabine Eckhardt[4], Laura Saunders[5], Dr Stephen Arnold[6], Dr Rong-You Chien[7], Dr Jesper Christensen[8], Dr Greg Faluvegi[9,10], Dr Mark Flanner[11], Dr Joshua Fu[12], Dr Michael Gauss[13], Dr Jens L Hjorth[8], Dr Lin Huang[14], Dr Ulas Im[15], Dr Zbigniew Klimont[16], Dr Thomas Kühn[17,18], Dr Joakim Langner[19], Dr Kathy Law[20], Dr Andreas Massling[8], Dr Tatsuo Onishi[20], Dr Naga Oshima[21], Dr Yiran Peng[22], Dr David Plummer[3], Dr Olga Popovicheva[23], Dr Luca Pozzoli[24], Dr Jean-Christophe Raut[20], Dr Maria Sand[25], Dr Julia Schmale[26], Dr Sangeeta Sharma[14], Dr Henrik Skov[8], Dr Fumikazu Taketani[27], Dr Yugo Kanaya[27], Dr Manu Thomas[19], Dr Kostas Tsigaridis[9,10], Dr Svetlana Tsyro[13], Dr Kaley Walker[5], Dr Minqi Wang[22], Dr Duncan Watson-Parris[28]
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

Abstract

The Arctic Council's Arctic Monitoring and Assessment Programme (AMAP) is preparing an assessment of short-lived climate forcers (SLCFs) to report on the distribution, trends, and impacts of SLCFs on climate, health, and ecosystems in the Arctic. As part of this effort, several atmospheric and Earth system models were run to simulate SLCFs globally and in the Arctic. Participating models, using the ECLIPSE v6b anthropogenic emissions, simulated atmospheric concentrations and deposition of SLCFs such as black carbon, sulfate, ozone, methane, and ozone precursors, as well as optical properties of aerosols, and cloud properties.

To provide confidence in the modelled impacts of SLCFs and understand their uncertainties, all model simulations were evaluated against a vast set of measurements. These include surface monitoring networks, aircraft- and ship-based campaigns, and ground-based and satellite remote sensing. While the focus of the AMAP SLCF report is on the near surface Arctic region, the model evaluation includes the entire Northern Hemisphere from the surface to the upper-troposphere/lower-stratosphere in order to assess long-range transport of SLCFs in addition to the local and regional emissions.

Our results suggest that models have recently improved in their ability to simulate aerosol seasonal cycles in the Arctic. However, the vertical distribution of black carbon still show large variability among models, sometimes varying by a couple orders of magnitude. Generally, models show similar spatial patterns in their biases, but with greater variability in the Arctic. Trends in Arctic surface concentrations (1990-2015) were well-modelled over that time period compared to measurements. All showed a decrease in black carbon and sulfate over that time period, and little-to-no change in the mixing ratio of ground-level ozone. Deposition remains a significant source of uncertainty, with large variability between models. This has implications for the long-range transport of SLCFs in models.

Early Career Scientist

NO, I am not an early career scientist.

PACES-6C

Modelling Air Quality in the Arctic and Northern Latitudes: An assessment of surface ozone.

Dr Stephen R Beagley, Dr wanmin Gong, Dr Roya Ghahreman
ECCC, Toronto, Ontario, Canada

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Using the Environment and Climate Change Canada's air quality prediction model GEM-MACH, annual simulations of the year 2015 were carried out on a pan-Arctic domain at 15-km horizontal resolution. A comprehensive model evaluation against available observations is being carried out to examine the model's capability of simulating and exploring Arctic air quality. The 2015 annual simulations were also used in the new AMAP SLCF assessment report. This study focuses on an assessment of the model's capability to simulate surface ozone, including its spatial and seasonal variations, throughout the Arctic region (both in the High Arctic and over sub-Arctic regions). Surface ozone observations from the National Air Pollution Surveillance network (NAPS), the Canadian Air and Precipitation Monitoring Network (CAPMON), the Norwegian Institute for Air Research EBAS database, and the O-Buoy Chemical Network are used for this assessment. Statistical analysis is conducted on hourly time-series for available sites to evaluate our ability to simulate the ozone observed, and to help identify issues in understanding and modeling the Arctic. Key results from this assessment will be presented, including discussions on the impact of biogenic emissions from northern boreal regions and ozone deposition on model simulations over the Arctic and northern latitudes.

Early Career Scientist

NO, I am not an early career scientist.

PACES-7A

Source attribution of Arctic black carbon and sulfate aerosols and associated Arctic surface warming during 1980–2018

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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

China Working Group

Abstract

Observations show that the concentrations of Arctic sulfate and black carbon (BC) aerosols have declined since the early 1980s, which potentially contributed to the recent rapid Arctic warming. In this study, a global aerosol-climate model equipped with an Explicit Aerosol Source Tagging is applied to quantify the source apportionment of aerosols in the Arctic from sixteen major source regions and the role of aerosol variations in the Arctic surface temperature change over the past four decades. Changes in radiative forcing of sulfate and BC through aerosol-radiation interactions are found to exert a +0.145 K Arctic surface warming between the first and last five years of 1980–2018, with the largest contribution by sulfate decrease, especially originating from the mid-latitude regions. The changes in atmospheric BC outside the Arctic produced an Arctic warming of +0.062 K, partially offset by –0.005 K of cooling due to atmospheric BC within the Arctic and –0.041 K related to the weakened snow/ice albedo effect of BC. Through aerosol-cloud interactions, the sulfate reduction gave an Arctic warming of +0.193 K between the first and last five years of 1980–2018, the majority of which is due to the mid-latitude emission change. The results suggest that changes in aerosols over the mid-latitudes of the Northern Hemisphere have a larger impact on Arctic temperature than other regions associated with enhanced poleward heat transport from the aerosol-induced stronger meridional temperature gradient. The combined aerosol effects of sulfate and BC together produce an Arctic surface warming of +0.297 K during 1980–2018, explaining approximately 20% of the observed Arctic warming during this time period.

Early Career Scientist

NO, I am not an early career scientist.

PACES-8B

Can a global chemistry climate model reproduce interannual variabilities and trends ofdepositions of sulfate, nitrate, and ammonium preserved in the SoutheasternGreenland Dome ice core?

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, CATCH: the Cryosphere and Atmospheric Chemistry, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Japan National Committee

Abstract

Inorganic compounds like sulfur and nitrogen oxides (SOx/NOx) are mainly emitted from fossil fuel combustion or high-temperature air combustion associated with anthropogenic activities and are oxidized in the atmosphere to form aerosols. For accurate evaluation and future projection of global changes in atmospheric environment and climate, it is vital to quantitatively validate a chemistry climate model which simulates these chemical species. In this study, we evaluate global simulation by a chemistry climate model (CHASER) using a long-term (60 years) record of aerosol depositions preserved in the High-Accumulation Dome ice core in Southeast Greenland (SE-Dome) and investigate controlling factors of interannual variation and trends in inorganic ions of sulfate (SO_4^{2-}), nitrate (NO_3^-), and ammonium (NH_4^+).

It is found that our model simulation basically well captures both seasonal cycles and interannual variabilities in the flux of each component as seen in the ice core record for 1970s to 2010. The model calculations suggest that the long-term SO_4^{2-} trend seen in the ice core (-0.15 mmol L^{-1} d^{-1}) is mostly from SO_2 emission changes in the source areas like Europe, U.S. , and Asia over the decades. In contrast, long-term trends for NO_3^- and NH_4^+ (-0.06 and 0.01 mmol L^{-1} d^{-1}, respectively) appear to be affected largely by changes in natural sources and meteorological conditions in addition to the anthropogenic emissions of NOx and NH_3.

Interestingly the model simulation replicates the spiky peaks (positive anomalies) in concentrations (particularly for SO_4^{2-}) recorded in May 1992. The peaks were tentatively attributed to the 1991 eruption of Mt. Pinatubo in the previous studies. Our model simulation, however, nicely reproduces the concentration peaks even without any direct injection from the Mt. Pinatubo to the atmosphere, implying that anomalous changes in meteorological fields (most probably for transport and precipitation) are the dominant factors of the peaks in May 1992.

Early Career Scientist

NO, I am not an early career scientist.

PACES-9C

Modelling Atmospheric Chemistry and Vertical Transport in Fairbanks, Alaska

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

Abstract

Poor air quality results in millions of premature deaths each year worldwide and is an issue in Arctic cities. Fairbanks, Alaska, experiences frequent exceedances of health-based air quality standards during the winter, as a result of the unique interplay between emissions, chemistry, and meteorology. The cold and dark conditions of polar winter result in large emissions from residential heating and wood burning. Emitted gas-phase pollutants encounter extremely cold temperatures and low actinic fluxes, which affect their chemical transformation pathways. Furthermore, strong surface-based temperature inversions limit vertical mixing and dispersion of pollutants and contribute to high concentrations of particles and gas-phase pollutants near ground-level.

Using our Platform for Atmospheric Chemistry and Transport in one-dimension (PACT-1D) model, we investigate underlying chemical mechanisms and mixing processes resulting in observed gas-phase and particulate pollution in Fairbanks during the winter of 2019-2020. Specifically, we study the production pathways of key atmospheric oxidants such as OH radicals under dark and highly stable atmospheric conditions. We analyze the impact of vertical mixing processes and reproduce observed vertical profiles of gas-phase pollutants such as ozone and NO_2. We demonstrate that the PACT-1D model provides a framework to explain the interplay of vertical mixing and chemistry in Fairbanks, Alaska, during the winter.

Early Career Scientist

YES, I am an early career scientist.

PACES-10A

Observations of Extreme Wildfire Enhancements of CH_3OH, HCOOH, and PAN over the Canadian High Arctic

Tyler Wizenberg[1], Kimberly Strong[1], Dylan Jones[1], Erik Lutsch[1], Emmanuel Mahieu[2], Bruno Franco[3], Lieven Clarisse[3]
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Americas Working Group

Abstract

Wildfires are a common occurrence in many parts of the globe and can emit significant quantities of trace gases and particulate matter, negatively impacting air quality on large spatial scales. Among the various trace gases emitted by wildfires are volatile organic compounds (VOCs). Three VOCs that are of particular importance are methanol (CH_3OH), formic acid (HCOOH), and peroxyacetyl nitrate (PAN). CH_3OH is the one of the most abundant VOCs in the atmosphere, and it influences the budgets of many tropospheric species including the hydroxyl radical, carbon monoxide, formaldehyde, and ozone. HCOOH is the most abundant tropospheric carboxylic acid, and thus can have significant impacts on atmospheric acidity, particularly in remote regions such as the Arctic. Lastly, PAN is a key, thermally unstable reservoir species of tropospheric nitrogen radicals ($NO_x = NO + NO_2$), controlling the production of tropospheric ozone, and contributing to the 'Arctic haze' pollution phenomenon at high latitudes.

During August 2017, two independent large-scale wildfires in British Columbia and the Northwest Territories of Canada generated vast smoke plumes that merged and were subsequently transported to the high Arctic. Simultaneous observations by a high-resolution ground-based Fourier transform infrared (FTIR) spectrometer at the Polar Environment Research Laboratory (PEARL) in Eureka, Nunavut (80.05°N, 86.42°W), and the Infrared Atmospheric Sounding Interferometer (IASI) satellite instruments display extreme enhancements in these three species relative to background concentrations during the fire-affected period in late August 2017, demonstrating the long-range transport and secondary formation of these typically short-lived species. Initial results of the analysis of this unique biomass burning event will be presented, including comparisons of observations with the GEOS-Chem global chemical transport model.

Early Career Scientist

YES, I am an early career scientist.

PACES-11B

Size-Resolved Elemental Analysis of High-Latitude Mineral Dust Aerosol in Kluane National Park, Yukon

Mr. Arnold R Downey, Dr. Patrick L Hayes, Dr. James King
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Americas Working Group

Abstract

Mineral dust emitted in Arctic regions plays a potentially significant role in the radiative forcing of the Northern atmosphere through scattering and absorption of solar radiation. Dust also contributes to the transport of metals and minerals that are relevant for biological processes and impacts local air quality of Northern communities. Northern dust production is expected to increase with average temperature rise, which diminishes snow and ice cover, exposing more dust sources.

However, relatively few measurement campaigns have been conducted to study the composition of Arctic mineral dust, especially in Canada, signaling a need for attention to this area. In addition, size-resolved information on the composition of this mineral dust is relevant to its transport and optical properties. Presented here is our group's work on the sizing, sampling, chemical analysis, and fluxes of Arctic mineral dust at Ä'äy Chù (Slim's River) in Yukon, Canada during spring and summer in 2018, 2019, and 2021.

Early Career Scientist

YES, I am an early career scientist.

PACES-12C

Evaluating air quality and atmosphere composition impacts of Arctic wildfires in the summers of 2019 and 2020

Mark Parrington[1], Steve Arnold[2], Jingqiu Mao[3], Jessica McCarty[4], Sebastien Garrigues[1], Johannes Flemming[1], Melanie Ades[1], Anna Agusti-Panareda[1], Jerome Barre[1], Nicolas Bousserez[1], Richard Engelen[1], Vincent Huijnen[5], Antje Inness[1], Zak Kipling[1], Julien Nicolas[1], Vincent-Henri Peuch[1], Samuel Remy[6]
[1]European Centre for Medium-Range Weather Forecasts, Reading, United Kingdom. [2]University of Leeds, Leeds, United Kingdom. [3]University of Alaska Fairbanks, Fairbanks, AK, USA. [4]Miami University, Oxford, OH, USA. [5]Royal Netherlands Meteorological Institute, De Bilt, Netherlands. [6]Hygeos, Lyon, France

IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, GEIA: Global Emissions Initiative

Abstract

The boreal summers of 2019 and 2020 were witness to extensive high northern latitude wildfire activity, most notably within the Arctic Circle across Asian Russia in both years and Alaska in 2019. Near-real-time monitoring of the wildfire activity, based on satellite observations of active fires, showed widespread and persistent fires at a scale that had not been observed in the previous years that satellite observations are available. We present an analysis of Arctic and high northern latitude wildfires during the summers of 2019 and 2020 and their impact on air quality and atmospheric composition. We will review the underlying climatological conditions, the estimated emissions, long-range smoke transport over the Arctic Ocean and local air quality impacts. The European Centre for Medium-Range Weather Forecasts (ECMWF) through its operation of, and contribution to, different Copernicus Services is in a unique position to provide detailed information to monitor high-latitude wildfire activity, including their evolution and potential impacts, when they occur. Analyses based on observations of fire radiative power, along with analyses and forecasts of associated atmospheric pollutants, from the Copernicus Atmosphere Monitoring Service (CAMS) aid in quantifying the scale and intensity in near-real-time and the subsequent atmospheric impacts, including local air quality and long-range smoke transport. Surface climate anomalies from the Copernicus Climate Change Service (C3S) provide context to the environmental conditions required for wildfires to persist. We will show how CAMS operational products provide a wealth of information required for monitoring wildfire and air quality and highlight how these products can be improved by filling gaps in our current knowledge in these regions.

Early Career Scientist

NO, I am not an early career scientist.

PACES-13A

Wintertime surface based temperature inversions are related to differences in particulate matter and ozone on a 20 m vertical scale in Alaska

Meeta Cesler-Maloney[1], William R Simpson[1], Tate Miles[1], Jingqiu Mao[1], Tjarda Roberts[2], Sarah Johnson[3], Jochen Stutz[3]
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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

During winter in Fairbanks, Alaska, pollutants can accumulate to large concentrations at ground level during surface based inversions (SBIs), but little is known about the composition of the atmosphere aloft. We measured $PM_{2.5}$ and O_3 at 3 m and 20 m AGL, as well as $PM_{2.5}$ and temperature on a tower at 3 m, 6 m, 9 m and 11 m AGL to quantify near surface gradients in $PM_{2.5}$ and SBIs. We defined SBIs to include data with an 11 m minus 3 m temperature difference > 0.5°C. We determined that vertical mixing was reduced during SBIs, as $PM_{2.5}$ accumulated to larger concentrations at 3 m than at 20 m. During SBIs, we found the median $PM_{2.5}$ concentration was 4.8 microgram m^{-3} lower at 20 m than 3 m and the O_3 mixing ratio was > 2 nmol mol^{-1} larger at 20 m than at 3 m in 48% of the data. Results show that during SBIs in Fairbanks, significant pollution trapping occurs in the lowest 20 m AGL. We also show changes in the oxidation regime of the atmosphere across this 20 m vertical scale, as large vertical differences in O_3 mixing ratios were measured during SBIs.

Early Career Scientist

YES, I am an early career scientist.

PACES-14B

Source and variability of formaldehyde (HCHO) vertical column density at northern high latitude: an integrated satellite, ground/aircraft, and model perspective

Tianlang Zhao[1], Jingqiu Mao[1], William R Simpson[1], Isabelle De Smedt[2], Lei Zhu[3], Thomas F Hanisco[4], Gonzalo Gonzalez Abad[5], Caroline R Nowlan[5], Barbara Barletta[6], Simone Meinardi[6], Donald R Blake[6]
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

Americas Working Group

Abstract

Here we use satellite observations of HCHO vertical column densities (VCD) from the TROPOspheric Monitoring Instrument (TROPOMI), ground-based and aircraft measurements, combined with a nested regional chemical transport model (GEOS-Chem at 0.5°×0.625° resolution), to better understand the variability and sources of summertime HCHO VCD in Alaska. We first evaluate GEOS-Chem with *in-situ* airborne measurements during ATom-1 aircraft campaign and ground-based measurements from Multi-AXis Differential Optical Absorption Spectroscopy (MAX-DOAS). We show reasonable agreement in spatiotemporal variabilities between observed and modeled HCHO, isoprene and monoterpenes. In particular, HCHO profiles show large spatial homogeneity in Alaska, suggesting a minor contribution of biogenic emissions to HCHO VCD. We further examine the TROPOMI HCHO product in Alaska during boreal summer. We find that for the year of 2018, background HCHO column, resulting from methane oxidation, contributes to 66-80% of HCHO VCD, wildfires contribute to 14% and biogenic VOC contributes to 5-9% respectively. The majority of wildfire contribution is due to direct combustion HCHO emission. For the year of 2019, a year with large wildfires, wildfires contribute to 40~65%, and background signal account for 30~50% of HCHO VCD in June and July. We find that the signal contributed by biogenic VOC is often too small and below TROPOMI detection limit. The source and variability of HCHO VCD in Alaska summer is mainly driven by background methane oxidation and wildfires.

Early Career Scientist

YES, I am an early career scientist.

PACES-15C

Wintertime anthropogenic Arctic Air Pollution over Alaska

Eleftherios Ioannidis[1], Kathy S. Law[1], Jean-Christophe Raut[1], Tatsuo Onishi[1], Louis Marelle[1], Tjarda J. Roberts[2], Brice Barret[3], Barbarra D'Anna[4], Brice Temine-Roussel[4], Rachel M. Kirpes[5], Kerri A. Pratt[5], Lucia Upchurch[6], Patricia K. Quinn[6], Elisabeth Andrews[7], Sho Ohata[8], Tatsuhiro Mori[9], Yutaka Kondo[10], Nicole Mölders[11], Meeta Cesler-Maloney[12], Jingqiu Mao[12], William Simpson[12]
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, CATCH: the Cryosphere and Atmospheric Chemistry

Abstract

Air pollution transported from mid-latitudes influences the Arctic during wintertime, leading to the formation of Arctic Haze. Local emissions, such as combustion for heating in cold winter conditions, also contribute to wintertime air pollution. However, the formation of secondary aerosol particles in cold/dark wintertime Arctic conditions, is poorly understood.

In this study, which contributes to the Air Pollution in the Arctic: Climate, Environment and Societies - Alaskan Layered Pollution and Arctic Chemical Analysis (PACES-ALPACA) initiative, the Weather Research Forecasting Model with chemistry (WRF-Chem) is used to investigate wintertime pollution over Alaska focusing on Prudhoe Bay and the Fairbanks region, respectively. Fairbanks is the most polluted city in the United States during wintertime, due to high local emissions and the occurrence of strong surface temperature inversions trapping pollutants near the surface. On the other hand, the Prudhoe Bay oilfields contribute to wintertime air pollution in northern Alaska.

In a first study, the sensitivity of simulated aerosols to local anthropogenic emissions is investigated over northern Alaska and evaluated against observations at Utqiaġvik, collected during a campaign in Jan-Feb 2014. FLEXible PARTicle dispersion model coupled with WRF, is also used to identify the pollutant origins in air masses in the boundary layer, which are influencing Utqiaġvik during periods with elevated aerosols. The contribution of locally produced anthropogenic and natural aerosols relative to remote pollutants is also examined.

In a second study, focusing on winter 2019 (ALPACA pre-campaign) over Fairbanks, large-scale synoptic conditions and remote anthropogenic sources affecting background aerosols are estimated. The sensitivity of secondary aerosol formation to meteorological factors, such as relative humidity, boundary layer stability are examined. Discrepancies in modelled secondary aerosols compared to available data are investigated (e.g. missing dark formation mechanisms, removal processes, emissions). The role of local/regional dynamical processes influencing aerosols under different meteorological conditions observed during the field campaign, such as a cold stable episode or a period with potential mixing of air masses from aloft, are also investigated.

Early Career Scientist

YES, I am an early career scientist.

SH-1A

Development of a regional airshed chemical transport model for priority airsheds in Western Australia

Dr Sean HM Lam
Department of Water and Environmental Regulation, Perth, Australia

IGAC Activities

GEIA: Global Emissions Initiative, CCMi: Chemistry Climate Model Initiative, ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group, Southern Hemisphere Working Group, MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The purpose of this project is to develop a state-of-the-art regional air quality model through the integration of a highly explicit representation of atmospheric chemistry and next generation meteorological model. Critical to the development of this next generation model will be the meteorological data, detailed emission data and chemical mechanism scheme.

The Western Australian Department of Water and Environmental Regulation (DWER) has conducted numerous sensitivity analyses using the Weather Research Forecast (WRF) model in the priority airsheds in Western Australia. The recent update of the Perth metropolitan emissions inventory offers a great opportunity to incorporate a state-of-the-art meteorological model with detailed emissions in the metropolitan area and other priority airsheds.

This project involves the development of the next-generation regional photochemical transport model that extends the existing representation of the atmospheric chemistry. The modelled results will be evaluated and compared to long term observational data in the region.

Early Career Scientist

NO, I am not an early career scientist.

SH-2B

Particulate matter mass concentration in different size fractions related to meteorological variables in the Metropolitan Area of São Paulo

Master of Science Victória M L Peli, Head of Laboratory Rosana Astolfo, Associate Professor Adalgiza Fornaro
Institute of Astronomy, Geophysics and Atmospheric Sciences, University of São Paulo, São Paulo, SP, Brazil

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

Particulate Matter (PM) interacts in different ways with meteorological factors, depending on its size. The objective of this study is to analyze the PM mass concentrations in different size fractions related to meteorological variables in the Metropolitan Area of São Paulo. In order to accomplish this, it was sampled 12 PM size fractions with Micro-Orifice Uniform-Deposit Impactor. The sampling was made in the Institute of Astronomy, Geophysics and Atmospheric Sciences of University of São Paulo (IAG/USP) principal building's terrace. After sampled, the filters were weighted in a micro-analytical balance in an environmental controlled room (temperature of 22°C and relative humidity of 45%). The values found were divided by the volume of air sampled to obtain PM mass concentrations. Data of meteorological variables were from Meteorological Station of IAG/USP; satellite images and synoptic charts were from Centro de Previsão do Tempo e Estudos Climáticos of Instituto Nacional de Pesquisas Espaciais; and the radiosounding data were from Campo de Marte Airport (available on http://weather.uwyo.edu/upperair/sounding.html). The Pearson Linear Correlation Coefficient was used to analyze the relations between PM mass concentrations and meteorological variables. It was found that the increase in PM mass concentrations was associated with temperature increase, relative humidity and wind speed decreases, and lack of rainfall. The decrease in PM mass concentrations was associated with pressure, wind speed and relative humidity increases, and rainfall occurrence. Temperature and relative humidity were variables the most influenced the different PM sizes. Particles smaller than 0.020 µm were more influenced by temperature (0.67), relative humidity (-0.81), specific humidity (-0.62) and rainfall (-0.27). Cold front passages decreased PM mass concentrations and they started increasing one day after the cold front passed. Accordingly, PM size fractions were influenced differently by meteorological variables.

Early Career Scientist

YES, I am an early career scientist.

SH-3C

Temperature response measurements from eucalypts give insight into the impact of Australian isoprene emissions on air quality in 2050

Dr Kathryn M Emmerson[1], Dr Malcolm Possell[2], Dr Michael J Aspinwall[3,4], Dr Sebastian Pfautsch[4], Prof Mark G Tjoelker[4]
[1]CSIRO, Aspendale, VIC, Australia. [2]University of Sydney, Sydney, NSW, Australia. [3]University of North Florida, Jacksonville, FLA, USA. [4]Western Sydney University, Penrith, NSW, Australia

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Forecasting future air quality in Australian cities dominated by eucalypt emissions requires an understanding of their emission potentials in a warmer climate.

This talk presents measurements of the temperature response in isoprene emissions from saplings of four different *Eucalyptus* species grown under current and future average summertime temperature conditions. The future conditions represent a 2050 climate under Representative Concentration Pathway 8.5, where CO_2 is predicted to reach 550 ppm.

The eucalypts continued to emit isoprene 4-9 K beyond the default maximum emission temperature in the Model of Emissions of Gases and Aerosols from Nature (MEGAN). New emission factors were also obtained.

We applied the new temperature responses and emission factors to Australian trees within MEGAN and ran the CSIRO Chemical Transport Model for three summertime campaigns in Australia. Two runs simulated a 2050 atmosphere by delta-scaling surface temperatures and including the CO_2 effect on isoprene emissions.

Compared to current conditions, an additional 2 ppb of isoprene is predicted in 2050 causing hourly increases up to 21 ppb of ozone and 24-hourly increases of 0.4 mg m^{-3} of aerosol in Sydney. This forecasted increase in ozone is one fifth of the hourly Australian air quality limit and suggests anthropogenic NOx should be further reduced to maintain healthy air quality in future.

New urban developments should consider the isoprene emission potential of trees before planting. However, trees emit isoprene to protect against heatwave damage, and low emitting species may not survive in a hotter Australian climate.

Early Career Scientist

NO, I am not an early career scientist.

SH-4A

Identifying the factors driving the Biogenic VOC uncertainty in CTM models in south-east Australia.

Mr. Jhonathan Ramirez[1], Dr. Jenny Fisher[1], Dr. Kathryn Emmerson[2]
[1]University of Wollongong, Wollongong, Australia. [2]CSIRO, Aspendale, Australia

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Emissions of biogenic volatile organic compounds (BVOCs) depend on temperature, light, solar radiation and other factors. Isoprene and monoterpenes together comprise most of the BVOC emissions and are the species known to cause secondary organic aerosol (SOA) and tropospheric ozone formation. That is why understanding the BVOC chemistry in the atmosphere is important for air quality and climate. There are many uncertainties regarding the emissions of BVOCs and their subsequent atmospheric chemistry especially in south-east Australia. These uncertainties have hindered the ability of Chemical Transport Models (CTMs) to model BVOCs, as shown by large discrepancies when comparing model estimates against observations specially during the summer season.

This project aims to identify which factors are driving the differences and uncertainties in BVOC concentrations between the CTMs and observations. For the modelling performance analysis two CTMs were compared for January in 2013, GEOS-Chem and CSIRO-CTM. To estimate the biogenic emissions both CTMs use the Model of Emissions of Gases and Aerosols from Nature (MEGAN). Two available emission estimation regimes from MEGAN were used here, the Plant Functional Type (PFT) and emission factor maps for the region. The analysis showed how both CTMs are overestimating BVOCs during days with temperatures over 30 °C. The rest of the time the models differ depending on the emission regime. GEOS-Chem has a poor representation of monoterpenes. Although the meteorology factors seem statistically similar, small differences in the planetary boundary layer height, wind speed and temperature increase the concentration variation between models and observations. The chemistry mechanism in both models do not agree with the observations. GEOS-chem show a faster reaction of isoprene producing mainly oxidated products of isoprene, whilst CSIRO-CTM the reactions are occurring at a lower rate than the inferred from the observations isoprene/methacrolein and methyl-vinyl ketone ratios.

Early Career Scientist

YES, I am an early career scientist.

SH-5B

Dust emissions modelling over the semi-arid Argentinian territory

Ramiro Espada[1], Pablo Lichtig[1], Melisa Diaz Resquin[1], Cristina Rössler[1], Laura Dawidowski[1], Guy Brasseur[2]
[1]CNEA, Buenos Aires, Argentina. [2]MPIMET, Hamburg, Germany

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Dust has significant impacts on weather, air quality, visibility, and human health. A proper representation of dust sources is needed to adequately predict the concentration of airborne dust particles in the atmosphere. In Argentina, major dust events originate from the South American Arid Diagonal and the shores of Mar Chiquita lake.

The atmospheric forecasting system "Weather Research and Forecasting with Chemistry" (WRF / Chem) developed by the "National Center for Atmospheric Research" (NCAR) includes different approaches for estimating dust emitted on the Earth's surface. We examined the performance of the 3 dust emission schemes available in the WRF/Chem system, namely GOCART, Air Force Weather Agency (AFWA), and University of Cologne (UoC) , to assess how they represent dust dynamics in the Argentinean territory and analyse their strengths and weaknesses. To this end, we perform simulations of dust transport for the 9 most remarkable dust events of the past 30 years and we compared them with data retrieved by satellite image and products such as MODIS Terra & Aqua products of Aerosol Optical Thickness and Angstrom Exponent (MOD08 and MYD08).

For almost every event studied, the results indicate that empirical-based schemes (GOCART and AFWA) exhibited better performance on predicting the localization, geometry and bulk mass of dust emissions than based on the physical theory of erosion processes (UoC schemes). Nevertheless, the fact that UoC's emission quantification methods require significantly more parameters to characterize the emission process may indicate the need for improved datasets to correctly represent more accurately surface characteristics and erodavility.

Early Career Scientist

YES, I am an early career scientist.

SH-6C

Quantification and characterization of PM2.5 in Buenos Aires, Argentina.

Llc. Pablo Lichtig[1,2], Lic. Facundo Baraldo[1], Dr.. Julián Gelman Constanin[1,2], Eng. Julio Murillo Hernández[3], Dr. José Herrera Murillo[3], Eng. Darío Gómez[1], Lic. Laura Dawidowski[1]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

In Latin America, the most urbanized region of the world, the health problems linked to poor air quality are among the main environmental concerns. One area of interest, in which knowledge is lacking, is the composition of fine aerosol fraction, and the need for standardized measurements. To address this issue, the International Atomic Energy Agency (IAEA) is funding a regional project, consisting of long term monitoring of PM2.5 in thirteen Latin American cities, with the aim of identifying local and regional relevant pollution sources.

We present preliminary results for the Metropolitan Area of Buenos Aires (MABA), the third megacity in the region, where 120 samples were collected between April 2019 and March 2020. PM2.5 concentration and chemical components have been measured, including carbonaceous portion (EC/OC/TC and BC), ions (Na^+, Cl^-, SO_4^{2-}, NH_4^+, NO_3^-) and metals (Mg, S, Ca, V, Cr, Fe, Cu, As, Se, Sr, Hg, Pb, Zn, Mn, Mo, Ni, Ti, Sb, Al, K, Co, Ag, Cd, and Ba). We applied different mass closure schemes as listed by [1], taking into account the negative bias in the mass collected due to ammonium nitrate losses during storage. Although categories may vary in type and definition, according the best performing scheme, organic mass atones for ~60% of total mass on average, followed by geological minerals (~13%), inorganic ions (~8%), elemental carbon(~6%) and sea salt (~2%). ~12% remains unexplained.

Seasonal variation of PM2.5 major components has been identified and jointly analyzed with regional intrusions from nearby and far biomass burning sources, identified with data retrieved from satellite observations.

References

[1] Chow, J.C., Lowenthal,D.H., Chen, L.W.A., Wang,X., Watson, J.G., 2015. Mass reconstruction methods for PM2.5: a review. Air Quality, Atmosphere & Health 8, 243–263.

Early Career Scientist

YES, I am an early career scientist.

SH-7A

Black Carbon atmospheric emissions from biomass burning in the Amazon reaching the Chilean Central Andes: evidence from a multi-technical approach

Dr Maria F Ruggeri[1], Dr. Tomás R Bolaño-Ortiz[1,2,3], Víctor Vidal[1], Dr. Salvador E Puliafito[2,3], Dr. Francisco Cereceda-Balic[1]
[1]Universidad Técnica Federico Santa María, Valparaíso, Chile. [2]Universidad Tecnológica Nacional, Mendoza, Argentina.
[3]CONICET- Consejo Nacional de Investigaciones Científicas y Técnicas, Buenos Aires, Argentina

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

The year 2019 presented the largest number of wildfires in the Amazon in the last decade. Brazil's National Institute for Space Research (INPE) counted more than 41,000 "fire spots" between January and August, compared with 22,000 in the same period in 2018. These fires, in which mainly biomass is burned, emit large amounts of pollutants to the atmosphere, and some of them could be transported for long distances. Such is the case of Black Carbon (BC), produced by incomplete combustion during biomass burning. Atmospheric circulation and dispersion models showed that smoke plumes produced during august, the most active month in terms of fires, reached the Chilean Central Andes (ChiCA). In this area, the atmospheric BC is prone to be deposited in snow/ice surfaces, causing their darkening and fastening their melting. In this work, we studied daily variations of snow albedo and aerosol optical depth (AOD) using MODIS images of the ChiCA. Results showed an increase in AOD and a decrease in snow albedo from August 22 to 27,2019, suggesting the arrival of this aerosol plume. To validate and contrast these observations, measurements of atmospheric BC from July to September 2019, carried out in Portillo, ChiCA, in the "Nunatak" laboratory-refuge (3000 m.a.s.l) were analyzed. BC concentrations were monitored by a Multi-Angle Absorption Photometer (Model 5012, Thermo), based on optical attenuation at 637 nm. Data were originally sampled in one-minute resolution, but hourly and monthly means were extracted for further analysis. Measured BC atmospheric levels showed a significant increase during the last week of august, with a maximum value of 4.73 $\mu g\ m^{-3}$ registered on August 24. These data evidence that pollution generated in the Amazon basin can reach and impact in the Andean Cryosphere. These findings are key pieces to identify patterns and sources of BC in the area.

Early Career Scientist

YES, I am an early career scientist.

SH-8B

An Overview of the COALA-2020 campaign at Cataract (Characterising Organics and Aerosol Loading in Australia)

Clare Murphy (Paton-Walsh)
Univerisity of Wollongong, NSW, Australia

IGAC Activities

GEIA: Global Emissions Initiative

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

The COALA-2020 (Characterising Organics and Aerosol Loading in Australia-2020) campaign took place near Cataract Lake in New South Wales from January to March 2020. The campaign included:

1. Approximately 8 weeks of ambient sampling, with continuous (1-3 minute) aerosol and gas-phase measurements, supplemented by daily (or two-day) filter samples from the University of Nagoya. Instruments deployed at the site included a proton-transfer-reaction-time-of-flight-mass spectrometer (PTR-TOF-MS) for measurements of volatile organic compounds (VOCs) and an aerosol composition mass spectrometer, along with particle counters, aerosol size distribution counters, cloud condensation nuclei counters and measurements of black carbon, carbon monoxide, carbon dioxide, methane, nitrogen oxides, ozone

2. Enclosure measurements to provide emission rates of biogenic volatile organic chemicals from six different tree species (with three replicates) run twice over – in January and in March.

3. Measurements of soil emissions of nitrogen oxides and VOCs, including regular daily measurements and two sets diurnal measurements.

4. An intensive examination of the emissions from a mature Scribbly Gumtree using three different branches for approximately 24 hours each, sampling from an enclosure onto a PTR-TOF-MS. These measurements occurred for 10 minutes every half an hour, interspersed with 10 minutes of ambient measurements up a 10 m mast and 10 minutes from an open tube into the leaves of the Gumtree.

Early in the campaign the site was impacted by smoke from the huge bushfires burning in south-eastern Australia. To our knowledge, these measurements are the most comprehensive aerosol and gas-phase measurements made in smoke from Australia bushfires.

Later in the campaign, after very substantial rain, there were some significant new particle formation events. This poster aims to provide an overview of the campaign to foreshadow some of the exciting science we hope will come out of the analysis of the data obtained.

Early Career Scientist

NO, I am not an early career scientist.

SH-9C

Mass spectrometry system (MALDI-TOF) validation in the identification of Aspergillus Nigri Section species of atmospheric air from São Paulo, Brazil.

Specialist Valter Batista Duo Filho, PhD Dulcilena de Matos Castro e Silva
Adolfo Lutz Institute, São Paulo, São Paulo., Brazil

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Southern Hemisphere Working Group, Americas Working Group

Abstract

Airbone composition is still a challenge to researchers in environmental microbiology. The laboratory analysis is presenting so many issues such as techniques standardization and funding. Between airbone fungi, the *Aspergillus* genus has the most incidence and are known at least 344 species divided into relevant sections: Fumigati, Flavi, Terrei, Usti, Nigri and Nidulantes. The Nigri Section has at least 26 species, being *A. niger* the most frequent species. Molecular biology techniques are very used to measure several laboratory parameters. However, when we work with a big volume of samples, like in environmental researches, this methodology brings high costs. Mass spectrometry (MALDI-TOF), a technology already validated, can be a methodology more useable in the identification of environmental fungi species. Methods: For the analysis, the samples were first separated phenotypically. Were analyzed 88 samples of *Aspergillus* Nigri Section isolated from São Paulo's city air. The identification by mass spectrometry was applied to distinguish several species from Nigri Section what commonly are identified using molecular diagnosis. Results: From the 88 samples, were identified three species from the *Aspergillus* genus using the MALDI-TOF system, distributed as the following frequency: 96,5% *A. niger*, 2,2% *A. japonicus* and 1,1% *A. brasiliensis*. The medium scores found in the measures for *A. niger* was 2.2, for *A. brasiliensis* was 2.1 and for *A. japonicus* was 2.4, confirming the efficiency of MALDI-TOF system in the species identification. Conclusion: MALDI-TOF system was adequate to the identification of the different species from *Aspergillus* Nigri Section in airbone samples, showing the reliability in the use of mass spectrometry to identify species from *Aspergillus* genus in the airbone, as molecular diagnosis as well.

Early Career Scientist

YES, I am an early career scientist.

SH-10A

Intercontinental Air Pollution Transport in the Southern Hemisphere

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IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Intercontinental air pollution transport has received little attention in the Southern Hemisphere in comparison to the Northern Hemisphere. As air quality becomes an increasingly important environmental and health issue for countries in the Southern Hemisphere, it is vital to be able to quantify the impact a given region's anthropogenic air pollution emissions will have on other regions downwind. The Hemispheric Task Force on Air Pollution (HTAP2) Protocol was used to quantify the impact of intercontinental air pollution transport for pollution emissions from 2008, 2030 (using the RCP4.5 scenario) and an alternate African renewable energy emission scenario for Southern Hemisphere ozone (O_3) and particulate matter ($PM_{2.5}$) in Australia, South America, Southeast Asia and Sub-Saharan Africa. It was found that in 2008 foreign sources were responsible for the majority of Australian O_3 concentrations and Southeast Asian O_3 and $PM_{2.5}$ concentrations, whereas local sources were responsible for the majority of Australian $PM_{2.5}$ concentrations, South American O_3 and $PM_{2.5}$ concentrations and Sub-Saharan African O_3 and $PM_{2.5}$ concentrations. It was shown that in 2030, the ratio of foreign to local sources impacting O_3 and $PM_{2.5}$ concentrations will change for all four regions. Australia will experience the largest change, with relative foreign source contributions to O_3 and $PM_{2.5}$ concentrations increasing. An alternate 2030 African renewable energy emissions scenario showed impacts both within the Sub-Saharan African region and outside the region. Most notably, the sources impacting Australian $PM_{2.5}$ concentrations became more local, with a small decrease in the relative ratio of foreign to local sources. This research shows as Southern Hemisphere countries seek to improve their air quality, they must consider not only their own local sources of air pollutants but also those from distant continents, highlighting the need for global cooperation in the area of air quality.

Early Career Scientist

YES, I am an early career scientist.

SH-11B

Radon Dosimetry in Nchanga Underground Mine on The Copperbelt Province

Mr. RABBISON DONTI BANDA, Mr. Patrick Hayumbu, Dr. Nandi Mumba
Copperbelt University, Kitwe, Zambia

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Americas Working Group, MANGO: Monsoon Asia and Oceania Networking Group, Southern Hemisphere Working Group, China Working Group, Japan National Committee

Abstract

Objective: Radon is a potential airborne pollutant of the underground copper mines of the uraniferous Katanga Basin. Radon measurements conducted by Hayumbu et al in 2005 at Nchanga Underground Mine showed that radon dose levels in substantial sections of the mine, especially near underground water sumps, were above the action level for individual dosimetry (5 mSv/a). Some measurements were above the occupational exposure limit of 20 mSv/a. Since Zambia is yet to promulgate an occupational hygiene surveillance monitoring programme for carcinogenic airborne pollutants in its underground mines, it no wonders that in the past 15 years no follow-up radon measurements have been done at Nchanga underground. This study is to measure radon concentration levels in workplace air and underground water.

Methodology: Two different techniques will be used in this study, namely;

1. Radon grab sampling technique using Lucas Cells to collect 20 workplace air samples that will be counted on three alternate days over a week.
2. Gamma spectrometry analysis of water samples collected alongside radon grab sampling. Analyses of the water samples will be done at the National Institute for Scientific and Industrial Research's Nuclear Analytical Laboratory in Lusaka.

Results: The study results will be evaluated to obtain radon exposure levels at sampled sites and will be compared to internationally accepted exposure level values for miners.

Implications: The study findings will be added to the nascent national database of radon measurements in Zambian mines and be used by the Radiation Protection Authority (RPA) in their regulatory duties. It is anticipated that these results may contribute to the formulation of the ongoing Naturally Occurring Radioactive Materials/Technologically Enhanced Naturally Occurring Radioactive Materials (NORM/TENORM) national policy formulation by RPA.

Keywords: Radon Gas, Gamma Spectrometer, and Lucas Cells.

Early Career Scientist

NO, I am not an early career scientist.

SH-12C

Can we see the impact of indigenous fire management on the interannual variability of carbon monoxide?

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Fire is an essential global phenomenon that existed soon after the appearance of terrestrial plants and is vital for the regeneration of the plant species. Long-term trends in fire behaviour can reveal critical information about important human and climate-driven influences across many landscapes. Human activities have contributed to a changing climate and impacted fire regimes, resulting in more intense, frequent and severe fires. In particular, the 2019-20 bushfires in southeastern Australia were unprecedented in their extent and intensity. However, human activities can also play a dominant role in regulating fire behaviour effectively through better fire management practices. In Northern Australia, indigenous fire managers are using prescribed burns during the early dry season to prevent large late dry season fires, which shifts the overall temporal distribution of fire activity earlier during the primary biomass burning season. This increasing trend of prescribed burns has helped to significantly reduce the size and extent of the intense late dry season fires, indicating that such fire management practices can be effective at managing wildfires in savannas.

Biomass burning can emit many chemical species that have an impact on human health. One of the most abundant, and widely measured is carbon monoxide (CO), whose long-term exposure can lead to potential human health risk. CO is also a good proxy for emissions of other shorter-lived and harder to measure atmospheric constituents. This study is focussed on better understanding the earlier fire season in Northern Australia, and the associated interannual variability of CO. Column CO data from the ground-based Total Carbon Column Observing Network (TCCON) site in Darwin will be used together with surface measurements complemented by the surface mixing ratio observations from MOPITT, in order to disentangle the CO emitted from the study region from that measured in the column from remote emissions coupled with long-range transport.

Early Career Scientist

YES, I am an early career scientist.

SH-13A

Prediction of Aerosol acidity in the remote marine boundary layer of the southern ocean during summer.

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IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Aerosol acidity is a fundamental parameter of aqueous chemistry that impacts the lifetimes of pollutants, biogeochemical cycles, human health, and climate. However, despite this importance, aerosol pH effects on these processes are difficult to constrain, in part because there are no direct methods to measure aerosol pH. The lack of observations in remote clean atmosphere makes quantifying pH of aerosol even more challenging.

Here, two independent datasets of aerosol chemical composition collected in the marine boundary layer of the summertime Southern Ocean during a cruise from Cape Town (34.11°S, 18.03°E) to Antarctica (70°S, 2.11°W), were used as inputs to the thermodynamic model ISORROPIA-II to estimate the pH of marine aerosols. The thermodynamically predicted aerosol pH from both filter-based (collected daily) and the continuous (collected every two hours) measurements are consistently acidic. The estimated pH ranged from -0.40 to 2.63 with an average value of 1.21 and -0.68 to 5.01 with an average value of 2.08 for the filter-based and continuous datasets, respectively. Controlling factors on the variability of the predicted pH, such as the presence of non-volatile cations, will be discussed, along with implications in our understanding of biogeochemical cycling in remote marine regions.

Early Career Scientist

YES, I am an early career scientist.

SH-14B

Southern Ocean latitudinal gradients of Cloud Condensation Nuclei

Dr Ruhi S Humphries[1,2], Dr Melita D Keywood[1], Sean Gribben[1], Ian M McRobert[3], Jason P Ward[1], Paul Selleck[1], Sally Taylor[1], James Harnwell[1], Connor Flynn[4], Gourihar R Kulkarni[5], Gerald G Mace[6], Alain Protat[7,2], Simon P Alexander[8,2], Greg McFarquhar[4]
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IGAC Activities

PACES: Air Pollution in the Arctic: Climate, Environment, and Societies, CATCH: the Cryosphere and Atmospheric Chemistry

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

The Southern Ocean has been plagued by a dearth of measurements for decades, owing to its harsh environment far from major population centres. Since 2015, there has been a flurry of measurements, most notably continuous measurements aboard the RV Investigator which houses the world's first mobile station of the Global Atmosphere Watch, as well as numerous significant campaigns in the region. In this study, we utilise aerosol and cloud condensation nuclei (CCN) measurements made two concurrent, co-located summertime campaigns in the Southern Ocean and Antarctic regions: MARCUS and CAPRICORN-II.

The aerosol data (CN10 and CCN at numerous supersaturations) were divided into 5° latitudinal bins. The northern-most bin (40-45°S) was found, unsurprisingly, to exhibit the highest concentrations ($CCN_{0.2}$ ~100 cm^{-3}; $CCN_{0.5}$ ~250 cm^{-3}; CN_{10} ~600 cm^{-3}), with back-trajectory analyses revealing substantial influence from continental sources of Tasmania and to a lesser extent, Victoria. Latitudinal bins between 45-65°S were reasonably consistent ($CCN_{0.2}$ ~ 100 cm^{-3}; $CCN_{0.5}$ 150 cm^{-3}; CN_{10} ~300 cm^{-3}), with trajectories showing a marine boundary layer source region from the south-west. CCN measurements in this latitudinal range agreed with concurrent measurements at Macquarie Island and at Cape Grim. The southern-most latitudinal bin (65-70°S) showed a distinct change in populations, with increases in aerosol concentrations ($CCN_{0.2}$ ~130 cm^{-3}; $CCN_{0.5}$ 250 cm^{-3}; CN_{10} ~350 cm^{-3}) and CCN/CN_{10} ratios, consistent with previous measurements resulting from transitioning across the atmospheric polar front. Analyses to further understand these changes showed corresponding increases in sulfate aerosols, decreases in sea-salt aerosol and decreases in both wind speed and precipitation influence.

This dataset is important observational data that will help verify climate and earth system models, and constrain satellite data. These data also help to untangle the mystery of the compositional changes consistently observed across the atmospheric polar front.

Early Career Scientist

NO, I am not an early career scientist.

SH-15C

Mapping the sources of organic PM_1: A case study from the COALA campaign in Southeast Australia

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IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Organic aerosols (OA) make up a substantial fraction of PM_1, the measurement of which is often challenging as it requires highly sensitive instrumentation. One instrument commonly used to achieve this is the Aerodyne Aerosol Chemical Speciation Monitor (ACSM) due to it being real-time as well as having high sensitivity and temporal resolution. Monitoring of particulate matter (PM) typically measures PM_{10} and $PM_{2.5}$, but measurement of submicron PM is not conducted at a widespread level, even though PM_1 can have more severe adverse health effects than the coarser PM fractions, as well as playing an important role in mechanisms such as cloud formation.

Source apportionment of particulates is performed to approximate the different loadings of aerosols that originate from different sources, which helps to better understand the health effects and climate forcing of aerosols. While many source apportionment studies have been conducted using ACSM data, few if any have attempted to analyse the relationship between concentrations of different kinds of OA at the receptor with the transport and chemical mechanisms that take them there. This study uses time-of-flight-ACSM data collected during the Characterising Organics and Aerosol Loading over Australia (COALA) field campaign conducted in Cataract, a forested site 50 km southwest of Sydney, Australia, along with analysis using Positive Matrix Factorisation, back trajectories, and measurements of local meteorology and atmospheric constituents to establish a spatial profile of the different sources of OA around the site. Given that the campaign's early stages coincided with the catastrophic Black Summer bushfires in January and February 2020, while the subsequent period in the campaign was more associated with more temperate weather, it is expected that there is a clear distinction between the sources of OA in the two parts of the campaign.

Early Career Scientist

YES, I am an early career scientist.

SH-16A

Using Climate Mode Indices to Forecast Carbon Monoxide Variability in Fire-Prone Southern Hemisphere Regions

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group, Southern Hemisphere Working Group

Abstract

Fire is a major driver of atmospheric carbon monoxide (CO) variability in the Southern Hemisphere. The magnitude of fire emissions, such as CO, is connected to climate through both the availability and dryness of fuel. We use interpretable models with predictive skill to explain this relationship between CO and climate. Specifically, we model CO column-averaged volume mixing ratios from the satellite-borne instrument MOPITT using indices for the following climate modes: the El Nino Southern Oscillation, the Indian Ocean Dipole, the Tropical Southern Atlantic, the Southern Annular Mode, and the Madden-Julian Oscillation. We model CO in two regions that have recently experienced extreme fire seasons: Maritime Southeast Asia and Southeast Australia. Our models can capture complex relationships between climate and CO by accommodating multiple lags of a single climate mode. We use these models to identify the most influential climate modes and their lead times for explaining CO variability in both study regions. We also highlight the importance of first-order interactions between climate modes and demonstrate that our models have good predictive skill at considerable lead times (about 25 weeks for the Maritime SEA region). Finally, we evaluate the impact of clouds on regional CO variability by applying satellite cloud detections to global model output from the Community Atmosphere Model with chemistry (CAM-chem). Overall, successful prediction of CO is important for air quality forecasting, especially during the tropical fire seasons.

Early Career Scientist

YES, I am an early career scientist.

SH-17B

Biomass burning smoke and coincident water vapor over the southeast Atlantic stratocumulus region: results from observations and models

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IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Southern Hemisphere Working Group

Abstract

In southern Africa, widespread agricultural fires produce substantial biomass burning (BB) emissions over the region. The seasonal smoke plumes associated with these emissions are then advected westward over the persistent stratocumulus cloud deck in the Southeast Atlantic (SEA) Ocean. We present airborne observations made during the NASA ORACLES (ObseRvations of Aerosols above CLouds and their intEractionS) campaign over the SEA. Using multiple airborne datasets, we observe a strongly linear correlation between biomass burning indicators (carbon monoxide (CO) and aerosol loading) and atmospheric water vapor content, seen at all altitudes above the boundary layer. This relationship was particularly strong in the 2016 observations, but was also present in the 2017 and 2018 deployments.

Using ECMWF and MERRA-2 reanalyses and specialized WRF-Chem simulations, we trace the plume-vapor relationship to an initial humid, smoky continental source region, where it mixes with clean, dry upper-tropospheric air and then is subjected to conditions of strong westward advection, namely the South African Easterly Jet (AEJ-S). Our analysis indicates that airmasses likely left the continent with the same relationship between water vapor and carbon monoxide as was observed by aircraft, though the vapor did not originate as a product of the BB combustion itself. This linear relationship developed over the continent due to daytime convection within a deep continental boundary layer (~5-6km) and mixing with higher-altitude air, which resulted in fairly consistent vertical gradients in CO and water vapor, decreasing with altitude and varying in time. The smoky, humid air is then subjected to strong zonal winds and advected over the SEA following largely isentropic trajectories. HYSPLIT back trajectories support this interpretation. With better understanding of this relationship, and its spatial and temporal variations, we are working towards accurately quantifying the radiative and dynamical effects of both aerosol and water vapor over this region.

Early Career Scientist

NO, I am not an early career scientist.

SH-18C

AVOC and BVOC sensitivity study for ozone pollution in Santiago, Chile combining observations and a box model

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IGAC Activities

CCMi: Chemistry Climate Model Initiative, TOAR: Tropospheric Ozone Assessment Report, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Tropospheric ozone (O_3) is an important greenhouse gas, but it is also an air pollutant that, in high concentrations, can severely harm health and environment. It is well known that in urban environments, O_3 depends on radiation and O_3 precursors: nitrogen oxides (NO_x) and volatile organic compounds (VOC). In central Chile, high O_3 levels that exceed the primary standard of 61 ppbv (maximum daily 8 h average) are still an unsolved problem, despite the decline observed in mixing ratios in some areas and mitigation measures adopted for its precursors, mainly in the transport sector. The current air quality monitoring network provides hourly means of O_3 and NO_x. VOC measurements are generally lacking except for a few short field campaigns conducted years ago.

Emission inventories, on the other hand, provide estimates of O_3 precursors including anthropogenic (A-VOC) and biogenic (B-VOC) VOC, as well as anthropogenic NO_x. While NO_x emissions can be constrained by in situ and remote observations, so far, we have not been able to assess the accuracy of VOC emissions. In this study we aim to infer the VOC levels in Santiago (Chile capital city) using available O_3 and NO_x observations and a chemistry box model (boxChem). We use this approach as a previous step to the use of a full three-dimensional chemistry transport model. The estimated VOC levels and speciation are contrasted against VOC measurements obtained in 2020-2021 using a Proton-Transfer-Reaction Time-of-Flight Mass Spectrometry system (PTR-TOF MS), which speciate and quantify VOC continuously.

Early Career Scientist

YES, I am an early career scientist.

SH-19A

Update of Tropospheric Ozone trends at Ushuaia GAW Station

environmental science student Pablo E Medina[1], Chemical engineer Sergio Luppo[1], Renewable Resources Engineer Sergio J Camargo[2], Electronic Engineer Lino F Condorí[3]
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IGAC Regional Working Groups

Southern Hemisphere Working Group

Abstract

Update of Tropospheric Ozone trends at Ushuaia GAW Station

The Ushuaia GAW Station (54.84846°S 68.31069°W) (18 m a.s.l.) is located roughly 10 km south-west of Ushuaia, Tierra del Fuego, Antártida e Islas del Atlántico Sur Argentina (77.260 inhabitants).

It is situated in a coastal cliff at the altitude of 18 m above sea level, on a remote sub-Antarctic marine coast.

Steady winds blow prevailing from the clean air sector (SW) down the Beagle Channel.

The ground around the station is covered with pasture and bush.

Vegetation in the surrounding area is mainly shrub and southern beech (Nothofagus species).

For a previous meeting, tropospheric ozone trends, where shown for the decade1990-1999; 2000-2009.

The objective of this work is to analyze the trends for the years 2009 to 2019. Completing three decades of tropospheric ozone analysis to observe if there are variations on it.

Also, the analysis of CO (carbon monoxide) trends will be presented.

This analysis will be useful, to visualize if there are significant variations related to the global pandemic of Covid-19.

Early Career Scientist

NO, I am not an early career scientist.

SH-20B

The influence of ventilation coefficient on carbon monoxide concentration in São Paulo city: An observation from lidar data

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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, AMIGO: Analysis of eMIssions usinG Observations

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

The city of São Paulo is characterized by its high population density (7.4 thousand inhabitants/km²) and vehicular fleet (8.7 million). These are key factors that contribute to several air quality problems in such urbanized area. In this scenario, this work presents the effect of the ventilation coefficient (VC) on concentrations of carbon monoxide (CO) in the city of São Paulo, between 2013 and 2019, from 14 to 21 UTC (local time: UTC - 3). VC was calculated from the hourly planetary boundary layer height (PBLH), which was obtained from elastic lidar data at MSP-1 station, and surface wind speed provided by the Environmental Company of the State of São Paulo (CETESB) - Pinheiros air quality station, located in a region characterized by intense traffic. Hourly values of CO concentration were also collected at the same air quality station. CO and VC behave in an inversely proportional way, with maximum values of VC close to the central hours of the day, coinciding with maximum values of PBLH, and lower concentrations of CO. In the middle afternoon, CO concentration values start increasing again alongside the decrease of VC. During the winter, when air quality is expected to worsen due to unfavorable meteorological conditions to pollutant dispersion, the highest average values of CO concentration and lowest average values of VC were observed. During the summer, higher PBLH and VC average values led to the lowest average values of CO concentration. From these results, we observe the positive influence of VC on the dispersion of CO.

Keywords: Remote sensing, air quality, dispersion

Early Career Scientist

YES, I am an early career scientist.

SH-21C

Anthropogenic air pollutant emission inventories for South America

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IGAC Activities

GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

Americas Working Group, Southern Hemisphere Working Group

Abstract

Emission inventories are an essential input to model and predict changes of the atmospheric composition, and to design and evaluate cost-effective mitigation measures. National emission inventories in South America (SA) focus on Greenhouse Gases (GHG) as part of their international agreements. Emission inventories other than GHG focus mainly on large urban areas and megacities, with different levels of development in each SA country. In order to have national emission inventories, with similar methodologies in all countries of the region, a network has been created, bringing together researchers from various countries and institutions. One output from this collaborative network is a paper describing emission estimates of air pollutants from various global inventories for five SA countries: Argentina, Brazil, Chile, Colombia and Peru. Although total emissions between down-scaled global inventories and local city inventories are often comparable, large discrepancies exist between the sectorial contributions. Additionally, an emission dataset combining global and local information in LAC was prepared within the framework of the project “Prediction of Air Pollution in Latin America and the Caribbean”. Specifically, Argentina has developed high-resolution inventories covering monthly emissions of several species and sectors for the period 1995-2020. Chile has also generated high-resolution national inventories for pollutants produced by transport, industry, and residential activity between 2015 and 2018. Brazil and Colombia also estimated their own multisector national inventories, with different levels of detail. One of the conclusions of the network highlights the importance of using local information when generating national emission inventories, especially for air quality modeling and development of effective mitigation measures. A summary of the activities of this network will be presented as well as the main results from these updated emission inventories and the planned future activities to keep the collaborative network active.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-2B

Reactive Uptake of Ozone to Simulated Seawater: Factors Affecting Uptake and Iodine Formation

Stephanie R. Schneider[1], Pascale S. J. Lakey[2], Manabu Shiraiwa[2], Jonathan P. D. Abbatt[1]
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Abstract

The reaction of ozone with iodide in the ocean is a major ozone dry deposition pathway, as well as an important source of iodine to the marine troposphere. Although this reaction has been studied extensively, there is still disagreement in the literature assessment for the overall reaction rate with respect to the relative contributions of an interfacial reaction via ozone adsorbed to the ocean surface versus a bulk reaction with dissolved ozone. There is also still uncertainty in the yield of $I_{2\,(g)}$ formed in the presence of other chemical species, such as bromide, chloride and organics. This uncertainty is largest at the low concentrations of both ozone and iodide characteristic of genuine environmental conditions, due to few direct laboratory measurements in that regime. In this study, we measure the uptake coefficient of 100 ppb ozone and the formation of $I_{2\,(g)}$ over a buffered salt solution at pH 5-8, while replicating the concentrations of iodide, bromide and chloride in the ocean. The production of $I_{2\,(g)}$ from the ozone-iodide reaction is monitored with an Iodide Adduct – Chemical Ionization Mass Spectrometer. $I_{2(g)}$ yield was found to be dependent on both pH and the concentration of bromide and chloride in solution. The experimental results at pH 8 are compared to a kinetic multilayer model resolving mass transfer of ozone, bulk diffusion, as well as interfacial and bulk reactions. The time-dependent ozone uptake coefficient agrees well with the model, but only if the depletion of iodide in the solution is explicitly modeled. The results from this study indicate that the rate of ozone dry deposition to the ocean is sensitive to the replenishment rate of iodide at the ocean surface.

Early Career Scientist

YES, I am an early career scientist.

TOAR-3C

The TOAR-II Satellite Ozone Focus Working Group

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

The TOAR-II satellite ozone working group (SOWG) was formed to diagnose and understand the differences in satellite records of tropospheric ozone and their change with time, building on findings from TOAR-I. Understanding the sources of these differences is critical if we are to use these data for assessing trends in tropospheric ozone or to develop combined data records that extend beyond time periods covered by any individual instrument record. Phase 1 of the SOWG effort will address the root causes of different trends and variations in satellite ozone vertical profile products. Using a chemical reanalysis sampled with each satellite instrument's sampling pattern and vertical sensitivity, we will examine to what degree differences in these attributes and their evolution with time explain differences between the instrument records. Phase 2 will be a direct comparison between individual tropospheric ozone products and a common set of ozonesonde data using identical methods to assess whether there are changes in the biases with ozonesondes over time. Phase 3 will examine the trends in satellite tropospheric O3, in consultation with the TOAR-II Statistics WG. Trends in the mean and percentile ranges will be assessed to estimate changes in both background and polluted levels. This analysis would also account for potential step changes in the ozone record due to events such as the 2008-2009 global recession, the 2015 El Nino fires and COVID-19 lockdowns. Biases and uncertainties that are quantified in Phases 1 and 2 will be included in the trend error estimates. Results from the SOWG will benefit other TOAR-II working groups that rely on satellite observations and will be essential for the updated assessment of tropospheric ozone effects on climate change.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-4A

Trends of surface ozone and its precursors over 20 years in Southern Germany

Dagmar Kubistin, Anja Claude, Thomas Elste, Robert Holla, Felix Klein, Jennifer B.A. Müller-Williams, Christian Plass-Dülmer
Deutscher Wetterdienst, Hohenpeissenberg Meteorological Observatory, Hohenpeissenberg, Germany

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Anthropogenic emissions, climate change and mitigation strategies alter the composition of trace gases with impact on air quality and climate. Since 1995, the Hohenpeissenberg meteorological observatory operated by the German Meteorological Service (DWD) performs observations of atmospheric key species in Southern Germany within the Global Atmosphere Watch (GAW) program. The atmospheric composition, characteristic for central Europe, has been continuously monitored including reactive gases such as in-situ ozone, nitrogen oxides, carbon monoxide, anthropogenic and biogenic VOCs and total OH reactivity. The ground level ozone concentration at Hohenpeissenberg showed an increasing trend in the 80's and 90's and has stagnated since then. Whilst anthropogenic O3 precursors have been regulated by emission ceilings, biogenic precursor emissions are impacted from climate change, e.g. increasing temperature. We present the trends of ozone and its precursors during the past 20 years alongside with meteorological parameters.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-5B

Links between oceanic ozone uptake and biogenic organic matter found in the sea surface microlayer

Miss Katherine A Weddell, Professor Lucy J Carpenter, Dr Rosie Chance, Dr Liselotte Tinel, Dr Claire Hughes, Dr Matt Pickering
University of York, York, United Kingdom

Abstract

Dry deposition is a major sink of tropospheric ozone and a large proportion of this deposition is to the ocean surface. Marine organic matter at the sea surface, which is primarily produced by marine biota such as phytoplankton, is thought to play a key role in ozone deposition, although there are large uncertainties associated with this process. The aim of this study is to investigate how the composition of organic matter in the sea surface microlayer (SML) and bulk seawater impacts ozone uptake. An important component of this organic matter are the fatty acid compounds such as lipids, free fatty acids, and dicarboxylic acids. These compounds are surface active and can therefore potentially react with tropospheric ozone at the ocean surface. There are, however, few measurements of dissolved fatty acids in seawater. A solid phase extraction (SPE) method with a modified styrene divinyl benzene sorbent was used to extract fatty acid compounds from bulk seawater, SML and artificial seawater spiked with fatty acids. The fatty acid compounds extracted were converted into their fatty acid methyl esters (FAMEs) and analysed via GC-MS. Using this SPE method, it was possible to extract free fatty acids, both saturated and unsaturated, and dicarboxylic acids out of bulk seawater and SML samples from the English Channel near Plymouth, and spiked artificial seawater samples. This same method was then applied to phytoplankton culture extracts, although the blanks were comparable to the samples, suggesting higher volume extracts are required. Future work will involve continuing to extract seawater samples to create an 18-month time series of fatty acid compounds present at the sea surface.

Early Career Scientist

YES, I am an early career scientist.

TOAR-6C

Productions of gaseous isoprene, acetone, and acetaldehyde from reactions between ozone and seawater.

Mr Daniel P Phillips[1,2], Ms Yinghao Chen[1], Dr Frances E Hopkins[1], Prof Peter S Liss[2], Prof Philip D Nightingale[1,2], Prof Claire E Reeves[2], Dr Mingxi Yang[1]
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Abstract

Dry deposition to the ocean surface is a significant sink for tropospheric ozone that appears to be sensitive to seawater organic content. We present laboratory measurements for the productions of volatile organic compounds (VOC; here specifically isoprene, acetone and acetaldehyde) from reactions between seawater and artificially generated ozone, in an rapid exchange bubble equilibrator. Among the gas phase VOCs quantified by the high-sensitivity PTR-MS, isoprene was generally produced with the highest rate, followed by acetone and then acetaldehyde.

Three types of seawater were investigated: a) natural seawater from the L4 marine station in the south-west UK, b) aged seawater spiked with algal culture, and c) aged seawater spiked with fatty acids (FA). A seasonal comparison was made between natural seawater sampled in Feb-May (spanning across the spring algal bloom) and Sep-Nov (post bloom). In the pre-bloom period, mean (± 1 SD) ozone-driven production rates were 0.0011±0.0003, 0.00028±0.00006 and 0.00025±0.00008 for isoprene, acetone and acetaldehyde respectively. Here production units are dimensionless as they represent a ratio for VOC out per ozone in. Isoprene production doubled (0.0022±0.0014) and acetone tripled (0.00089±0.00052) during the bloom, compared to the weeks before, while acetaldehyde remained unchanged (0.00026±0.00005). In comparison, productions were higher for VOCs in the autumn period at 0.0099±0.0038, 0.00084±0.00029 and 0.00043±0.00015 respectively.

The experiments with spiked seawaters contained dissolved organic carbon concentrations that were of the same order of magnitude as the natural coastal seawater at L4. The *E. huxleyi* culture resulted in comparable amounts of acetone compared to the seawater samples, but less acetaldehyde and significantly less isoprene. This confirmed that some VOC precursor organics were of biological origin. Oleic acid (unsaturated) was shown to only result in isoprene production. In contrast, nonanoic acid (saturated) resulted in productions of acetaldehyde and acetone only.

Early Career Scientist

YES, I am an early career scientist.

TOAR-7A

Harmonised assessment of tropospheric ozone data records from multiple satellites with the ozonesonde global network

Arno Keppens[1], Daan Hubert[1], Jean-Christopher Lambert[1], Klaus-Peter Heue[2], Diego Loyola[2], Gordon Labow[3], Catherine Wespes[4], Pierre-Francois Coheur[4], René Stübi[5], Anne M. Thompson[3], Roeland Van Malderen[6], Deniz Poyraz[6]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Under the umbrella of the international Commission on Atmospheric Chemistry and Global Pollution (iCACGP), the International Global Atmospheric Chemistry project (IGAC) endorsed the first phase of the Tropospheric Ozone Assessment Report (TOAR) in 2014. Its mission was to provide the research community and policy makers with a scientific assessment of the distribution and trends in ozone from the surface up to the tropopause. The first TOAR assessment was not entirely conclusive and highlighted a list of scientific challenges to be addressed during a second phase. Among them is the difficulty to interpret tropospheric observations from space, especially when trying to interconnect data records from multiple satellites with significant differences in sensitivity, resolution and spatial domain. Additional confounding factors are time-varying biases and the lack of harmonisation between the different satellite datasets, e.g., regarding geophysical quantities, units and the definition of the tropopause. Similar concerns are raised for ground-based datasets, which introduce further disagreement in trends. Last but not least, the trend analysis method itself adds uncertainties to those associated with the measurements. The overall result is an ensemble of (local) trend estimates with a large spread, which impedes firm assessments relevant for policy, society and science.

In preparation for the second phase of TOAR, the Committee on Earth Observation Satellites (CEOS) has initiated a coordinated activity on tropospheric ozone assessments from space. In this framework, the study reported here aims at a better interconnection of tropospheric ozone time series recorded by past and present satellites and by the ozonesonde networks contributing to WMO's Global Atmosphere Watch (GAW). This study starts with a review of definitions, calculation methods and uncertainties of tropospheric column data, while also giving proper attention to differences in vertical sensitivity. First assessments are illustrated with various tropospheric ozone data records from GOME-2, IASI, OMI and TROPOMI.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-8B

Large contribution of biomass burning emissions to ozone throughout the global remote troposphere

Ilann Bourgeois[1,2], Jeff Peischl[1,2], J Andrew Neuman[1,2], Steven S Brown[2,3], Chelsea R Thomspon[1,4], Kenneth C Aikin[1,2], Hélène Angot[5], Eric C Apel[6], Colleen B Baublitz[7], Jared Brewer[8], Pedro Campuzano-Jost[1,3], Róisín Commane[7], John D Crounse[9], Bruce C Daube[8], Joshua P DiGangi[10], Glenn S Diskin[10], Louisa K Emmons[6], Arlene M Fiore[7], Georgios I Gkatzelis[11], Alan Hills[6], Rebecca S Hornbrook[6], L Gregory Huey[12], Michelle Kim[9], Forrest Lacey[6], Kathryn McKain[1,13], Lee T Murray[14], Benjamin A Nault[15], David D Parrish[1,2], Eric Ray[1,2], Colm Sweeney[13], David Tanner[12], Steven C Wofsy[8], Thomas B Ryerson[16]
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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Tropospheric ozone (O_3) is a secondary air pollutant that adversely affects human and ecosystem health and is an important greenhouse gas. Biomass burning (BB) is a significant source of O_3 precursors to the atmosphere, but its impact on tropospheric O_3 is poorly constrained. Here we report global-scale, in situ airborne measurements of O_3 and tracers of both BB and urban (UR) pollution in the remote troposphere from the NASA Atmospheric Tomography (ATom) mission. Measurements were taken during four seasonally-resolved circuits over the Pacific and Atlantic Ocean basins, each with near pole-to-pole latitudinal coverage. We find that tropospheric O_3 is consistently enhanced above background in polluted air masses in all regions of the globe. Moreover, these regional O_3 enhancements are on average larger in mixed BB + UR polluted air (2.1–23.8 ppbv) and BB-influenced air (2.2–20.9 ppbv), than compared to UR-influenced air (-7.7–6.1 ppbv). Using ATom observations, we attribute from a factor of two less (in the northern hemisphere) to ten times (in the southern hemisphere and in the tropics) more O_3 above background to BB than to UR emissions. Comparing our observations with simulations from three global chemistry transport models, we find that all three models underpredict the influence of BB emissions on tropospheric O_3. Our findings reveal the significant and ubiquitous influence of BB emissions on tropospheric O_3 and demonstrate that accurately accounting for this source is necessary to understand the O_3 burden in the remote troposphere.

Early Career Scientist

YES, I am an early career scientist.

TOAR-9C

(Global) direct and in-direct effects of heat-stressed vegetation on ozone extremes

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Institute of Energy and Climate Research, IEK-8: Troposphere, Forschungszentrum Jülich, Jülich, Germany

Abstract

Terrestrial vegetation represents a critical component of Earth system models coupling the atmosphere with the land. This coupling process is increasingly influenced by plant heat stress which becomes more frequent and intense due to climate warming. In fact, heat stress induces an immediate reduction of stomatal opening to prevent plant' dehydration and thus impact evapotranspiration and dry deposition. Evapotranspiration is a key process which drives the moisture cycling of the atmosphere determining among others air temperature, boundary layer height and cloud cover. Also, dry deposition to plants represents a relevant sink for atmospheric trace gases, such as tropospheric ozone and its precursors. Globally, dry deposition is estimated to account for 20 % of the total tropospheric ozone loss. Tropospheric ozone is an important air pollutant with relevant levels of 50-80 ppb in ambient conditions causing significant harm for human health. Furthermore, due to its reactivity it is involved in many chemical processes affecting the evolution of other pollutants.

In this model study, we investigate direct and in-direct effects of heat-stressed vegetation on the chemistry and fate of ozone. Namely, we analyse the global impact of dry deposition on ozone and its precursors. Also, we assess the impact of evapotranspiration reduction on heat intensity and subsequent effects on dry deposition fluxes and photochemical production of ozone. For this, we conduct high-resolution simulations with the global atmospheric chemistry model ECHAM/MESSy applying a heat stress factor to each of the two processes. The here used Mainz Organic Mechanism (MOM), which includes the oxidation of more than 800 gaseous species with about 2000 reactions, stands out for its advanced and detailed atmospheric chemistry in global models. By the means of passive tracer terms the impacts of the individual changes on tropospheric ozone and related chemistry are identified. Implications for future air pollution will be discussed.

Early Career Scientist

YES, I am an early career scientist.

TOAR-10A

Oxidation of low-molecular weight organic compounds in cloud droplets: global impact on tropospheric oxidants and other trace gases

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

In-cloud aqueous-phase chemistry is known to decrease tropospheric ozone (O_3) via O_3+O_2^- with hydroperoxyl radicals (HO_2) being the major source of O_2^-. The significance of this O_3 sink is therefore sensitive to the aqueous-phase chemistry of HO_x (HO_x=HO_2+OH). The lack of explicit aqueous-phase chemical kinetics in cloud droplets in most global atmospheric models leads to a general underestimation of this sink. In this study, a detailed aqueous-phase oxidation mechanism for water soluble oxygenated volatile organic compounds (OVOC's) is developed. The mechanism focuses on OVOCs containing up to four-carbon atoms and uses OH and NO_3 as the main oxidants during day and night time, respectively. A detailed box-model analysis with CAABA/MECCA is performed to understand the full implications of this new mechanism. Additionally, the newly developed mechanism is implemented into the global atmospheric model ECHAM/MESSy (EMAC), which is capable of representing the described processes explicitly and integrates the corresponding ODE system using a Rosenbrock solver. By using EMAC, the global impact of the proposed mechanism is estimated focusing mainly on tropospheric VOC, O_3 and HO_x concentrations. This is achieved by performing a detailed O_x and HO_x budget analysis in the gas- and aqueous-phase. The resulting changes are evaluated using satellite measurements. In general, the in-cloud OVOC oxidation shifts the HO_2 production from the gas-phase to the aqueous-phase. As a result, the O_3 budget is perturbed with scavenging being enhanced and the gas-phase chemical losses being reduced. These changes in the free troposphere significantly reduce the modelled tropospheric ozone column, which is known to be generally overestimated by EMAC and global atmospheric models.

Early Career Scientist

YES, I am an early career scientist.

TOAR-11B

Recent Chinese ozone trends as seen from space and models: exploring the impact from local precursor emissions reductions

Gaëlle Dufour[1], Didier Hauglustaine[2], Yunjiang Zhang[2], Yann Cohen[2], Maxim Eremenko[3], Audrey Gaudel[4], Mathieu Lachatre[5,6], Guillaume Siour[3], Axel Bense[3], Bertrand Bessagnet[7,8], Juan Cuesta[3], Valérie Thouret[9], Jerry Ziemke[10]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

China is facing an important environmental issue with a strong degradation of air quality in the last decades. All the major pollutant concentrations exceed the thresholds recommended by the World Health Organization. In response to this, Chinese authorities have started to apply emission mitigation plans with significant reduction of SO_2 and NOx emissions during the last decade. The question of the impact of such reductions on secondary pollutants, such as ozone, is then arising. In this study, free tropospheric ozone (O_3) trends in the Central East China (CEC) and export regions are investigated for 2008-2017 using the IASI O_3 observations and the LMDZ-INCA model simulation, including the most recent Chinese emission inventory. The observed and modeled trends in the CEC region are in good agreement for example -0.07 ± 0.02 DU/yr ($p<0.01$) and -0.08 ± 0.02 DU/yr ($p<0.01$) respectively for the lower free troposphere (3-6km column). A good agreement between the satellite observations and the model is also observed in the region including Korea and Japan and corresponding to the region of pollution export from China. Conducting sensitivity studies with the model, we evaluate at 60% and 52% the contribution of the Chinese anthropogenic emissions to the trend in the lower and upper free troposphere, respectively. The second main contribution to the trend is the meteorological variability (34% and 50% respectively). The results will also be discussed in the light of the recent work done within the framework of the TOAR (Tropospheric Ozone Assessment Report) initiative and confrontation with in situ measurements (IAGOS) and other satellite products (e.g. OMI-MLS).

Early Career Scientist

NO, I am not an early career scientist.

TOAR-12C

New tropospheric ozone dataset from OMPS/NPP and the detection of enhanced tropospheric ozone above South American megacities

Andrea P Orfanoz-Cheuquelaf, Dr. Carlo Arosio, Dr. Alexei Rozanov, Dr. Mark Weber, PD Dr. Annette Ladstätter-Weißenmayer, Prof. Dr. John P Burrows
Institute of Environmental Physics, Universität Bremen, Bremen, Germany

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

Americas Working Group

Abstract

Around 10% of the total amount of ozone resides in the troposphere, where it acts as a potent greenhouse gas. Overexposure to this pollutant causes health problems and damage to vegetation. Anthropogenic emissions and biomass burning are the main sources of ozone in the troposphere.

Besides in-situ measurements and space-borne tropospheric profile retrievals in IR spectral range, a combination of the limb and nadir measurements in UV-visible spectral range (so-called limb-nadir matching) provides valuable information on the tropospheric ozone column. This study uses the data from the Ozone Mapping and Profiler Suite, on board of Suomi National Polar-Orbiting Partnership (OMPS/NPP) since 2012, which observes the atmosphere in both limb and nadir geometry. Tropospheric ozone columns are retrieved globally by subtracting the stratospheric ozone column calculated from limb observations (OMPS-LP) from the total ozone column, derived from the nadir measurements (OMPS-NM). The obtained dataset of tropospheric ozone columns has a spatial resolution of approximately 150 km in longitude times 50 km in latitude.

The dataset is validated using ozonesondes and compared with tropospheric ozone from TROPOMI/S5P. Using this dataset, we identified enhanced tropospheric ozone above megacities in South America.

Early Career Scientist

YES, I am an early career scientist.

TOAR-13A

Local and global impacts of C_1-C_3 alkyl nitrate chemistry and emissions on tropospheric ozone

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IGAC Activities

CCMi: Chemistry Climate Model Initiative, TOAR: Tropospheric Ozone Assessment Report

Abstract

Alkyl nitrates ($RONO_2$) are important reservoirs of tropospheric reactive nitrogen. They are produced from the oxidation of their parent alkanes in the presence of NO_x and emitted from oceanic and biomass burning sources. Due to their relatively long lifetime of a few days to a few months they can be destroyed far away from their sources by photolysis or OH oxidation and alter tropospheric ozone concentrations on regional levels.

While C_1-C_3 $RONO_2$ chemistry is well understood, information about their oceanic and biomass burning sources is limited. We derived a new estimate of C_1-C_3 $RONO_2$ biomass burning emissions from the Global Fire Emissions Database and implemented these emissions into a global 3D chemistry-climate model UM-UKCA, along with C_1-C_3 $RONO_2$ chemistry from the Master Chemical Mechanism, dry deposition and oceanic emissions.

We performed six perpetual year UM-UKCA simulations designed to explore the statistical significance of the global and localised impacts of C_1-C_3 $RONO_2$ on tropospheric chemistry. We also compared the regional mean vertical profiles of C_1-C_3 RH and $RONO_2$, NO_x and O_3 observed during the Atmospheric Tomography mission and simulated by UM-UKCA in 8 remote regions in February and August.

We found that C_1-C_3 $RONO_2$ oceanic emissions have the largest global impact on tropospheric ozone chemistry among all alkyl nitrate sources considered in this study, while their biomass burning emissions have the smallest impact. The combination of C_1-C_3 $RONO_2$ chemistry and emissions increases tropospheric ozone burden by 2.96±0.69 Tg (1.09±0.25%) and decreases methane lifetime by 0.151±0.036 yr (1.56±0.37%). Statistically significant increases in seasonal mean ozone concentrations of up to 2 ppbv (≤5%) are located within 0-5 km over the Southern Ocean during boreal winter and autumn and within 0-10 km near the equator during boreal winter, summer and autumn.

Early Career Scientist

YES, I am an early career scientist.

TOAR-14B

Long-term trends in troposperic ozone at the Cape Verde Atmospheric Observatory

Dr Matthew J Rowlinson[1,2], Professor Mathew J Evans[1], Professor Lucy J Carpenter[1,2], Dr Katie A Read[2], Dr Shalini Punjabi[1], Professor James D Lee[1]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Long-term observations of climate composition are essential to detect and understand changes occurring in the Earth's atmosphere. Since 2006 the Cape Verde Atmospheric Observatory (CVAO, 16° 52' N, 24° 52' W), a World Meteorological Organisation-Global Atmosphere Watch (WMO-GAW) global station in the tropical Atlantic Ocean, has measured a wide range of trace gases and aerosols. The CVAO time series represents one of the few long-term records of composition of the sub-tropical marine boundary-layer. Analysis of trends between 2006 and 2020 shows that ozone concentrations have increased by 2.2 ppb at a rate of 0.2 ppb yr^{-1}. Concentrations increased at an elevated rate of 0.8 ppb yr^{-1} between 2016 and 2019, before falling in 2020. Here we analyse this trend both in terms of the annual mean concentration and the seasonality. We also employ the GEOS-Chem chemistry transport model to conduct an emissions sensitivity analysis, identifying key sources of sub-tropical background ozone. In addition, GEOS-Chem is used alongside other observations made at the site (CO, CH_4, NO_x, VOCs etc), and back-trajectories from the FLEXPART Lagrangian particle dispersion model to understand the processes which have led to the recent increase in tropospheric ozone.

Early Career Scientist

YES, I am an early career scientist.

TOAR-15C

Vegetation feedbacks during drought exacerbate ozone air pollution extremes in Europe

Meiyun Lin[1,2], Larry W. Horowitz[2], Yuanyu Xie[1], Fabien Paulot[2], Sergey Malyshev[2], Elena Shevliakova[2], Angelo Finco[3], Giacomo Gerosa[3], Dagmar Kubistin[4], Kim Pilegaard[5]
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IGAC Activities

CCMi: Chemistry Climate Model Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

Americas Working Group

Abstract

Using six decades of observations and Earth system model simulations (1960-2018), we highlight a previously under-appreciated 'climate penalty' feedback mechanism - namely, substantial reductions of ozone removal by drought-stressed vegetation – as a missing piece to the puzzle of why ozone air pollution in Europe has not decreased satisfactorily in recent decades, despite marked reductions in regional emissions of ozone precursors due to regulatory changes. Under drought stress, plants close their stomata to conserve water, consequently limiting the ozone uptake by vegetation and increasing surface ozone concentrations. Such land-biosphere feedbacks are often overlooked in prior air quality projections, owing to a lack of long-term ozone flux measurements and process-based model formulations. In contrast to the widely-used Wesely scheme or other empirical approaches, our new dry deposition scheme includes a mechanistic simulation of ozone deposition to vegetation depending on photosynthesis, soil water stress, atmospheric CO_2 concentration and vapor pressure deficit. Severe drought stress can cause ~70% reductions in ozone removal by forests. During European's recent mega-heatwaves, accounting for reduced ozone removal by drought-stressed vegetation leads to a three-fold increase in simulated high MDA8 ozone events above 80 ppbv, in good agreement with observations. These vegetation feedbacks increased the sensitivity of ozone extremes to increasing temperature by 20-30% during 1990-2018. As the frequency of hot and dry summers is expected to increase in the coming decades, effective emissions policies for Europe must consider the ozone climate penalty. I will also discuss the implications for other northern mid-latitude regions. Specifically, I will present results from a variable-resolution global chemistry-climate model with regional grid refinements (12x12 km^2) over North America. Resolving cities, mountains, valleys, and the heterogeneity of land-atmosphere coupling processes, the variable-resolution model provides a rare opportunity to assess the impacts of vegetation feedbacks on air quality in a changing climate.

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Early Career Scientist

NO, I am not an early career scientist.

TOAR-16A

Contributions of World Regions to the Global Tropospheric Ozone Burden Change From 1980 to 2010

Dr. Yuqiang Zhang[1], Prof. J. Jason West[2], Dr. Louisa K Emmons[3], Dr. Johannes Flemming[4], Dr. Jan Eiof Jonson[5], Dr. Marianne T Lund[6], Dr. Takashi Sekiya[7], Dr. Kengo Sudo[8], Dr. Audrey Gaudel[9], Dr. Kai-Lan Liang[9], Dr. Philippe Nédélec[10], Dr. Valérie Thouret[10]
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IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group

Abstract

In recent decades, emissions of ozone precursors have shifted toward the equator, as emissions in some high-income regions have decreased, while emissions have increased markedly from especially East and South Asia. This change in the spatial distribution of emissions is troubling because of the greater sensitivity of tropospheric ozone to emissions from tropical and subtropical regions. In this study, we investigate the contributions of emission changes from 10 world regions, as well as the global methane concentration change, on the global tropospheric ozone burden change from 1980 to 2010. The modeled global tropospheric ozone burden has increased by 28.1 Tg, with 26.7% (7.5 Tg) of this change attributed to the global methane increase. Emission increases in Southeast Asia, South Asia, and East Asia contribute over half of the global tropospheric ozone burden increase from 1980 to 2010. Southeast Asia (5.6 Tg) and South Asia (4.0) contribute comparably to the global ozone burden change as East Asia (5.6), even though NOx emission increases in each region are less than one-third of those in East Asia, highlighting the greater sensitivity of global ozone to emissions from these regions. Emission decreases from North America, Europe, and Former Soviet Union have led to ozone burden decreases of 2.8, 1.0, and 0.3 Tg. The greater sensitivity of the global ozone burden to emission changes in tropical and subtropical regions emphasizes the importance of controlling emissions in these regions for global ozone.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-17B

Global Surface Ozone Concentration Mapping Through Data Fusion at Fine Resolution for 1990 to 2017 to Support Health Impact Assessment

Professor Jason West[1], Marissa DeLang[1], Jacob Becker[1], Dr. Kai-Lan Chang[2], Professor Marc Serre[1], Dr. Owen R. Cooper[2,3], Dr. Martin Schultz[4], Sabine Schroder[4], Dr. Xiao Lu[5], Prof. Lin Zhang[6], Dr. Makoto Deushi[7], Dr. Beatrice Josse[8], Dr. Christoph Keller[9], Jean-Francois Lamarque[10], Meiyun Lin[11], Dr. Junhua Liu[9], Dr. Virginie Marecal[8], Dr. Sarah Strode[9], Dr. Kengo Sudo[12], Dr. Simone Tilmes[10], Dr. Li Zhang[13], Ms. Stephanie Cleland[1], Ms. Elyssa Collins[1], Prof. Michael Brauer[14]
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IGAC Activities

CCMi: Chemistry Climate Model Initiative, TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

Abstract

Estimates of ground-level ozone concentration are necessary to determine the human health burden of ozone. To support the 2019 Global Burden of Disease (GBD) study, we produce fine resolution global surface ozone estimates for each year 1990–2017 through a statistical fusion of ground observations and nine global chemistry-climate models. We use ozone observations from the Tropospheric Ozone Assessment Report and the Chinese National Environmental Monitoring Center Network (8834 stations total). Ozone is estimated for a 6-month ozone season average of 8-hr. daily maximum metric, to support GBD. We first find the linear combination of nine global atmospheric chemistry models that best reproduces observations in each world region and year, creating a multi-model composite. We use the Bayesian Maximum Entropy (BME) framework to integrate surface observations with the multi-model composite in both space and time. The BME estimation output matches observations at each monitoring site, with the influence of an observation decreasing across space and time. Far from observations, the output matches the multi-model composite. The influence of observations through time is seen in the years prior to the China data coming online, mainly starting in 2013. After estimating ozone globally at 0.5° resolution using BME, we add fine spatial detail based on a fine resolution global atmospheric model. Further work explores the use of the Regionalized Air Quality Model Performance (RAMP) method to perform a regional and non-linear bias correction before BME data fusion, based on model performance with respect to the nearest observation stations. Our final product estimates at 0.1° resolution, improving substantially upon the simple multi-model mean (R^2=0.81 vs. 0.28). Results suggest that global ozone exposure is increasing, driven by ozone increases in highly populated regions of Asia and Africa, and despite decreases in the United States and Russia.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-18C

The TOAR-II Ozone and its Precursors in the Tropics Focus Working Group's activities

Dr. Audrey Gaudel[1], Dr. Bastien Sauvage[2], Dr. Beatriz Aristizábal[3], Dr Yann Cohen[4], Dr. Suvarna Fadnavis[5], Dr. Daan Hubert[6], Dr. Béatrice Josse[7], Dr. Pavlos Kalabokas[8], Dr. Mohd Talbi Latif[9], Dr. Virginie Marécal[7], Dr. Kazuyuki Miyazaki[10], Dr. Pallavi Saxena[11], Dr. Bhupendra Bahadur Singh[5], Dr. Ryan M. Stauffer[12], Dr. Saurabh Sonwani[13], Dr. Maria Tsivlidou[14], Dr. Corinne Vigouroux[6], Dr. Catherine Wespes[15], Dr. Jason West[16], Dr. Yuqiang Zhang[16], Dr. Jerald Ziemke[17]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Tropospheric ozone is a short-lived climate forcer, is detrimental to human health, crop and ecosystem productivity, and controls the oxidizing capacity of the troposphere. The Tropospheric Ozone Assessment Report, an official IGAC activity designed in 2014, began Phase II in 2020. In this context, we launched the Ozone and its Precursors in the Tropics (OPT) Focus Working Group (FWG) in early March, 2021. This effort is motivated by recent results showing that over the past three decades, the emissions of ozone precursors have shifted from the mid-latitudes toward the equator, where the production of ozone is more efficient and deep convection contributes to the redistribution of the ozone-rich air masses toward mid-latitudes. In the equatorial band, human-induced emissions are increasing, especially in Southeast Asia. Significant changes are also expected in Africa and South America.

We will present the main goals and plans of the TOAR-II OPT FWG to support the next TOAR report:

1. **Gather scientists around the world to better understand ozone and precursors variability in the tropical band, using up-to-date observations and atmospheric model outputs.**
2. **Deliver three key papers on the ozone and precursors distribution, trend in the tropics and their impact on the global ozone burden and radiative effect.**

Early Career Scientist

NO, I am not an early career scientist.

TOAR-19A

The observation and modelling study of ozone enhancement in NO_x-saturated megacity during the 2018 summer heat wave

Junsu Gil[1], Sunggu Kang[1], Meeye Lee[1], Hojoon Rhee[1,2], Moonsoo Park[3], Eunmi Jeon[2], Mihee Shim[2]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Surface O_3 continuously increased in North-east Asia with the climate change. The O_3 interacts with temperature as one of the Short-Lived Climate Pollutants (SLCPs), but the detailed relation still unknown due to its complex mechanism. In this research, the relation of temperature and O_3 in extreme high temperature periods was studied using the concept of O_3-climate penalty, that the change of O_3 by temperature be analyzed in terms of physical processes, chemical mechanism, and precursor emission.

From Jul to August 2018, comprehensive ground measurement of gaseous pollutants (NO_x, VOCs, HONO, PAN, and O_3) and of meteorological variables was conducted in Seoul, South Korea. During the measurement, rapid enhancement of O_3 be observed with the occurrence of heatwave. The daily maximum temperature over 39 ℃ be recorded, also the O_3 increased up to 169 ppbv.

Based on observation data, photochemical F0AM model was used to calculate the effect of temperature to O_3 increase. As a result, linearities between O_3 and temperature show the difference between heatwave and non-heatwave periods, caused by the influence of mixing layer height expansion and variated VOCs. This implies that the relation between O_3 and temperature be changed when temperature increased, and it is well-presented by the quadratic regression.

Early Career Scientist

YES, I am an early career scientist.

TOAR-20B

Lower than expected summertime clean-background ozone concentrations derived from ozone precursor relationships in the Southeast United States

Ms Qiyang Yan[1], Dr Yuhang Wang[1], Dr Cheng Ye[1], Dr Jianfeng Li[1,2]
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IGAC Activities

Abstract

Background ozone in this study is defined as the amount of ozone not affected by the emissions of ozone precursors in the region of study and is transported from the distant troposphere or the stratosphere. It is one of the factors that must be considered in regional ozone control strategies. Different methods have been applied to define the background ozone level. We develop a new method based on the O_3-CO-HCHO relationships, which can be applied to both observation and modeling data for regions with high isoprene emission ozone, such as the Southeast United States. We make use of the extensive aircraft and surface observations in the Southeast in the summer of 2013. Compared to the diagnostic results using the relationship of O_3-NO_z (total reactive nitrogen excluding nitrogen oxides), zero-emission (model-only), and 5th percentile methods, the new method is most consistent using observation or model data and the resulting background ozone concentrations are 10-100% lower than the other methods for field campaigns. Using this method, we find that the summertime background ozone at the surface is in the range of 10-15 ppbv in the inland areas of the Southeast, lower than previous studies. The better quantitative estimates of background ozone using the new method provide further incentives to control anthropogenic emissions in ozone nonattainment areas of the Southeast.

Early Career Scientist

YES, I am an early career scientist.

TOAR-21C

Night-time Ozone Chemistry and Influence of Meteorological Parameters at a ground level site in Delhi, India

Dr. Pallavi Saxena[1], Ms. Shweta Tejan[2], Ms. Shivangi Verma[2], Dr. Saurabh Sonwani[3]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, GEIA: Global Emissions Initiative, TOAR: Tropospheric Ozone Assessment Report

Abstract

The present study focus on estimation of magnitude, frequency and time of night-time ozone maxima at a ground level site of urban city, Delhi, India. Data was analyzed of 6 months duration from April to October, 2019. The maximum ozone was found in the range of 45-65 ppbv. The average maxima occurrences are mostly found in early morning hours, however, maxima sometimes also occurred in night hours too. The frequency of occurrence is found to be maximum in the range of 8-14 ppbv. The night-time ozone concentrations are also analyzed with meteorological parameters like ambient temperature, relative humidity, wind speed etc. The nocturnal chemistry of nitrogen oxides (NO_x) and ozone (O_3) are also investigated with special consideration to NO_2-NO_3-N_2O_5 cycle. An interesting relationships were noted between chemistry and transport as the night progresses.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-22A

TOAR-II Chemical Reanalysis Focus Working Group

Kazuyuki Miyazaki[1], Helen Worden[2], Dylan Jones[3]
[1]JPL, Pasadena, USA. [2]NCAR, Boulder, USA. [3]University of Toronto, Toronto, Canada

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Chemical reanalysis is a systematic approach to create a long-term data record of atmospheric composition, consistent with model processes and observations, using data assimilation. Similar to meteorological reanalyses that have extensively been used to study weather and climate variability, chemical reanalysis has the great potential to provide comprehensive information on atmospheric composition variability. Chemical reanalyses have made considerable progress in recent years and offer a unique global coverage of decadal ozone trends during the satellite data records including the COVID-19 era.

The following goals of the chemical reanalysis focus WG, working together with other TOAR-II WGs, would support TOAR-II objectives to investigate the impacts of tropospheric ozone on climate, human health and vegetation, on regional to global scales:

- Evaluation of chemical reanalyses with TOAR-II observations and other data will assess the potential of using reanalysis data for studying spatial gradients at both regional and global scales and trends in areas with sparse in-situ observations. The long-term record provided by the chemical reanalyses will also assist in determining the contribution of precursor emissions and changing meteorology to observed ozone trends and surface ozone exceedances.
- Sensitivity analyses of the impacts of satellite and in-situ observations of ozone both at the surface and in the free troposphere and precursors will assess the relative importance of individual observations to improve surface ozone analyses and help to design observing systems that better capture the distribution and regional trends in tropospheric ozone.
- Inter-comparisons of top-down precursor emissions from reanalyses, and their impacts on surface/tropospheric ozone and subsequent radiative effects, within the reanalysis framework that includes various observational constraints, will facilitate evaluation of emission scenarios and environmental policy.
- Well-validated chemical reanalysis ozone fields will provide an opportunity to improve the TOAR-II observation quality control processes and representativeness by providing first guess information.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-23B

Trends of Surface and Tropospheric Ozone over Southeast Asia and their drivers during 2005 to 2014

Ph.D. Xiaolin Wang[1], Professor Tzung-May Fu[2], Professor Lin Zhang[1], Professor Xiao Lu[3], Professor Xiong Liu[4], Professor Teerachai Amnuaylojaroen[5], Professor Mohd Talib Latif[6], Ph.D. Yaping Ma[7], Ph.D. Lijuan Zhang[1], Ph.D. Xu Feng[1], Professor Xin Yang[2], Professor Lei Zhu[2]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

China Working Group

Abstract

Several analyses have indicated increases in tropospheric ozone over different parts of Southeast Asia (SEA) during recent decades, which have important implications for human and ecosystem health, food security, and regional climate. We combined ozone measurements from surface sites, aircrafts, soundings, satellites, and simulations using the GEOS-Chem chemical transport model, to assess the trends of seasonal surface and tropospheric ozone over SEA during 2005 to 2014. We found that surface ozone had significantly increased over the Peninsular Southeast Asia (PSEA) in all seasons at rates of 0.4 to 1.2 ppb yr-1. Over the Malaysian Peninsula, surface ozone had increased during JJA to DJF at rates of 0.4 ppb yr-1. Surface ozone measured at the one available surface site in Indonesia showed no significant changes during March to August but showed slight decreases during September to November. Observations from the Ozone Monitoring Instrument showed that the tropospheric ozone column concentrations over PSEA had increased significantly in MAM and SON, while the changes in JJA and DJF were small. Tropospheric ozone over Maritime continent (MC) increased in DJF while showed small changes in other seasons. Sensitivity simulations using the GEOS-Chem model showed that the increases in surface ozone over PSEA were largely driven by the growing anthropogenic emissions from both within the PSEA (45.7±9.4%) and outside the SEA region (25.8±4.1%). Increases of surface ozone over Indonesia were mainly driven by growing local anthropogenic emissions (79.4±10.1%). The increases of tropospheric ozone changes over the PSEA were due to a combination of factors, including the interannual variability of meteorology (5.9±52.2%), and changes in anthropogenic emissions both outside (25.3±19.8%) and within the SEA (25.1±8.3%). In contrast, the interannual variation of meteorology (41.9±11.6%) and increases in local anthropogenic emissions (42.3±11.0%) drove the increases of tropospheric ozone in MC.

Early Career Scientist

YES, I am an early career scientist.

TOAR-24C

Current organizational and research plans of the TOAR-II Statistics Focus Working Group

Dr Kai-Lan Chang[1], Dr Martin G Schultz[2]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

This presentation aims to give an overview of current organizational and research plans of the Statistics Focus Working Group during the second phase of the Tropospheric Ozone Assessment Report (TOAR) activity. We first review various statistical principles behind different trend detection techniques, and describe their strengths and weaknesses. The second focus is placed on the combination of trend detection techniques and other statistical applications, such as trend detection for multiple correlated time series from extensive monitoring networks or high resolution vertical profile data. Finally the implications of the above statistical principles on the validation and evaluation of chemistry-climate model output will be discussed. Throughout the presentation the importance of appropriate statistical thinking and best practices will be emphasized.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-25A

Improved high-quality data of volatile organic compounds thanks to metrological developements

Céline Pascale[1], Thérèse Salameh[2], Stephane Sauvage[2], Maitane Iturrate[1]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Volatile organic compounds (VOCs) play an important role in the atmospheric chemistry, especially in the oxidative capacity of the lower atmosphere. Besides their role as ozone and aerosol precursors, VOCs contribute directly and indirectly to the radiative forcing and in turn to climate change. In order to identify climate trends, comparable datasets at regional and temporal scales are essential. For that purpose, long-term, traceable and high-quality data of VOCs are needed. However, the lack of stable and traceable standards to the international system of unit for some VOCs, together with effects linked to reactivity with surfaces (i.e. memory effects, decomposition artefacts) and to ozone and humidity interferences, are common issues for sites monitoring VOCs in the atmosphere.

The EMPIR project "Metrology for Climate Relevant Volatile Organic Compounds" (MetClimVOC, 2020-2023) – a joint effort between National Metrological Institutes and ACTRIS Topical Centre for Reactive Trace Gases In Situ (CiGas) among others – pursues to overcome these limitations for climate-relevant VOCs prioritized by stakeholders (WMO-GAW, AGAGE, ACTRIS, EMEP). The project will produce novel SI-traceable reference gas mixtures at atmospheric amount fractions with a well-defined uncertainty, which will fulfil the Data Quality Objectives of the monitoring networks (1 nmol/mol to 1 µmol/mol with expanded uncertainty < 5% for oxygenated VOCs and terpenes). Thanks to these reference gas mixtures, sampling and analytical methods used in monitoring stations will be optimized in order to have high-quality data with a full uncertainty estimation on real air measurements.

We present the first results of the project focusing on how this novel calibrations procedures and analytical methods improve the quality of the data and therefore the observations of VOCs trends. In particular, the novel reference gas mixtures are used to study effects on sampling and analysis, such as artefacts due to ozone or humidity.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-26B

Highlights from a multi annual observation of ozone deposition in a deciduous mature forest in Italy

prof. Giacomo A. Gerosa, dr Riccardo Marzuoli, Dr Angelo Finco
Catholic University of the S.H., Brescia, Italy

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Multiannual measurements of ozone fluxes were performed from 2012 to 2020 at a mature deciduous forest in the Po valley, Italy. Fluxes were measured on a 41 m tall tower, 15 m above the top canopy with the eddy covariance measuring technique. A flux partition among stomatal and non-stomatal fractions was performed based on concomitant water and carbon dioxide measurements.

Total ozone fluxes revealed an interannual variability that was mainly driven by the stomatal activity. As a consequence, factors which influence stomatal conductance were responsible for the flux variability, with soil water availability being the main physiological driver among all.
Despite this variability, the stomatal fraction of the total ozone deposited on the forest was fairly constant around 42% on a 24-hours basis and around 60% in the daylight hours.

The non-stomatal deposition was mainly driven by air humidity, by surface wetness and by chemical sinks such as reaction of ozone with the NO emitted by soil in summer or advected in the trunk space in winter. On the other hand, the non-stomatal deposition resulted unaffected by wind speed or turbulence intensity, as well as by surface temperature, and this would exclude impact or thermal decomposition on surfaces from being important drivers of the total fluxes. Deposition on leaf cuticles was the main ozone removal pathway in the evening and during the first night hours.

Besides their implication for the ozone risk assessment for vegetation, these results could be employed to test the deposition models schemes to correctly assess the ozone budget in troposphere.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-27C

The TOAR database: data harmonization and quality assurance on global air quality data

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Forschungszentrum Jülich, Jülich, Germany

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

In the TOAR phase II we are extending the global database of air quality and weather data time series established at the Jülich Supercomputing Centre. The database combines different ground-level atmospheric observations and model products with high-resolution geographic data in order to characterize individual measurement locations and regional air pollution patterns. To harmonize the quality of the observation data an automatic flagging system is installed which employs different statistical measures to determine points that are likely erroneous or questionable. The results of these automated tests are combined with original quality flags provided by the data providers and saved with each data point in the database. This approach contributes to the reliability and documentation of the TOAR data in line with FAIR data concepts. TOAR data users are provided with a flexible and powerful infrastructure for data access and online analysis.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-28A

Harmonization and Evaluation of Ground-based Instruments for Free-Tropospheric Ozone Measurements by TOAR-II Focus Working Group "HEGIFTOM"

Roeland Van Malderen[1], Herman G.J. Smit[2], Romain Blot[3], Corinne Vigouroux[4], Thierry Leblanc[5], Irina Petropavlovskikh[6], Michel Van Roozendael[4], François Hendrick[4], Alexander Cede[7], Owen Cooper[8]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

TOAR I (Gaudel et al., 2018, Tarasick et al., 2019) showed that besides clear regional differences, the distribution and trends of ozone in the troposphere and tropopause region are not always consistent between different datasets obtained from the different standard ozone observing techniques. Therefore, within TOAR-II, to reconcile the different ground-based free-tropospheric ozone retrievals, a focus working group has been initiated, aiming at (i) strengthening and expanding existing activities of harmonization of within networks of well-established ozone measuring techniques (IAGOS, ozonesondes, LIDAR, FTIR and Brewer/Dobson Umkehr), and (ii) a cross-comparison of those homogenized data, and their associated uncertainties, at dedicated sites or for identical air masses (in case of e.g. ozonesondes and aircraft measurements). Furthermore, the development of tropospheric ozone retrieval with "new" techniques as MAX-DOAS and Pandora, including comparison with established instruments for some example sites, is foreseen. The major expected outcome of HEGIFTOM is hence the characterization and evaluation of instrumental differences and drifts among the different ground-based datasets, but this feedback is also essential to the TOAR-II Satellite Ozone Focus Working Group, which will rely also on ground-based measurements for comparing different satellite tropospheric ozone retrievals. Using those satellite retrievals as well as model output, HEGIFTOM and the TOAR-II Chemical Reanalysis Focus Working Group will analyze the spatial and temporal representativeness of the ground-based tropospheric ozone measurements. We will present the project in more detail and its links to other working groups within TOAR-II. Further we will give first preliminary results of the harmonization of the different free tropospheric ozone data sets.

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Tarasick et al., *Elem Sci Anth*, 7(1), p.39, doi: https://doi.org/10.1525/elementa.376, 2019

Early Career Scientist

NO, I am not an early career scientist.

TOAR-29B

Long-term measurements of tropospheric ozone and precursors (HCHO and CO) from the NDACC FTIR ground-based network

Dr Corinne Vigouroux[1], Dr Martine De Mazière[1], Dr Omaira García[2], Dr Michel Grutter[3], Dr James W. Hannigan[4], DR Frank Hase[5], Dr Nicholas Jones[6], Dr Rigel Kivi[7], Dr Erik Lutsch[8], Dr Emmanuel Mahieu[9], Dr Maria Makarova[10], Dr Isamu Morino[11], Dr Isao Murata[12], Dr Tomoo Nagahama[13], Dr Ivan Ortega[4], Dr Mathias Palm[14], Dr Amélie Röhling[5], Dr Dan Smale[15], Dr Wolfgang Stremme[3], Dr Kim Strong[8], Dr Yao Té[16], Dr Yana Virolainen[10], Dr Pucai Wang[17], Tyler Wizenberg[8], Shoma Yamanouchi[8]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Ground-based FTIR (Fourier transform infrared) measurements contributing to the Network for Detection of Atmospheric Composition Change (NDACC), deliver time-series of ozone and some of its precursors at more than 20 sites, starting from the 90's for the oldest stations. In the context of the continuation of the Tropospheric Ozone Assessment Report (TOAR-II), which now includes in its analyses also ozone precursors in addition to ozone itself, we will present the status of the FTIR ground-based sites providing tropospheric ozone, formaldehyde (HCHO), and/or carbon monoxide (CO).

From high-resolution solar absorption spectra, O_3, HCHO and CO total columns are obtained with a precision of about 2%, 8%, and 1%, respectively. In addition, the pressure dependence of fully resolved absorption lines allows retrieving low vertical resolution profiles and thus deriving few independent partial columns. For O_3, the degrees of freedom for signal (DOFS) is about 4.5, allowing O_3 amounts to be retrieved in four independent altitude layers: one in the troposphere and three in the stratosphere up to about 45 km, with a precision of 5–6 % for each partial column. For HCHO, the DOFS is only of order 1.0-1.5, and the information is located mainly in the troposphere where most of the HCHO lies. For CO, about 2 DOFS can be obtained, one DOF being located in the troposphere (ground to 8 km).

We will show the trends of HCHO total columns as well as of O_3 and CO partial columns (ground to 8 km) obtained at the FTIR stations where sufficiently long time-series are available. To derive those trends, we will use a multiple linear regression model including seasonal cycles and dynamical proxies explaining the species' variability such as, e.g., the tropopause height, or the Quasi-Biennial Oscillation.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-30C

TOAR-II Tropospheric Ozone Precursors (TOP)-Focus Working Group: Photochemical ozone formation and free radical chemistry in five Chinese megacities in summer 2018

Dr. Xufei LIU[1], Prof. Hai GUO[1], Dr. Xiaopu LYU[1], Dr. Lewei ZENG[1], Dr. Yu WANG[2], Ms Yangzong ZEREN[1], Ms Jin YANG[1], Ms Luyao ZHANG[1], Dr. Shizhen ZHAO[3], Prof. Gan ZHANG[3]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

China Working Group

Abstract

To investigate photochemical ozone (O_3) pollution in urban areas in China, intensive measurements of O_3 and its precursors were simultaneously conducted in urban areas of five megacities in China in summer 2018. The results showed that Beijing had the highest O_3 mixing ratio, followed by Lanzhou and Wuhan, while Chengdu and Shanghai had relatively lower O_3. Model simulations revealed that the net O_3 production rate in Lanzhou was the largest, followed by Beijing, Wuhan and Chengdu, while it was the lowest in Shanghai. Furthermore, the O_3 formation was mainly controlled by volatile organic compounds (VOCs) in most cities, but co-limited by VOCs and nitrogen oxides (NO_x) in Lanzhou, indicating that cutting NO_x and VOCs would effectively lead to O_3 alleviation in Lanzhou. However, during periods of high O_3, O_3 formation was in transitional regime in Beijing and Wuhan, while mainly determined by NO_x in Lanzhou, implying the complex O_3 formation mechanisms in different cities. Moreover, the dominant VOC groups contributing to O_3 formation were oxygenated VOCs (OVOCs) in Beijing and Wuhan, alkenes in Lanzhou, and aromatics and OVOCs in Shanghai and Chengdu. Source apportionment analysis identified six VOC sources in the study cities, including liquefied petroleum gas usage, diesel exhaust, gasoline exhaust, industrial emissions, solvent usage, and biogenic emissions. VOCs from vehicular emissions were more abundant in Wuhan and Beijing, while solvent usage contributed the most to ambient VOCs in Shanghai, followed by Chengdu. Industry emission was the top source of VOCs in Lanzhou. Furthermore, diesel exhaust and solvent usage dominated the O_3 formation in Beijing, while diesel exhaust, industrial emissions and solvent usage made comparable contributions in Lanzhou. The O_3 formation was solely dominated by solvent usage in the other three cities. The findings are helpful to mitigate O_3 pollution in China.

Early Career Scientist

YES, I am an early career scientist.

TOAR-31A

TOAR-II Tropospheric Ozone Precursors (TOP) –Focus Working Group: Evaluating the Regional and Global Distributions of Ozone Precursors in relation to Ozone

Dr. Yasin F. Elshorbany[1], Dr. Rodrigo J. Seguel[2], Dr. Helen Worden[3], Dr. Ulas Im[4], Dr. Benjamin Gaubert[3], Dr Min Huang[5], Dr. Hai Guo[6], Dr. Xiaopu Lyu[6], Dr. Néstor Y. Rojas[7], Dr. Thiago Nogueira[8], Dr. Thérèse Salameh[9], Dr. Stéphane Sauvage[10], Dr. Jerald R. Ziemke[11], Dr. Sarah Strode[11], Dr. Rebecca R. Buchholz[12], Dr. Amy Christiansen[13], Dr. Suvarna Fadnavis[14], Dr. Roberto P. Minetti[15], Dr. Manish Soni[16], Dr. Tamara Emmerichs[17], Dr. Domenico Taraborrelli[17], Dr. Kenneth Pickering[18], Dr. Maria Cazorla[19], and other TOP members[20]

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, CCMi: Chemistry Climate Model Initiative

Abstract

The TOAR-II Tropospheric Ozone Precursors working group (TOP) was established on December 18th, 2020, with the aim to evaluate the regional and global trends and variabilities of ozone precursors in relation to that of ozone. TOP will use data from monitoring networks, field campaigns, satellite retrievals, and state-of-the-art modelling on multiple temporal and spatial scales. Currently, the TOP has about 80 members from all over the world, with research interests spanning a wide array of subjects related to ozone precursors, regionally and globally. The group members' research focuses include global trends and variability of ozone precursors from surface anthropogenic and natural emissions, lightning NO_x, their sources and contribution to ozone variability and trends. In addition, studies will focus on assessing the contribution of tropospheric volatile organic carbon (VOCs) to ozone formation in East Asia, the climatology of high quality VOC data in Europe within ACTRIS-EU research infrastructure, including drivers of spatial and temporal variabilities, global overview on the spatial-temporal characteristics of the ozone formation regime, global modeling of precursor trends in relation to ozone chemical sources and sinks, and trends of ozone and its precursors over the Arctic. TOP members of mutual research interests will organize and focus on each subject and will deliver the results, including publications submitted to the TOAR community special issue, following the TOAR-II time plan.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-32B

Distribution and seasonal variability of ozone and carbon monoxide over the tropics with 20 years of measurements

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Tropospheric ozone acts as a greenhouse gas and as a harmful pollutant for human health. O3 production is favoured in the tropics due to high sunshine and humidity, and active natural sources. Additionally, since the 1990s anthropogenic emissions have shifted from mid latitudes towards the equator. Through deep convection polluted tropical air masses can be redistributed in higher latitudes. However, the variability of tropical ozone and its exchange on global scale is not fully understood.

In this study, we investigate the distribution and seasonal variability of tropospheric ozone (O3) and carbon monoxide (CO) for several regions over the tropics. To do so, we take advantage of the high accuracy and resolution of in situ aircraft data (IAGOS) since 1994 (for O3) and 2002 (for CO). Measurements during the ascend and descend phase are used to study in detail the vertical distribution of 22 tropical sites including megacities such as Rio de Janeiro and Bangkok. Measurements during cruise phase are used in order to examine interregional and seasonal differences between 9 and 12km. Further, global distributions provided by IASI-SOFRID O3 and CO retrievals since 2008 allow us to explore intercontinental connections such as transatlantic transport of biomass burning products in low troposphere.

To investigate further the large IAGOS CO dataset, we use the SOFT-IO tool which couples backward Lagrangian FLEXPART simulations with anthropogenic and fire emission inventories. It allows us to estimate the drivers (anthropogenic and fires sources, regions and transport) responsible for observed CO anomalies.

Early Career Scientist

YES, I am an early career scientist.

TOAR-33C

Characteristics and source analysis of tropospheric ozone in Qinghai Tibet Plateau

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

China Working Group

Abstract

Tropospheric ozone is one of the important air pollutants that threaten the ecology and human health. In recent years, ozone pollution in the eastern China has become more and more serious. Compared with the eastern cities, the Qinghai Tibet Plateau is higher in altitude and sparsely populated. Due to the vast area of the Qinghai Tibet Plateau, different regions have different ozone characteristics. In this paper, the characteristics and transmission sources of ozone in the Qinghai Tibet Plateau are discussed by using the site data from the Chinese Ministry of Ecology and Environment (MEE), background station data and tropospheric ozone satellite data. The average concentration of MEE stations in four years (from January 2015 to December 2018) is between 30-40 ppb. The concentration of Xianggelila background station is similar to this in its available time period, while the ozone concentration of Waliguan Background Station reaches 51 ppb. All sites' daily variation reached minimum in the morning and maximum in the afternoon except Waliguan, which was mainly influenced by valley wind. In terms of seasonal variation, both tropospheric ozone satellite data and ground data show that the northern region was observed with maximum ozone mixing ratios in summer, and the closer to the south, the more obvious the characteristics of high values in spring. Although the MEE station did not show a significant short-term trend, the background station and satellite ozone data showed an upward trend of ozone concentration. We get the source contribution area of the Qinghai Tibet Plateau by using the backtrajctory method: The western, central and southern regions may be affected by the high-level ozone intrusion in the Himalayas in spring and human activities in South and Southeast Asia, while the northern and eastern regions may be greatly affected by the transportation of Xinjiang and Gansu.

Early Career Scientist

YES, I am an early career scientist.

TOAR-34A

High ozone over the bread basket of India ramped up by isoprene and acetaldehyde

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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The north-west Indo-Gangetic Plain is the agricultural breadbasket of India owing to its prolific wheat and rice production (> 70% of India's annual yield). Recent studies have reported increasing ozone pollution over it. Yet, no detailed year-round in-situ experimental evidence is available till date to ascertain the volatile organic compound precursors and production regimes of ozone. Ozone production regimes inferred from satellite-derived proxies and chemical transport models suggest NOx limited regimes over the region. Here, using the first year-long continuous measurements of 23 major VOCs, ozone, NOx and CO and their atmospheric oxidation products from a regionally representative site in north-west India, we evaluated the VOC precursors and ozone production regimes. In contrast to existing understanding, the ozone production regime was found strongly sensitive to both VOC and NOx precursors (> 90% days in a year). In all seasons, isoprene and acetaldehyde collectively accounted for ~30-50% of the daytime reactive pollutant loading (OHR) and ozone formation potential (OFP). The average seasonal OHR ranged from 14 s^{-1} (winter) to 21.5 s^{-1}(summer). Strong biogenic emissions of isoprene up to 12.9 mg m^{-2} h^{-1} (summer) were detected along with high acetaldehyde from anthropogenic and photochemical sources. Our results show that for ozone control efforts over this agriculturally and demographically significant region of the world, biogenic sources and VOC monitoring, in particular for reactive compounds like isoprene and acetaldehyde will be additionally required, in addition to NOx measurements and regulation.

Early Career Scientist

YES, I am an early career scientist.

TOAR-35B

The TOAR-II Ozone Radiative Forcing (ORF) Working Group activities

Dr William J. Collins[1], Dr Fiona M. O'Connor[2], Dr Pasquale Sellitto[3]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

The Tropospheric Ozone Assessment Report (TOAR), an official activity within IGAC, started its second phase in 2020. TOAR's mission is to provide the research community with an up-to-date scientific assessment of tropospheric ozone's global distribution and trends and its impact on climate, human health and crop/ecosystem productivity. In this framework, we launched the Working Group (WG) on Ozone Radiative Forcing (ORF) to specifically address the role of ozone in historical and future climate forcing. This effort is motivated by the need to quantify the evolution of radiative forcing in order to understand the drivers of the climate response over the historical period and into the future. Recent analysis has suggested that a substantial proportion of the human-induced radiative forcing has come from tropospheric ozone. The contribution of tropospheric ozone precursors to future climate change will also be strongly affected by policy choices made. Analysis and exploitation of new model simulations, height-resolved ozone concentration observations collated and archived during TOAR Phase I, and satellite observations of infrared outgoing radiation can all contribute to this effort on the estimation of tropospheric ozone radiative forcing.

We will present the main goals and plans of the TOAR-II Ozone Radiative Forcing WG to support the next TOAR report:

1. Gather scientists from around the world with an interest in tropospheric ozone radiative forcing and review the current literature
2. Assess the different methodologies for calculating ozone radiative forcing
3. Report best estimates of present, past and future ozone radiative forcing, using models and observations

These assessments on ozone radiative forcing will be submitted for publication in the TOAR-II Community Special Issue.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-36C

Surface ozone concentrations response to current air pollution mitigation strategies in Chinese megacity agglomerations

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report, ACAM: Atmospheric Chemistry and the Asian Monsoon, CATCH: the Cryosphere and Atmospheric Chemistry, PACES: Air Pollution in the Arctic: Climate, Environment, and Societies

IGAC Regional Working Groups

China Working Group, ANGA: African Group on Atmospheric Sciences, Americas Working Group, MANGO: Monsoon Asia and Oceania Networking Group, Southern Hemisphere Working Group, Japan National Committee

Abstract

The rapid urbanization and industrialization in China has resulted in severe air quality deterioration in the recent decades. To tackle the problem, the Chinese government implemented the Clean Air Action Plan initiated in 2013. As a result, fine particulate matter ($PM_{2.5}$), nitrogen oxides (NO_x), and sulfur dioxide (SO_2) concentrations have shown significant declines nationwide. However, measurements coordinated by China's Ministry of Environment and Ecology (China MEE) have revealed an increase in ozone concentrations in recent years. Notably, for the period 2015-2020, surface ozone mixing ratios showed an increasing summer (winter) tendency in large megacity-agglomerations; 0.33 (0.10) ppbv yr^{-1} in Beijing-Tianjin-Hebei, 0.35 (0.12) ppbv yr^{-1} in the Yangtze River Delta, 0.58 (0.47) ppbv yr^{-1} in the Pearl River Delta, and 0.37 (0.12) ppbv yr^{-1} in the Sichuan basin.

In this study, the Weather Research and Forecasting with Chemistry (WRF-Chem) model was applied using the latest Multi-resolution Emission Inventory for China (MEIC): i) to simulate the variability and amounts of surface ozone during the summer and winter seasons and ii) to investigate the reasons behind the observed enhancement. Herewith, we present the simulated surface spatial and temporal variability of key trace pollutants (NO_x, O_3, CO, SO_2, $PM_{2.5}$) for the whole region of China and their validation against observations at urban, residential and remote-rural regions. The validated results will help us investigate the role of: i) changes in radiation due to the significant decline in particle number concentration and ii) precursor species amounts on ozone ambient levels. Overall, this study will pave the road for the improvement of air pollution control strategies in Chinese megacities.

Early Career Scientist

YES, I am an early career scientist.

TOAR-37A

Implementation of a New Value of the Ozone Absorption Cross-section per Molecule at 253.65 nm (air) for Global Atmospheric Ozone Measurement

Prof Paul J Brewer[1,2], Dr Andrew S Brown[1], Dr Sangil Lee[3], Dr Joele Viallon[4], Dr Robert Wielgosz[4], Dr Joseph J Hodges[5], Ms Jennifer Carney[5], Dr James Norris[5], Ms Louise Sorensen[6], Ms Joann Rice[7], Dr Christoph Zellweger[8], Dr Hiroshi Tanimoto[9], Dr Bernhard Niederhauser[10]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

A task group established by the Gas Analysis Working Group of the Consultative Committee for Amount of Substance: Metrology in Chemistry and Biology (CCQM-GAWG), analysed literature values and uncertainties for the absorption cross-section of ozone at room temperature at the mercury-line wavelength (253.65 nm, air) from fourteen independent sets of measurements from 1959-2016. From this study, a consensus value from a statistical analysis, $1.1329\ 10^{-17}$ cm^2 was recommended for the ozone absorption cross-section value with a standard uncertainty of 0.0035×10^{-17} cm^2. The new value is around 1.2% lower than the conventionally accepted reference value reported by Hearn and with an uncertainty approximately six times smaller.

Following a consultation of key stakeholders, the CCQM-GAWG issued a statement on its intention to change the ozone cross-section value used for surface ozone standards and measurement. It foresees a 3 to 5-year process in which the following changes will be implemented:

- The 2019 value of 1.1329×10^{-17} cm^2 and standard uncertainty 0.0035×10^{-17} cm^2 will be adopted for the ozone absorption cross-section per molecule at 253.65 nm (air) for use in ozone measurement standards maintained at the BIPM and for the calculation of the reference value for the BIPM.QM-K1 on-going comparison of surface ozone measurement standards;
- The identifier CCQM.O3.2019 will be used as a unique shorthand identifier to identify the 2019 value.

To manage and coordinate the change process a new CCQM-GAWG task group, with membership including all stakeholder communities, has been established. Activities include developing a timeline for implementation, considering the time needed for documentary change as well as implementation in measurement instruments and networks.

This presentation outlines the work that led to the recommendation, the rationale and the programme for implementing and managing the implementation of the new value of ozone cross-section per molecule at 253.65 nm (air).

Early Career Scientist

NO, I am not an early career scientist.

TOAR-38B

Effect of global and local biogenic emission inventories in surface ozone simulations using WRF-Chem

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

Americas Working Group

Abstract

Biogenic volatile organic compounds (BVOC) are reactive species emitted by the vegetation, considering very important in ozone (O_3) formation. Nevertheless, BVOCs are not properly estimated due to lack of specific emission factors and a wide vegetation distribution, which is one of the biggest causes of inaccuracies in air quality modeling (AQM). Currently, the Model of Emissions of Gases and Aerosols from Nature (MEGAN) is the common model to estimate BVOC emissions in AQM; nonetheless, some authors have identified that MEGAN lacks detailed vegetation distribution maps, especially in the tropics, and the spatial resolution of the model is not enough to represent the climatic variability of areas with high altitudinal changes. These limitations affect the spatial and temporal distribution of BVOC emissions, especially in areas of the tropical Andes where vegetation is varied, and the altitudinal changes influence the meteorological variables, such as temperature and solar radiation. As a response, a local model for Andean regions called Biogenic Altitudinal Gradient Model (BIGA) was developed to estimated BVOC emissions, using high-resolution landcover and topographic maps, as well as surface measurements of meteorological variables (temperature and solar radiation). In this study, the WRF-Chem chemical transport model was used to test the sensitivity of ozone (O_3) predictions to different biogenic emission inventories (MEGAN and BIGA). Two air quality simulations were performed over the department of Caldas, Colombia, and adjacent regions (Altitude from 300 to 5200 m.a.s.l), estimating BVOC emissions using MEGAN and BIGA. The model outputs were compared against ground O_3 measurements to assess which BVOC emission inventory leads to the most accurate spatial and temporal distribution of O_3 concentrations. Isoprene fluxes estimated with BIGA are 58% lower on average compared with MEGAN, and the spatial distribution of isoprene is different for both inventories. This has a later impact on O_3 estimation by WRF-Chem.

Early Career Scientist

YES, I am an early career scientist.

TOAR-39C

Observations of light NMHCs over the central Himalayas: Assessment of ozone production potential using a photochemical box model

Mr. Mahendar Chand Rajwar[1,2], Dr. Manish Naja[1], Mr. Samresh Bhatacharjee[1], Prof. Rakesh k. Tiwari[2], Mr. S. Venkatramani[3], Prof. Shyam Lal[3]
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IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

Tropospheric ozone is a secondary air pollutant in the earth's atmosphere that has adverse effects on human health and the crop growth. It has a very complex non-linear relation with its precursors, particularly NOx and NMHCs. NMHCs are also important precursors for secondary organic aerosols. Considering the limited observations of NMHCs in the Indian subcontinent, particularly over the Himalayan region, their observations have been initiated at a high altitude site in the central Himalayas (Nainital; 29.4o N, 79.5O E 1958 m amsl) and at a semi-urban site (Kathgodam,;29.3ON,79.5OE, 554 m amsl) in the Indo-Gangetic Plain (IGP). Diurnal variations with slightly higher values in noon are observed in n-butane, i-butane, m-xylene, and p-xylene while bi-mode variations are seen in ethane, propane, benzene and toluene. Noontime higher values indicate dominance of the photochemistry whereas importance of the convective boundary layer is reflected in the bi-mode variability. Ethane, toluene and benzene showed consistent seasonal variation, with winter time higher values while toluene and o-xylene showed higher values in autumn. Inter-correlation coefficients between ln((n-butane)/(ethane)) and ln((i-butane)/(ethane)) is greater than 0.8 with slope of about 0.9. Further, inter correlation between acetylene and ethane suggests biomass burning as a major source of these species during the spring season. We have also used the NCAR-MM photochemical box model and made a sensitivity analysis to study changes in ozone diurnal variations for different values of NOx and NMHCs. A preliminary estimate shows greater ozone production rate (P(O3)) for aromatics (>8.5 ppbv/h) followed by alkanes (>6.5ppbv/h) and alkenes (>5ppbv/h) for the IGP site. Detailed analysis will be presented during the conference.

Early Career Scientist

YES, I am an early career scientist.

TOAR-40A

Multimodel evaluation of present-day and climate-driven changes in surface ozone over Africa and South America

Florence Brown[1], Stephen Sitch[1], Gerd Folberth[2], James Haywood[1,2]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, CCMi: Chemistry Climate Model Initiative

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Southern Hemisphere Working Group, Americas Working Group

Abstract

Surface ozone (O_3) negatively impacts human health, plant productivity and crop yields. Previous studies have shown that models overestimate O_3 in tropical regions, especially in remote locations. This positive bias may lead to an overestimation of ecosystem ozone-damage in the tropics. In this study, we compare present-day modelled surface O_3 mixing ratio with observations compiled from the TOAR database to evaluate regional O_3 biases over South America and Africa.

Evaluation of the four Earth System Model (ESM) predictions from the 6th Coupled Model Intercomparison Project (CMIP6) against observations show a positive bias in all models of up to 20 ppb. We find that models overestimate surface O_3 mixing ratios in the biomass burning seasons in particular. Further analysis of the UKESM1-0-LL model shows the O_3 seasonal cycle is well-captured by the model. There is a consistent bias of approximately 15 ppb across all seasons except in areas of biomass burning, which contain biases of up to 40 ppb in biomass burning seasons.

This work will be taken further to explore the impact of ozone-damage on vegetation. Removing the bias in surface ozone mixing ratio will test whether an overestimate of O_3 in the tropics leads to greater tropical plant-ozone damage.

Early Career Scientist

YES, I am an early career scientist.

TOAR-41B

TOAR-II Tropospheric Ozone Precursors (TOP) – Focus Working Group: Addressing multi-scale processes in South America

Rodrigo J Seguel[1], Beatriz H Aristizabal[2], Fernanda Baquero[3], Lucas Castillo[1], María Cazorla[4], Felipe Cifuentes[2], Yasin Elshorbany[5], Laura Gallardo[1], Thiago Nogueira[6], Charlie Opazo[1], Roberto Pepino[7], Néstor Rojas[3], Jhojan Rojas-Quincho[8]
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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

The second phase of the Tropospheric Ozone Assessment Report (TOAR-II) was initiated in 2020, and since then, several Working Groups (WGs) have been established. TOAR-II WGs will lead to publications in the TOAR-II Community Special Issue, thus supporting the TOAR-II assessment. Thereby, the Tropospheric Ozone Precursors (TOP) Focus WG aims to examine the current regional and global distributions, variabilities, and trends of ozone precursors. The TOP focus WG has adopted a bottom-up strategy to collect, homogenize and process different sources of available data that eventually will support the global analysis. Particularly, we will use monitoring networks, field campaigns, satellite retrievals, and modeling to examine the distribution, variability, and trends in ozone precursors in South America. Additionally, these regional activities will offer concrete opportunities to strengthen the synergies with other existing TOAR-II focus WGs and IGAC activities. Therefore, within the TOP focus WG life cycle (2020-2023), we expect to deliver outcomes to improve the understanding of the processes controlling the current and future ozone precursor levels, including multi-scale processes occurring in South America.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-42C

Evaluation of tropospheric ozone measurements derived from the satellite UV sensors

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

Abstract

Satellite UV sensors provide global maps of total ozone columns daily. A number of methods have been tested to derive tropospheric ozone maps from the satellite observations. In this study we perform error analysis and evaluate sensitivity to the boundary layer ozone for the differential method in which tropospheric ozone columns are derived by subtracting independently measured and collocated stratospheric ozone columns (SOC) from total ozone. To derive SOC we use MERRA-2 ozone profiles that are based on assimilated MLS. We compare tropospheric ozone columns derived from several OMI total ozone algorithms: TOMS-V9 (NASA GSFC), GODFIT v4 (BIRA-IASB), OMI-DOAS (KNMI) and SAO PROFOZ (SAO Harvard). We evaluate the satellite-based tropospheric ozone columns with ozonesondes and the Goddard Modeling Initiative (GMI) model. We provide estimates of errors in tropospheric ozone columns due to errors in SCO, tropopause height and cloud correction.

Early Career Scientist

NO, I am not an early career scientist.

TOAR-43A

Impact of the 2020 Colorado wildfires on Ozone in the Front Range

Patricia N Razafindrambinina[1], Peter Effertz[2,3], Irina Petropavlovskikh[2,3]
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Abstract

Summer and fall of 2020 saw record-breaking wildfires in Colorado. Wildfires and biomass burning release aerosol and gaseous pollutants that are hazardous to human, animal, and plant health. Ozone, a pollutant not directly released but photochemically formed, is enhanced in wildfire plumes as the plumes age (Jaffe et al., 2012). Studies show that wildfires are increasing across North America and will become a larger contributor to the tropospheric ozone budget. To see how ozone was enhanced in the Colorado Front Range due to the wildfires in August and September 2020, we evaluate the correlations between surface ozone anomalies and wildfire tracers. Among tracers we select are carbon monoxide, carbon dioxide, aerosol light absorption coefficients, aerosol Ångström coefficients, photosynthetically active radiation, and boundary layer heights. These tracers are measured at NOAA's Table Mountain Facility monitoring site located in the foothills region of central Colorado. We use correlations between surface ozone and the wildfire tracers to identify episodes in the surface ozone record at TMF that are impacted by wildfires. The back-trajectories and satellite fire maps from GOES-R and MODIS are used to link episodes of ozone enhancements in Colorado front range to the wildfire origin. The ozone anomalies are compared to the days that are not impacted by fires (i.e. low CO and aerosol levels) to quantify the enhancement of ozone due to wildfires and biomass burning.

Early Career Scientist

YES, I am an early career scientist.

TOAR-44B

Ozone Chemistry over a Western Himalayan Site

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IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, TOAR: Tropospheric Ozone Assessment Report, CCMi: Chemistry Climate Model Initiative, CATCH: the Cryosphere and Atmospheric Chemistry, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group

Abstract

The abundance of ozone is highly variable over tropic and subtropical regions, and assessing the impact of anthropogenic activities over varying ozone levels can be accomplished with the availability of baseline values. To measure the background concentrations, several monitoring stations have been installed across the globe at different high altitude sites. Mountains are the best preference, due to their topography and sparsely settled human population, leading to low or no local emissions. The ozone production and destruction are quite complex processes due to the involvement of various atmospheric chemical and physical processes. In the past, several studies have been conducted to study the changes in the ozone chemistry over the urban regions but sparse studies are available over the remote high altitude sites. Therefore in this study, the variability of ozone over a western Himalayan site was studied for two consecutive summer seasons to understand the ozone chemistry. The data of ozone and its precursor gases measured at the remote atmospheric monitoring station of CSIR-National Physical Laboratory situated in Palampur (H.P., India; 32.12^{o} N, 76.56^{o} E at 1347 m AMSL) has been used for this study.

Low concentrations of ozone were observed under the high NO_x values, while an increase in ozone levels was observed with the decrease in NO_x values. The ozone showed two distinguished diurnal trends during the study period; one where ozone maxima were recorded during the daytime and minima during the early morning and late-night; while the other trend showed a reverse of it. The calculated photo-stationary state values revealed the strong influence of VOCs and other radicles over the ozone chemistry at the study site. The NMHCs to NOx ratio and other parameters revealed that the ozone chemistry over the site is complex due to the dynamic atmospheric circulation processes occurring over the study site.

Early Career Scientist

YES, I am an early career scientist.

TOAR-45C

Investigating the governing processes and synergic effect between anthropogenic and biogenic emissions on ozone pollution over northern China

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Key Laboratory of Marine Environment and Ecology, Ministry of Education, Ocean University of China, Qingdao, China

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report

IGAC Regional Working Groups

China Working Group

Abstract

Along with the abatement of emission precursors in China, the concentrations of particulate matters have decreased substantially recently. However, the ozone concentrations may even increase in particular over northern China. The investigation of ozone formation mechanism under different conditions is useful to illustrate the complexity due to the combined effect of meteorology and emissions. One of the primary methods used is to utilize the process analysis in region chemical models through the delineation of various of physical and chemical processes in the ozone formation. Different from the traditional methods by only considering these processes on the surface, the consideration of processes in planetary boundary layer (PBL) reveals some distinct characteristics. For instance, we found that the photochemical reactions within the PBL was almost the only factor triggering the accumulation of surface ozone concentration during the daytime. Furthermore, we proposed the “dynamical anthropogenic emission control” strategy based on the high correlation exhibited between chemical reactions within PBL and near surface MDA8 ozone, potentially useful for short-term episodic events control. In addition to the anthropogenic emissions, there is strong synergy between anthropogenic and biogenic emissions, which is largely ignored previously. Through a large number of numerical experiments, we found that the effect of biogenic emission in ozone enhancement may strikingly increase along with the decrease of anthropogenic emissions, putting forward a challenge on ozone pollution control in future when anthropogenic emissions are projected to decrease and biogenic emissions are likely to increment upon the increase of trees in particular under the targe of carbon neutralization.

Early Career Scientist

YES, I am an early career scientist.

TOAR-46A

Estimation of Ozone during lightning event in pre-monsoon season

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IGAC Activities

TOAR: Tropospheric Ozone Assessment Report, ACAM: Atmospheric Chemistry and the Asian Monsoon

Abstract

In this study, WRF-Chem model has been used to simulate lightning temporal and spatial distributions before, during, and after thunderstorm during pre-monsoon period over India. The functional relationship between thunderstorm, wind speed and lightning frequency is also analyzed. The domain with spatial resolution of 27 km is centered at 23^{o} N, 83^{o} E, covering most of the north-east part of India and some part of Bay of Bengal. The work has been focused on North Eastern States. The simulation has been run for 16th May to 25th May 2009 with/without lightning module. This study utilizes Emissions Database for Global Atmospheric Research (EDGAR) HTAP-2010, Fire Inventory from NCAR (FINN) and Model of Emissions of Gases and Aerosols from Nature (MEGAN) for anthropogenic, fire and biogenic emissions. The aerosol model chosen is Modal Aerosol Dynamic Model/Secondary Organic Aerosol Module (MADE-SORGAM). The model is integrated every one hour. The simulation outputs reveal that the surface concentration of NOx is found to be increased significantly after the lightning event. The magnitude of NOx and ozone is much higher with lightning module than without lightning module for higher affected areas. It is observed that surface ozone concentration is also changing with NOx concentration and there is a good correlation between the model simulated NOx and O_3 against satellite observations of OMI and TOMS ozone retrievals. The bias correction shows that model was able to successfully simulate high and low lightning dominant regions in terms of ozone concentrations.

Early Career Scientist

NO, I am not an early career scientist.