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IGACnews

coordinating and fostering atmospheric chemistry research towards a sustainable world

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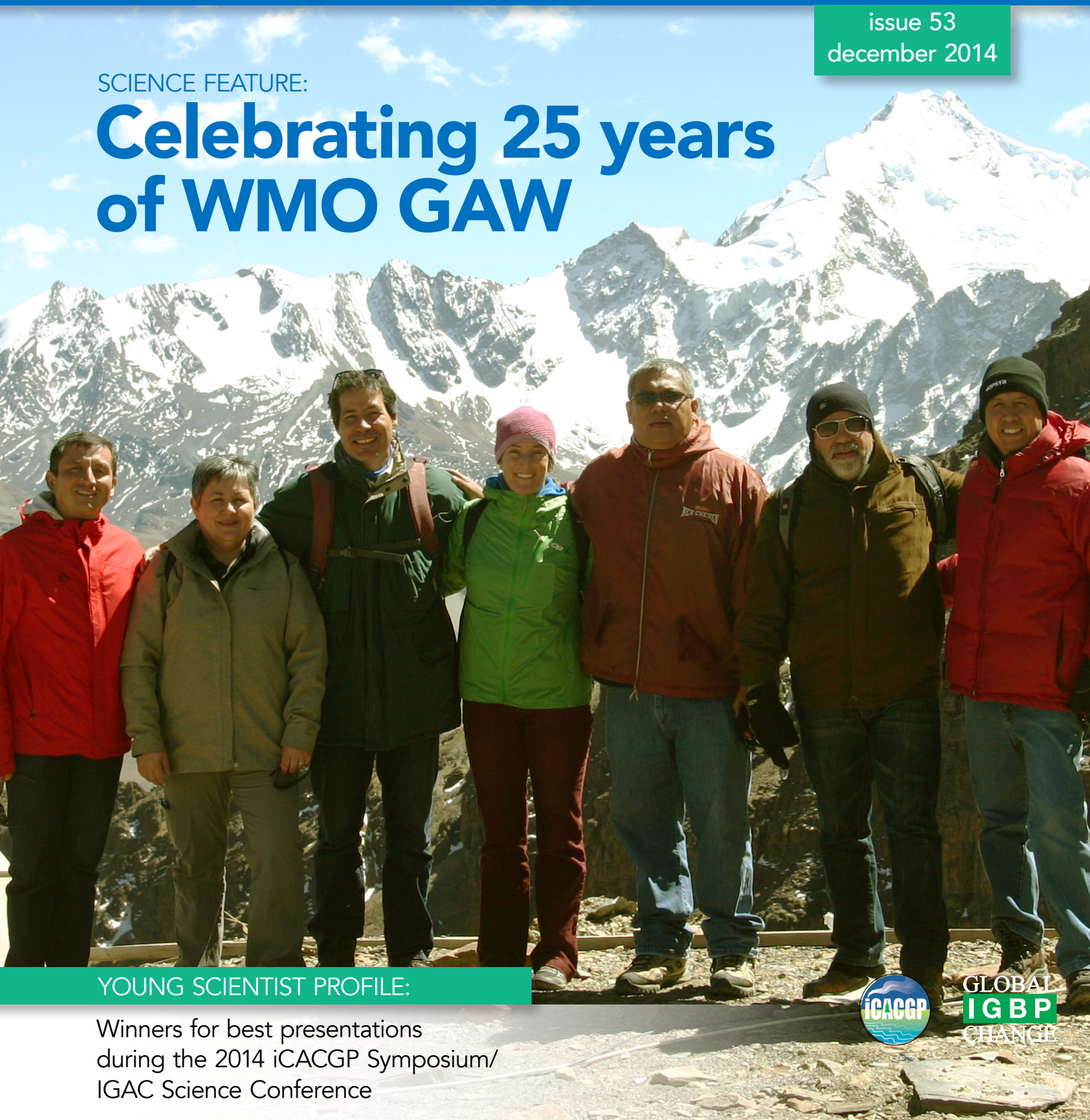
SCIENCE FEATURE:

Celebrating 25 years of WMO GAW



YOUNG SCIENTIST PROFILE:

Winners for best presentations during the 2014 iCACGP Symposium/ IGAC Science Conference

iCACGP

GLOBAL IGBP CHANGE

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on the cover **The IGAC Americas Working Group at the WMO GAW Chacaltaya observatory in Bolivia, 5240m.**
Photo Courtesy of Marcos Andrade.

IGAC was formed in 1990 to address growing international concern over rapid changes observed in Earth's atmosphere. IGAC operates under the umbrella of the International Geosphere Biosphere Programme (IGBP) and is jointly sponsored by the international Commission on Atmospheric Chemistry and Global Pollution (iCACGP). The IGAC International Project Office is hosted by the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado and is sponsored by the US National Science Foundation (NSF), National Oceanic and Atmospheric Association (NOAA), and National Aeronautics and Space Administration (NASA). The IGAC European Project Office is hosted by the Italian National Research Council and by the European Commission Network of Excellence (ACCENT Plus). Any opinions, findings, and conclusions or recommendations expressed in this newsletter are those of the individual author(s) and do not necessarily reflect the views of the responsible funding agencies.

Young Scientists' Vision for IGAC

By the Young Scientists Program Committee for the 2014 iCACGP/IGAC Conference

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The IGAC conference has become a platform for networking and state-of-the-art atmospheric chemistry science, in which the interaction between the modelling and the observation community becomes outstanding. The diversity of subjects during the presentations makes IGAC conferences completely fulfilling for a young scientist in Atmospheric Chemistry aiming to expand knowledge.

We were extremely happy to see that during this year's IGAC conference in Natal, Brazil, we had the highest attendance of Young Scientists to date, reaching up to 169 people. It was very striking to notice the difference between the IGAC conference in Beijing 2012, in which only five YS from Latin American countries were able to attend. On the contrary, this time up to 88 people from seven different Latin American countries attended, demonstrating the importance for such events in this region. However, the Asian YS participant number was still high with 21 people.

The Young Scientist program was full of events, starting with an icebreaker in order to get to know each other. In view of the necessity expressed by past programs of summer courses, we organized an introductory workshop in which the invited speakers introduced each session in order to allow all YS to have a general overview of what was going to be presented at the conference. Furthermore, we had a fantastic excursion to the Genipabu Beach as well as a meeting devoted to talk about the future of IGAC.

One of the key issues that was stressed during the young scientist program was the necessity of networking, not only with senior scientists but also with other young scientists. This was widely enforced throughout the conference.

Most YS had poster presentations, which led them to suggest the need of strengthening poster sessions for future conferences. Nonetheless, we counted on excellent oral presentations by Young Scientists, where we were also able to see the quality and the implications of their work for innovative science.

During the YS visioning meeting we discussed how IGAC can improve in the future. The Young Scientists came to the conclusion that their role in future steps to accomplish the challenges of the state-of-the-art science should be more delineated. We discussed the possibility of making IGAC conferences more interdisciplinary but this caused debate, due to the richness of subjects contrasting with the interdisciplinary needs of the atmospheric chemistry science. Furthermore, we also discussed a possible link to policy makers yet debate was also present due to the differences in knowledge and the consequent change of the audience of the conference. In addition to the last conference outcome of summer schools, during this conference we analysed the possibility of one-to-one meetings for details on measurements. At last, we clearly saw that the conference location provides emphasis on different subjects seeing as the

Young scientists listen to Tong Zhu from Peking University in China speak about atmospheric chemistry and urbanization during the Young Scientists Program workshop.

Young scientists at Genipabu Beach during the free afternoon of the conference.

IGAC conference in Beijing, China was more focused on megacities and their effects, while this year's conference seemed to be more focused on biomass burning events and characteristics. This aspect is of importance when choosing new locations for future IGAC conferences.

To finalize, we would like to thank every Young Scientist that attended the conference. We were extremely happy to see the ongoing, highly scientific discussions held during the conference as well as the excellent social atmosphere everyone had at sunny Natal.

13th Quadrennial iCACGP Symposium/13th IGAC Science Conference

22-26 September 2014
Natal, Brazil

IGAC was pleased to hold its 13th biennial science conference in junction with the iCACGP 13th Quadrennial Symposium in Natal, Brazil this past September. The conference was a huge success with approximately 425 participants from 46 different countries. The Local Organizing Committee, chaired by Judith Hoelzemann, did a wonderful job organizing the conference. The Scientific Program Committee, chaired by Yinon Rudich and Russell Dickerson, put together an excellent scientific program focused on the following six sessions:

- Session 1: Atmosphere-surface (ocean/vegetation/ice) interactions in a changing climate
- Session 2: Atmospheric chemistry and the coupling between biogenic and anthropogenic emissions
- Session 3: Interactions between aerosols, clouds and precipitation
- Session 4: Atmospheric chemistry and urbanization: from local to the global scales
- Session 5: Atmospheric chemistry fundamentals
- Session 6: Atmospheric chemistry in a changing climate

In addition to the 13 invited speakers and 60 oral presentations in the fore mentioned sessions, three keynote addresses were also given by Paulo Artaxo, Jos Lelieveld and A.R. Ravishankara on the biology and atmospheric chemistry in the Amazonia, air pollution and mortality in Asia, and atmospheric science and the Pasteur's quadrant, respectively. In addition to the plenary oral presentations, approximately 400 posters were presented throughout the week.

In this newsletter IGAC is delighted to feature the winners of the Young Scientists Program oral and poster presentation competition. Please read on to learn more about the future leaders in atmospheric chemistry research.

Thank you to the entire IGAC community for making the 2014 conference a success. More information on the conference can be found at **igac-icacgp2014.org**.

– Megan L. Melamed, IGAC Executive Officer

Participants in the 2014 iCACGP/IGAC Conference.

2014 IGAC SSC Meeting

The IGAC Scientific Steering Committee convened in Natal, Brazil for our annual meeting, in concert with the 13th iCACGP Quadrennial Symposium / 13th IGAC Science Conference. IGAC was happy to welcome two new members to our Steering Committee for 2014: Judith Hoelzemann from Brazil and Nouraddine Yassaa from Algeria. At the same time, we bid fond farewell to two valued members, John Abbatt from Canada and Olga Mayol-Bracero from Puerto Rico.

IGAC supports a vibrant set of activities that act as community foci and we were particularly pleased to hear about the growth of the Interdisciplinary Biomass Burning Initiative (IBBI) and the Atmospheric Composition and the Asian Monsoon (ACAM) initiatives. The Fundamentals in Atmospheric Chemistry activity has gained a lot of traction with the community, generating a large number of strong proposals received for workshops. Two upcoming fundamentals workshop are "Nitrate Radical and Biogenic Volatile Organic Compounds (VOCS): Oxidation, Mechanisms and Organic Aerosol" and "The Future of Laboratory Studies in Atmospheric Chemistry" June 2015. The IGAC steering committee is committed to supporting activities and research making sure that the roots of our research tree are firm in respect to fundamentals that underpin the more applied and stakeholder interaction oriented branches of the IGAC portfolio.

Looking forward, a particular focus for IGAC is to think about atmospheric chemistry in the context of global change and sustainability. The steering group spent a considerable amount of time thinking about how to build multidisciplinary activities and place IGAC at the heart of global change and sustainability research in the upcoming Future Earth programme.

IGAC has started a number of new initiatives around national and regional working groups, and was pleased to hear updates from the Japan National Committee and the China and Americas Working Groups, as well as the possibility of forming an Asian Working Group.

We were joined by a number of our global change partners to review some of the future directions and upcoming changes likely to arise while moving towards the Future Earth Initiative. Of particular interest was the increasing role of biogeochemistry in the World Climate Research Programme (WCRP). We were pleased to be joined by the World Meteorological Organization (WMO) representative Oksana Tarasova who reviewed some of the exciting things taking place with the Global Atmosphere Watch (GAW) programme. The IGAC Science Conference included a celebration of GAW's 25th year, with an excellent lecture by Greg Carmichael chronicling the history, contributions, and future of this critical atmospheric chemistry observation program.

Moving forward, IGAC reviewed future directions to make sure the balance of its programme was right and it was delivering on the key elements to support the community needs. The final element that was reviewed was the exciting plans for the 2016 IGAC Conference in Breckenridge, Colorado USA 26-30 September 2016, which with its majestic mountains looks to be a worthy successor to the warm, tropical shores of Natal, Brazil.

- Paul Monks and Allen Goldstein,
IGAC Co-Chairs

Participants in the 27th annual IGAC SSC Meeting in Natal, Brazil in September.

Save the Date!

The 14th biennial IGAC Science Conference will be held 26-30 September 2016 in Breckenridge, CO USA. The Local Organizing Committee is chaired by Christine Wiedinmyer (NCAR, Boulder, CO, USA). The Scientific Programme Committee is co-chaired by IGAC SSC members Claire Grainer (LATMOS, Paris, France and NOAA CSD/CU CIRES, Boulder, CO) and Hiroshi Tanimoto (NEIS, Japan). Please stay tuned for more details at **igac2016.org**!

Update on the IGAC/SPARC Atmospheric Composition and Asian Monsoon (ACAM) Activity

Over the last year, ACAM has gained official status as a developing activity and has continued to raise awareness through reports on the Kathmandu workshop in the IGAC and SPARC newsletters and reports to their Scientific Steering Committees. A special session was also convened at the AOGS meeting last July in Sapporo, and a side meeting was held to discuss plans for a second ACAM workshop in June 2015 in Bangkok, Thailand. During the recent IGAC conference in Natal, Brazil, ACAM sponsored both a poster and a side meeting to update the community. Both the poster and slides from the side meeting are available for download from the ACAM website at **www2.acd.ucar.edu/acam/activities**.

To move forward as a community, ACAM has organized four working groups and identified leads to address the needs that were identified during the discussions at the workshop in Kathmandu. The four ACAM working groups are as follows: Data Sharing, CCMI Partnership, Field Campaigns, and Training. To join a group, please contact one of the leads by email. Contact information for the working group leads can be found at **www2.acd.ucar.edu/acam/working-groups**.

Please mark your calendars for the Second ACAM Workshop. The announcement can be found at **www2.acd.ucar.edu/acam/bangkok2015**. More information on registration and logistics for the meeting will be coming soon.

- Jim Crawford and Laura Pan, ACAM Co-Chairs

Side Meeting Report: Latin America and Caribbean GEIA Working Group

A GEIA/IGAC Americas Working Group side meeting was held during the 13th iCACGP/IGAC Conference held in Natal, Brazil, 22 - 26 September 2014. The goal of the meeting was the formation of a Latin America and Caribbean (LAC) GEIA working group. The LAC-GEIA working group aims to enhance the connections between experts on emissions from across Latin America, inform GEIA's global emissions community about the best and latest emissions information in the region, and provide stronger connections between the global and regional atmospheric scientific and policy communities. The meeting had more than 50 attendees from different countries around the region and from other parts of the world. A survey organized and distributed prior to the side meeting allowed potential members of the LAC-GEIA working group to describe their research field, interests and priorities. The LAC-GEIA group plans to organize the development of the first Latin American regional emissions inventory. First steps on this activity include compiling existing information on emissions within LAC and preparing a review of the current state of emission estimates in LAC.

Those interested in participating in the LAC-GEIA group are invited to fill out this survey: **docs.google.forms/com/d/1VRHubL1983NNC07IgWzZ5gChpyFWXWt3Jtv4UqDR8A/viewform892**

– Laura Dawidowski and Nestor Rojas, IGAC Americas Working Group Co-Chairs
– Nicolas Huneeus, IGAC Americas Working Group Member
– Greg Frost, GEIA Co-Chair

Submit Articles to the next IGAC newsletter

IGAC is now accepting article submissions for the next IGAC newsletter. Workshop Summaries, Science Features, Activity News, and Editorials are all acceptable and desired. Science Features should have an approximate length of 1500 words with 1-2 images. All other submissions should be approximately 500 words and have a maximum of 1 image. Please provide high-resolution image files. The deadline for submissions for the March issue of the IGAC Newsletter is 13 February 2015. Send all submissions to **info@igacproject.org**.

IGAC moves to e-bulletins

Tired of seeing too many emails from IGAC in your inbox? We listened and IGAC will now send an e-bulletin for most announcements on the first of each month. The e-bulletins will include information on upcoming IGAC sponsored and IGAC related events, IGAC publications and information regarding the larger Global Environmental Change community. With the introduction of e-bulletins, IGAC will no longer be sending individual emails for non-IGAC Sponsored or Endorsed events.
If you would like an event or anything else to be included in the IGAC e-bulletin, please email **info@igacproject.org** and we will include it in the next monthly e-bulletin.

IGAC on Social Media

IGAC is on LinkedIn, Twitter and Facebook in an effort to further advance international scientific cooperation and serve as a resource to the public, especially you. Please join us to stay apprised of the most current news on conferences, workshops and publications. Let us hear from you on how to improve the international conversation, **@IGACProject**.

IGAC Americas Working Group Meeting

20-22 August 2014 • La Paz, Bolivia

The second IGAC Americas Working Group (AWG) meeting was held in La Paz, Bolivia 20-22 August 2014. Participants of the meeting were from the US, Mexico, Cuba, El Salvador, Colombia, Bolivia, and Chile with representatives from Puerto Rico, Brazil, and Argentina attending remotely. Funding for the meeting was generously provided by the Molina Center for Energy and the Environment (MCE2), the Inter-America Institute for Global Change Research (IAI) and IGAC.

La Paz, Bolivia

This meeting focused on completing the goals initiated in first IGAC AWG meeting in Bogotá, Colombia in January 2014. These goals include:

- Defining the organizational structure of the IGAC AWG;
- Completing an article on atmospheric chemistry research in Latin America – Caribbean (LAC) region; and
- Designing atmospheric chemistry courses for capacity building.

The organizational structure of the IGAC AWG will consist of 12 members; One from Argentina, one from Chile, three from the Andean countries (Bolivia, Peru, Ecuador, Colombia and Venezuela), one from Brazil, two from Central America, two from the Caribbean, one from Mexico, and one from the US or Canada. All new members will serve a 4-year term whereas current members are part of the implementation committee and will rotate in such a way that not more than three people will leave the group any given year.

A significant amount of time was spent writing a paper on atmospheric chemistry in the LAC region. The paper focuses on the heterogeneity of the region, examples of scientific research in the region and the scientific questions and needs in the region. The hope is that the paper will create great enthusiasm among the scientists in the LAC region (especially young scientists) dealing with different aspects of atmospheric sciences. The paper is a call to LAC scientists to improve collaboration and exchange within the region and contribute to answering scientific questions at both regional and global scales. The group expects to submit this paper to a refereed journal by the end of 2014.

Two short courses on atmospheric sciences are currently being developed in the LAC region. The first will address black carbon measurement techniques and will take place in La Paz, Bolivia June 2015. The second short course will address remote sensing measurements for atmospheric chemistry and will tentatively take place in Mexico City, Mexico August 2015. The group hopes to continue to develop short courses every year for capacity building purposes in the LAC region.

Finally, one of the reasons for having the meeting in La Paz, Bolivia was to visit the new World Meteorological Organization (WMO) Global Atmosphere Watch (GAW) station in the Andean mountains. The station is located on Mount Chacaltaya (~5400 m asl) and has been functioning since December 2011 hosting an important number of instruments for monitoring physical and chemical properties of gases and particles arriving at this high altitude (the station is at 5240 m asl). Some of the attendees had a nice walk to a cabin located at the summit where the station is using filters for measuring soluble ions but, in addition, where it is possible to have an spectacular view of the Andean mountains range, Lake Titikaka, and the deck of clouds below over the Amazon basin. Our friend Carlos Rudamas, the only "climber" coming from sea level, showed a great Salvadorian spirit reaching the summit along people living in Mexico, Bogota and Boulder (and Bolivia of course) which are high altitude cities.

– Marcos Andrade, Universidad Mayor de San Andres, Bolivia, La Paz, mandrade@fiumsa.edu.bo

Climate Engineering Conference 2014: Critical Global Discussions (CEC14)

18-21 August 2014 • Berlin, Germany

Climate engineering is rapidly becoming a contentious issue within political, scientific, and cultural discussions of climate change, in part due to a perceived lack of progress on crucial emission reductions. The recently released IPCC WG1 report suggests that without swift and dramatic mitigation of greenhouse gas emissions, global warming could easily exceed the internationally promoted upper limit of 2°C, creating risks which may prove intolerable. Climate engineering may be a dangerous distraction from the hard work required to reduce emissions to near zero. But global emission rates have not even started to decline, and RCP 2.6, the IPCC scenario that is associated with a 50-90% chance of staying below the 2°C threshold within the 21st century, assumes large-scale deployment of negative emissions technologies in addition to rapid investment in mitigation and widespread use of bioenergy. Indeed, to stay within this temperature threshold, the IPCC estimates that the maximum amount of carbon added to the atmosphere through anthropogenic emissions cannot exceed about 1,000 gigatons – 510 of which were already emitted by 2011, with currently about 10 more gigatons being added each year.

Are climate engineering approaches fatally prone to error and misuse, and worth excluding from the climate conversation on both practical and moral grounds? Are they an emergency measure that could have far-reaching and unpredictable consequences if deployed? Could they be a relatively straightforward remedy for some of the consequences of climate change? And how should research aimed at these questions be regulated?

These questions, and many others raised by the prospect of climate engineering, involve diverse ethical, social, political and technical issues that are extraordinarily complex and incredibly interlinked. However, the research, policy, and civic communities have had few opportunities to collectively engage with the subject across a wide range of viewpoints. During 18-21 August 2014, we held a large conference in Berlin, Germany entitled "Climate Engineering Conference 2014: Critical Global Discussions (CEC14)" (**ce-conference.org**). The aim of the conference was to provide a forum for vigorous exchange and creative dialogue, to bring new voices into these critical global discussions, and to examine how climate engineering intersects with other topics both within and outside of the climate change discussion.

The conference was held five years after the U.K. Royal Society's 2009 assessment of the science, governance, and uncertainty of climate engineering broadened the conver-

Mark Lawrence of IASS in Potsdam, Germany addresses the participants of CEC14.

sation. The 2010 Asilomar International Conference on Climate Intervention Technologies represented the first attempt by the academic community to generate research guidelines, but new governance proposals and initiatives have since proliferated. International governance for climate engineering is advancing rapidly in the case of marine activities; however, there have not been significant advances in international governance regarding atmospheric activities beyond what is accepted as customary international law. National and multinational projects include the German Research Foundation (DFG) Priority Programme on climate engineering, the EU-funded "European Transdisciplinary Assessment of Climate Engineering" (EuTRACE), the Oxford-based Climate Geoengineering Governance Project (CGG), the Geoengineering Model Intercomparison Project (GeoMIP), and others. Privately funded research projects with varying degrees of rigor, transparency and legitimacy are also being conducted, although a public registry of them does not yet exist.

The conference comes at an important moment in the governance of climate engineering and climate change in general:

- The Fifth IPCC Assessment Report, published in stages across 2013 and 2014, addresses climate engineering, likely leading to a significant increase in both scientific discussion and popular media coverage of the subject.
- The climate negotiations for a post-Kyoto regime ought to be finalized in 2015. The role of climate engineering in this process is undefined, yet particularly negative emission technologies may become relevant to achieve the agreed-upon political targets.
- Many ongoing projects have concluded or reached milestones shortly before the 2014 conference, including CGG, EuTRACE, the first phase of GeoMIP, the first year of the DFG Priority Programme, and the second year of the SCRiM (Sustainable Climate Risk Management) assessment of how best to balance mitigation, adaptation, and geoengineering strategies.
- Multiple studies by various governmental agencies, such as the US Government Accountability Office, the German Federal Environmental Agency and Federal Ministry of Education and Research, or various Parliamentary committees for technology assessment, have been drafted or prepared, and the agencies involved are planning their next steps.

The conference provided a thorough and timely update on these (and other) developments in the field. The large-conference format represented this rapidly expanding and evolving community in its diversity and complexity of backgrounds and opinions. CEC14 also served as an opportunity for a diverse audience of policy-makers, civil society organizations, and members of the public to critically engage with and expand upon current research that they would otherwise have little access to.

Before the conference, we outlined a series of overarching objectives of CEC14, which we feel were met with resounding success:

- to address comprehensively and in a balanced manner the technical, geophysical/geochemical, ethical, and social contexts in which the idea of engineering the climate is being contemplated;
- to bring together the diverse stakeholders involved in the debate — including academic researchers and representatives from the policy and civil society communities and from geographically and culturally diverse backgrounds — in order to promote transparency and dialogue;
- to provide a forum to (1) review the current state of the debate, (2) present and discuss recent research results, and (3) scope key research questions and challenges for academia and society, covering both solar radiation management (SRM) and carbon dioxide removal (CDR) technologies;
- to provide a forum for innovative session formats aimed at addressing the interdisciplinary and transdisciplinary complexity of the issue;
- to provide a platform for exchange, networking, and collaboration across disciplines, sectors (particularly academia, policy and civil society), geographical regions, cultures, and generations; and
- to explore the value of a large-scale conference held on a semi-regular basis as an appropriate forum for the emerging field of climate engineering.

The topic of climate engineering is likely to continue being studied, expanded, and debated over the coming years. Although this conference is by no means the sole effort in conducting a thorough assessment of any particular technology or idea, CEC14 has provided crucial momentum in advancing responsible investigation of climate engineering.

– Stefan Schäfer, IASS, Potsdam, Germany, stefan.schaefer@iass-potsdam.de

– Ben Kravitz. PNNL, Richmond, Washington, USA, ben.kravitz@pnnl.gov

Atmospheric Composition Change: Drivers, Feedbacks and Impacts in Air Quality and Climate

ACCENT-Plus Summer School
22-29 June 2014 • Urbino (Italy)

ACCENT *Plus*
ATMOSPHERIC COMPOSITION CHANGE
THE EUROPEAN NETWORK

Participants in the ACCENT Plus Summer School in Urbino, Italy.

ACCENT-Plus is an EU-FP7 coordination action aimed at maintaining the coordination and integration of the European science community in the field of atmospheric composition change, strengthening the outreach from the science domain into the policy arena and, where possible, to wider global decision making activities. ACCENT-Plus also aims at preserving and enhancing the excellence of European global change and air quality research within the European Research Area. In this context, ACCENT-Plus organised a Summer School, held in Urbino (Italy) from June 22-29, 2014. The main aim of the Summer School was to educate and provide the participants with the necessary background scientific knowledge to understand the current issues related to the drivers, impacts and feedback between atmospheric chemistry and climate change, as part of research projects as well as in the formulation of environmental policies.

The School comprised lectures on fundamentals of atmospheric chemistry and biogeochemistry as well on the impact of atmospheric composition change on air quality, human health, ecosystems, agriculture and their feedback with climate. Lectures on scientific diagnostic tools and atmospheric models used to test our understanding of the evolution of the atmospheric composition and its impact on climate were included.

In addition, studies of policy documents and lectures on how to improve communication skills were organised. The students also had the opportunity to perform practical work, e.g. analysing atmospheric data collected during the school, using emission databases, analysing time series of surface as well as satellite data, but also writing a press release or giving an interview.

The teachers included scientists from the ACCENT-Plus network but also specialists in specific fields, i.e. epidemiology, communication and integrated assessments. The videos of the lessons held during the school are available on the ACCENT-Plus web portal **accent-network.org**.

Sixty PhD students or early stage researchers from all over the word attended the school. Most of them were from Europe but all the continents were represented with students coming from North and South America, Africa, Australia and Asia.

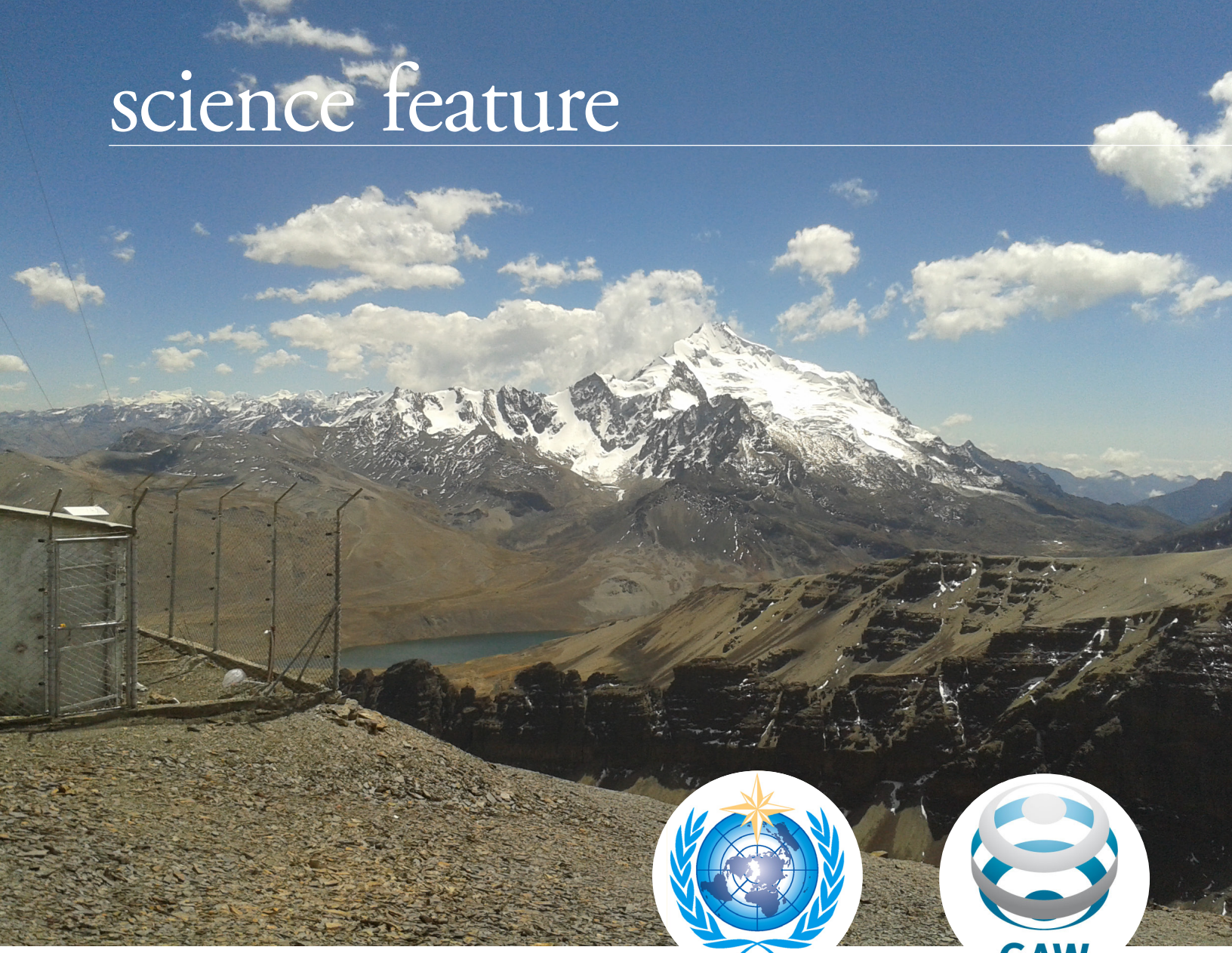
Besides presenting posters to illustrate their own research, the students were involved in the dramatization of a debate between scientists supporting the idea of climate change and sceptics, and also in using different communication tools to present what they have learned during the school.

A questionnaire distributed after the school has registered a high level of appreciation from all the students involved.

We would like to acknowledge the support of the WMO-GAW, the University of Urbino, the Italian National Research Council, the European projects ACCENT-Plus, PEGASOS and MACC-II, and IGAC. Finally, we would like to thank all the students and the teachers who contributed to make this school such a stimulating and successful event.

- Michela Maione, University of Urbino, Italy, michela.maione@uniurb.it

- Claire Granier, LATMOS/IPSL, Paris France and CIRES/NOAA, Boulder, USA, claire.granier@noaa.gov



Chacaltaya GAW station's cabin for measuring soluble ions at 5,400m

Global Atmosphere Watch (GAW) Programme:
25 years of global coordinated atmospheric composition observations and analyses

The Global Atmosphere Watch (GAW) Programme of the World Meteorological Organization (WMO) is the long-term international global programme that provides the technical basis for the assessment of atmospheric chemical composition through quality assured observations and derived data products. GAW Programme celebrated its 25th Anniversary at the 13th Quadrennial iCACGP Symposium/13th IGAC Science Conference to further foster collaboration with the scientific community as we collectively work to advance research and transition this knowledge to practice.

1. Background

Coordinated atmospheric composition observations started in the 1950s, when the WMO launched a programme on atmospheric chemistry and the meteorological aspects of air pollution. This transformed early sporadic measurements into regular observations. The new programme soon realized that adequate gathering of data on atmospheric composition and

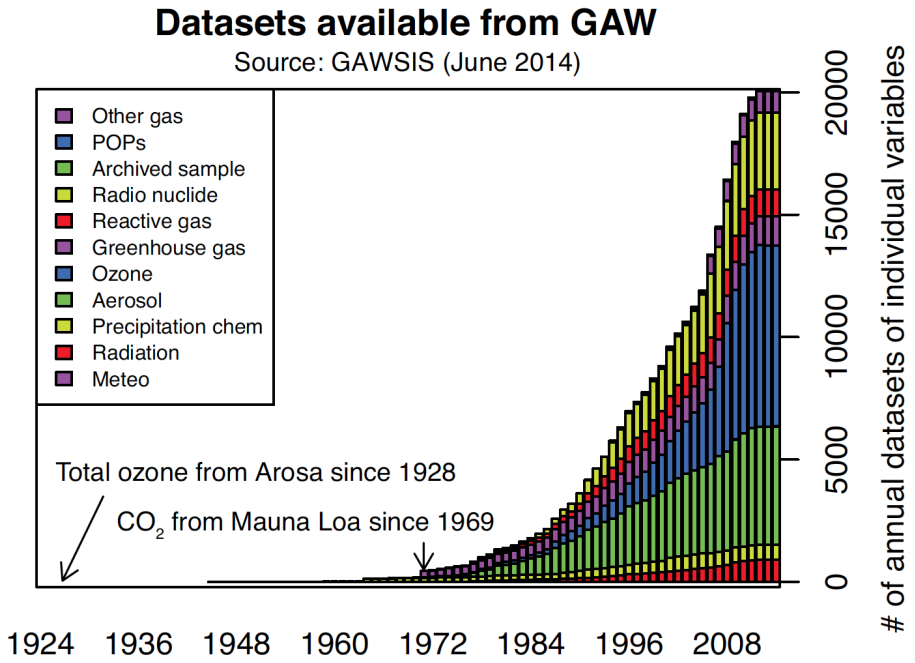


Figure 1. Statistics of the data sets available from GAW, contributing networks and predecessor programmes in WDCs

analysis of anthropogenic impact on a global scale requires all measurements be expressed in the same units and on the same scale, such that measurements performed by different countries are comparable. Consistent implementation of this principle led to establishment of the WMO/GAW in 1989.

2. GAW Organizational Structure

The GAW Programme addresses six classes of variables: ozone, ultraviolet (UV) radiation, greenhouse gases, aerosols, selected reactive gases and precipitation chemistry. The programme includes observational network, set of Central Facilities supporting quality assurance system, advisory groups, expert teams and steering committee. GAW activities are undertaken by WMO Members with a substantial contribution by National Meteorological and Hydrological Services (NMHSs). Many research institutes and universities contribute to and support the GAW Programme with measurements and data analyses.

3. Observations in GAW

The surface-based observational network includes distributed worldwide GAW Global (30 stations) and Regional (about 400 stations) stations. These stations are complemented by various contributing networks. All observations are linked to common reference standards and the observational data are made available at six designated World Data Centres (**wmo.int/pages/prog/arep/gaw/world_data_ctres.html**). Within its existence GAW accumulated substantial volume of data related to atmospheric composition (Fig. 1). Information about GAW stations and contributing networks is summarized in the GAW Station Information System (GAWSIS, **gaw.empa.ch/gawsis/**). Surface-based observations are increasingly complemented by airborne and space-based observations, that help to characterize the upper troposphere and lower stratosphere, in particular with regards to ozone, solar radiation, aerosols, and certain trace gases.

4. Achievements within focal areas

4.1 Ozone

Measurements of total ozone are performed by Dobson and Brewer spectrophotometers, while the vertical distribution of ozone is measured either in-situ with ozonesondes carried by small balloons, or remotely from the ground by lidars, microwave radiometers and Umkehr inversions of data measured by ozone spectrophotometers (Dobsons and Brewers). GAW coordinated observations of total ozone have been supporting the Scientific Assessment of Ozone Depletion, prepared jointly by WMO and the United Nations Environment Programme (UNEP). Ground based ozone observations are important for the validation of satellite derived ozone data and for ensuring the continuity among different satellite missions. Near real-time observations from Antarctic stations are used for preparation of the Antarctic ozone Bulletins (**wmo.int/pages/prog/arep/gaw/ozone/index.html**).

4.2 Greenhouse gases

Observations of the long-lived greenhouse gases (LLGHG) within GAW include both flask sampling and continuous measurements. This network of fixed stations is supported by aircraft measurements and measurements of total column of

a number of LLGHG. These observations are used to estimate a radiative forcing on the atmosphere. The NOAA`s Annual Greenhouse Gas Index shows that from 1990 to 2013 radiative forcing by LLGHG increased by 34%, with CO_2 accounting for about 80% of this increase. Annual levels of the global averaged mole fractions of LLGHG and the rate of their change are reported in the WMO Greenhouse Gas Bulletins (**wmo.int/pages/prog/arep/gaw/ghg/GHGbulletin.html**).

Ushuaia GAW Global Station in Argentina, 20 years in operation.

Measurements of GHGs by GAW members were used in a mass-balance analysis to provide an important constraint on global emissions, e.g. in Levin et al. (2010). The observed spatial patterns in LLGHGs can be combined with a chemical transport model (CTM) to estimate emissions at continental to country scales as was shown by Thompson et al. (2014) for the N_2O global flux distribution.

4.3 Reactive gases

The global surface ozone and CO observations are carried out at more than 150 stations worldwide. Observations allowed for detections of a slight negative global CO trend related to the reduction of anthropogenic emissions. More recent additions to the GAW Programme are nitrogen oxides (NO and NO_2), sulfur dioxide (SO_2) and a number of key Volatile Organic Compounds (VOCs), enabled by developments in measurement technology that now allow for reliable detection of these gases at trace levels.

GAW reactive gases data have been used in a large number of scientific studies including review articles (Cooper et al., 2014), trend analysis (Gilge et al., 2010; Parrish et al, 2012; Logan et al., 2012), process studies (Mannschreck et al., 2004) and the evaluation of chemistry climate models (Parrish et al., 2014). Data from several GAW stations are used in delayed mode for verifications of the European Monitoring Atmospheric Composition and Climate (MACC) project forecasting system (**gmes-atmosphere.eu/d/services/gac/verif/grg/gaw/gaw_station_ts/**).

4.4 Atmospheric wet deposition

An important step in building up precipitation chemistry focal area was development of a Manual for the GAW Precipitation Chemistry Programme (WMO/GAW, 2004). This document led to harmonization of observations by national and regional programmes and to improvement of the quality of global data. A collective effort of GAW community allowed for the production of A Global Assessment of Precipitation Chemistry and Deposition of Sulfur, Nitrogen, Sea Salt, Base Cations, Organic Acids, Acidity and pH, and Phosphorus (Vet et al., 2014, Fig.6). A major product of the assessment was a database of quality-assured ion concentration and wet deposition data gathered from regional and national monitoring networks and made available in the World Data Centre for Precipitation Chemistry (**wdcpc.org/**).

4.5 UV Radiation

The radiation component of GAW has concentrated its efforts on UV radiation. As a consequence of this interest in UV measurements, many instruments have been developed throughout the years. Within GAW the Measurement Guidelines for different groups of instruments were developed. A number of regional and global calibration facilities support quality assurance of the global UV radiation observations. GAW collaborates with other programs and agencies,

Pyramid GAW Station/Nepal Climate Observatory, 5079m.

in order to produce documents related to public health and awareness. An important achievement for public information has been the development of the UV Index (**exp-studies.tor.ec.gc.ca/cgi-bin/clf2/uv_index_calculator?lang=e&printerversion=false&printfullpage=false&accessible=off**) jointly with World Health Organization (WHO), UNEP and International Commission on Non-Ionizing Radiation Protection (ICNIRP).

4.6 Aerosols

WMO/GAW, through its network of 109 own and contributing stations provides exceptional records to determine the spatio-temporal distribution of aerosol particle properties related to climate forcing and air quality on multi-decadal time scales and on regional, hemispheric and global spatial scales. Through scientific and technological recommendations to station operators (GAW report 153, Petzold et al., 2013), GAW managed to address changes in observing practices, evolution of technologies but also the evolving demand for additional monitored variables from the scientific community (Laj et al., 2010). A direct result of these efforts is the capability to derive long-term trends for non-CO_2 climate forcers on the global scale (Asmi et al., 2013; Collaud Coen et al., 2013).

The GAW Aerosol Lidar Observation Network (GALION) provides the vertical component of aerosol distributions through advanced laser remote-sensing in a network of globally distributed ground-based stations. Lidar stations are used to study the vertical profiles of aerosol properties and play important role in detecting volcanic ash layers (Pappalardo et al., 2013).

4.7 GURME

The GAW Urban Research Meteorology and Environment (GURME) project is a component of GAW which focuses on developing improved meteorological and environmental urban services. GURME promotes pilot projects including Latin American Cities Project, India Commonwealth Games project, Shanghai Expo project. One of the major achievements was development of the System of Air Quality forecasting and Research (SAFAR) by the Indian Institute of Tropical Meteorology (IITM), Pune and of a new air quality and related services component of the Expo Multi-hazard Early Warning System for the Shanghai Expo in 2010. Near Real-Time (NRT) Data Application to Air Quality Forecasts is the newest pilot project under the leadership the Chinese Academy of Meteorological Sciences. The pilot projects illustrated some of the ways that research is being translated into enhanced weather and air quality services, in particularly through addressing the complex interaction of aerosol with weather and climate system.

6. The Future of GAW

While much has been accomplished over the past 25 years, GAW will continue to evolve in response to societal needs for meteorological and environmental services to reduce risks from high impact weather and air pollution, and to mitigate the impacts of, and adapt to, changing climate. These services will move towards user-driven products that require integrated observing and prediction systems.

The future will rely on the GAW measurement networks, which remain the backbone of the program and provide long-term "climate-quality" data on trends and the spatial distributions of a variety of important chemical and climate parameters. In order to ensure the availability of reliable information when needed, it will be of paramount importance to

maintain a healthy and robust global measurement network and to further expand the network in areas that are still undersampled. The comprehensive/global atmospheric chemical information provided by GAW will continue to be used in a wide variety of applications, e.g to estimate changes in radiative forcing, to constrain budgets of emissions and losses at global to regional spatial scales, and to verify bottom-up emission inventories and process models.

GAW data will be used increasingly to support advanced numerical weather prediction and climate models and for further development of warning networks for long-range tracking of intense, episodic events such as volcanoes, sand/dust storms, wildfires and nuclear accidents. GAW surface-based observations will continue to be useful in the validation of retrievals of distributions from satellite radiance measurements. This use will become ever more important as the space-based observing system evolves and the assimilation of satellite retrievals of aerosols and trace gases in weather forecast systems and climate models grows.

GAW products and services will further expand in support of the needs of megacities and large urban complexes. These will require enhanced efforts to evolve GAW networks to smaller scales, and to extend collaborations across a spectrum of organizations and authorities such as local government, public health, city planners and environmental agencies.

The GAW Programme is at the dawn of a new and exciting phase of its evolution. There is much to look forward to, building on the significant achievement over the 25 years since its establishment.

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young scientist spotlight

Roelof P. Burger

Best Young Scientist Oral Presentation

Presentation Title: **In-situ characterization of air quality over South Africa**

Session 4: **Atmospheric chemistry and urbanization: from local to the global scales**

Roelof P. Burger is currently a lecturer in the unit for Environmental Sciences and Management, Faculty of Science at North-West University, Potchefstroom, South Africa and a PhD graduate student at the University of Witwatersrand, South Africa. His research interest is the feedbacks between climate and atmospheric chemistry and control of regional pollution. Roelof received his undergraduate degree from the University of Pretoria, South Africa.

What and/or who motivated you to pursue a career in science and more specifically in atmospheric chemistry?

I got an opportunity to be part of a field campaign and had so much fun doing practical science that I never considered anything else. I enjoy traveling the world, playing with expensive equipment, making friends and trying to unravel nature's mysteries. It is the best job in the world!

How do you want your career to progress and where do you think you can ultimately have the greatest impact?

I'd like to finish my Ph.D. soon and then continue to do research that has an impact on people's lives. Working in a developing country with lots of problems is the ideal setting to do applied research.

What advice can you offer to those just starting a masters or PhD program in atmospheric chemistry?

You have to make sure you have a supervisor that is passionate about his/her work and about his/her students. It's contagious.

What was the highlight of the 2014 iCACGP Symposium/IGAC Science Conference for you?

The highlight of the conference for me was meeting many interesting people and listening to great talks. It was also nice to get to know so many young scientists and share ideas. I hope we'll see more of each other in the future. Remember, you are all welcome to come and visit us in South Africa.

Extended Abstract

Natural and anthropogenic sources of air pollution in South Africa have a significant global footprint. A frequently visible 'river of smoke' forms out of the complex interplay between persistent industrial and metropolitan sources and spatio-temporally variable sources, like biomass and domestic burning. South Africa's coal-based economy easily reaches the list of top 20 carbon emitting countries. The South African Highveld is home to a high number of tall stack industries, including 14 coal-fired power stations with a total installed capacity just over 38GW. These result in a well-known pollution hotspot visible from satellite platforms. This area also features prominently in air quality burden of disease studies (Lelieveld et al, 2013; Silva et al., 2013).

A series of intensive field campaigns between 1999 and 2007, which included SAFARI2000 (Swap et al., 2002), collected hundreds of hours of in-situ data characterizing major pollution sources in the region. Electricity generation, other industrial activities and motor vehicles contribute the majority of NOx, SO_2, CO_2, CO and particulate matter (PM) emissions. Biomass burning contributes significantly to CO, PM and CH_4, but is limited in space and time.

Residential solid fuel burning is common in rural and low-income settlements in sub-Saharan Africa. These areas have by far the highest ambient particulate concentrations. They are, however, not captured directly by remote sensing platforms because of the strong diurnal emissions pattern and low level of release (Hersey et al., 2014). Compared to other important sources of air pollution, the uncertainties in fuel types, load, emission factors and spatio-temporal distributions are not well understood. Measurements during the 2013 winter months in a small, low-income settlement relatively far away from other

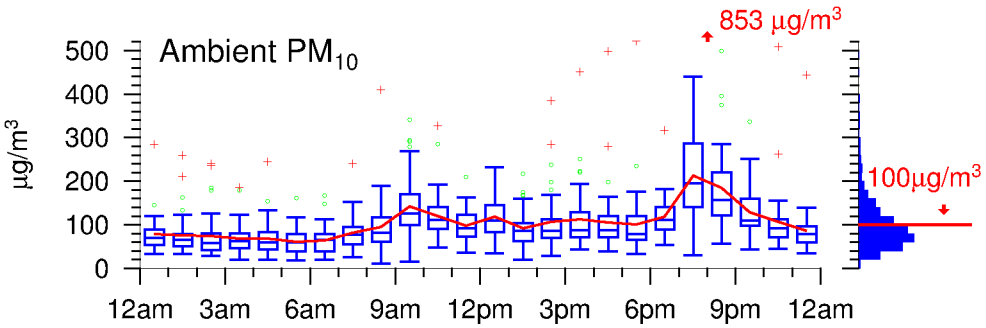

Figure 1. The diurnal distribution of hourly averaged ambient PM10 measured in a relatively isolated, small, low-income settlement on the South African Highveld. The red line shows the average values. The maximum hourly average measurement was 853 µg/m³ and the average 100 µg/m³.

major particulate air pollution sources show the impact of residential solid fuel burning on ambient particulate matter load (Figure 1). According to the national census, only 285 of the total 984 households in this settlement use solid fuels primarily for cooking and heating. A detailed fuel survey in the settlement suggests that the number of households using solid fuels is likely around 665 (582 – 739).

This study underscores the importance of residential solid fuel burning in national and global air quality related health and co-benefit of greenhouse gas reduction assessments. The dynamics of poverty, fuel use and emission control strategies need to be explored in more detail and customized solutions found especially in developing economies.

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A woman cooking in a small, low-income settlement in South Africa.

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young scientist spotlight

Mingxi Yang

Best Young Scientist Poster Presentation

Session 1: **Atmosphere-surface (ocean/vegetation/ice) interactions in a changing climate**

Poster Title: **Direct Measurements of Air-Sea Volatile Organic Carbon Transport**

Mingxi Yang is currently a postdoc research fellow at the Plymouth Marine Laboratory in the UK. He received his undergraduate degree from Boston University, US and went to graduate school at the University of Hawaii, USA. Mingxi's research interest is air-sea exchange trace gas cycling in the lower atmosphere and surface ocean.

What and/or who motivated you to pursue a career in science and more specifically in atmospheric chemistry?

My undergraduate degree was in analytical chemistry. While I enjoyed my laboratory research in university, I sometimes questioned the societal application and relevance of my work. After my third year in university, I rather accidentally applied to and was accepted into the Woods Hole Oceanographic Institution (WHOI)'s summer research program. All the different areas of ocean research there were eye-openers to me, and motivated me to pursue further in environmental science. The fact I work partly on atmospheric chemistry is a result of being a Ph.D. student of Prof. Barry Huebert at the University of Hawaii.

How do you want your career to progress and where do you think you can ultimately have the greatest impact?

I haven't considered career progression very much. Just being able to do the research I like generally keeps me quite happy. I would like to keep doing societally relevant science. I sometimes think doing fairly basic sci-

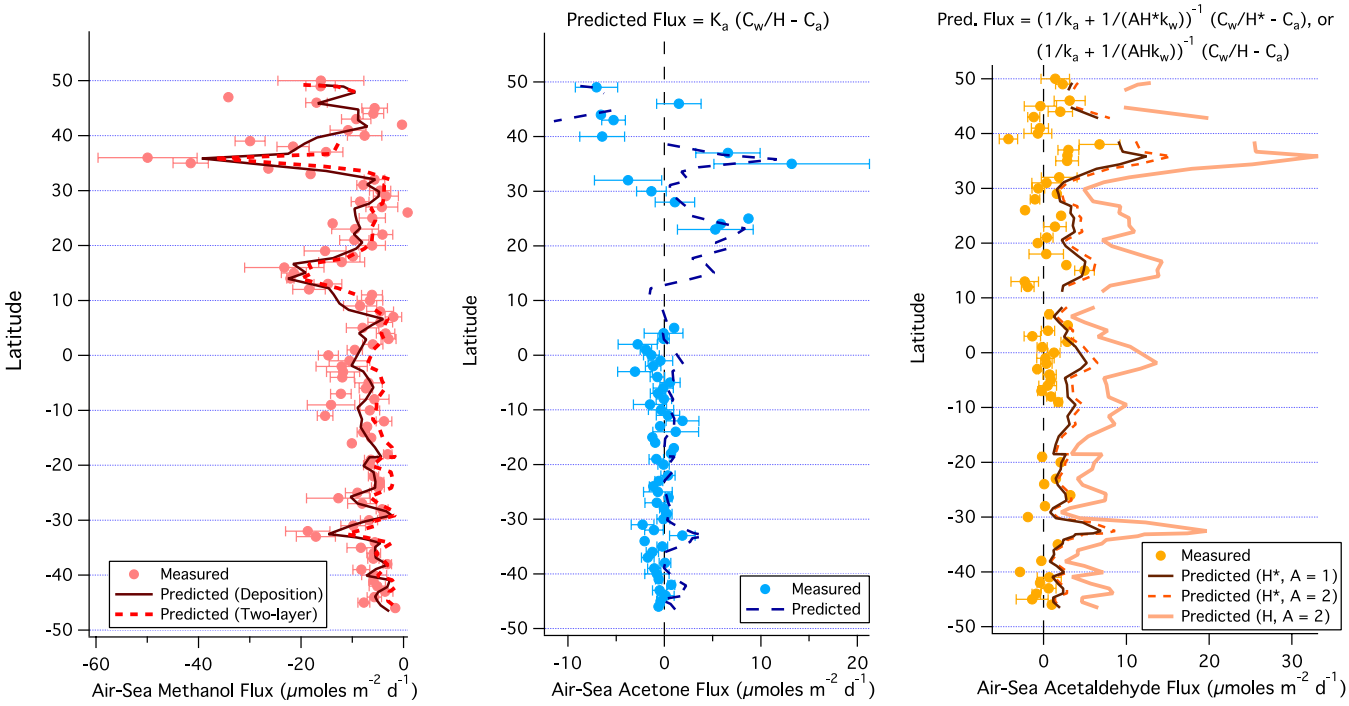

Figure 1. Air-sea transport of methanol (left), acetone (middle), and acetaldehyde (right) during the 2012 Atlantic Meridional Transect cruise. Negative sign indicates oceanic uptake. Flux was measured by the eddy covariance technique and also predicted based on air/sea concentrations and gas exchange parameterizations. See Yang et al PNAS 110, 50, 20034-20039, 2013 and Yang et al ACP 14, 7499-7517, 2014 for details.

ence in developing countries can have as much impact as doing very cutting-edge science in western countries, if not more.

What advice can you offer to those just starting a masters or Ph.D. program in atmospheric chemistry?

Enjoy what you do. For me, the day when I wake up not feeling excited about my science, it is probably time to switch to doing something else.

What was the highlight of the 2014 iCACGP Symposium/IGAC Science Conference for you?

The integration of atmospheric chemistry (processes, long term observations, and global modeling), medical and health effects (e.g. of PM2.5), societal impact (e.g. premature mortalities and costs for regulations), etc. That air pollution is an important global issue cannot be presently more clearly.

Extended Abstract

Oxygenated Volatile Organic Compounds (OVOCs) in the atmosphere affect the tropospheric oxidative capacity due to their high abundance and reactivity towards the hydroxyal radical. While many studies have focused on terrestrial emissions of OVOCs (e.g. from plants), the atmosphere-ocean transport of OVOCs has received much less attention and represents a significant uncertainty in the global budgets of these compounds. Here we present air-sea flux measurements of three of the most abundant OVOCs (methanol, acetone, and acetaldehyde) by the eddy covariance technique from two recent research cruises in the Atlantic: the Atlantic Meridional Transect cruise from the United Kingdom to Chile in Oct/Nov 2012, and the HiWinGs cruise from Greenland to the United States in Oct/Nov 2013.

Atmospheric OVOC mixing ratios were quantified by a high-resolution proton-reaction-transfer mass spectrometer (PTR-MS) at a frequency of >2 Hz. Isotopically labeled standards were continuously injected into the sample air stream as internal standards, which helped to account for variable instrumental efficiency and drift. In the eddy covariance technique,

the air-sea OVOC fluxes were derived by correlating rapid fluctuations in air concentrations with concurrent fluctuations in the vertical wind velocity, which was corrected for ship's motion. Dissolved concentrations of OVOCs near the sea surface (5-m depth) were measured twice-a-day using the same PTR-MS coupled to a silicone membrane equilibrator. This enabled a direct comparison between fluxes measured by eddy covariance and predicted using the two-layer gas exchange model.

For both cruises, methanol flux was consistently from the atmosphere to the ocean due to the low surface ocean saturation, with the largest influx occurring in continental outflow regions in the N. Hemisphere. Acetone varied from undersaturation (influx) in higher latitudes to supersaturation (efflux) in the subtropics of the N. Atlantic. In the S. Atlantic, the surface ocean was near equilibrium with atmospheric acetone and the air-sea acetone flux was close to zero. Air/sea concentration measurements indicated significant supersaturation of acetaldehyde through out the Atlantic but the covariance flux was near zero, probably in part because the small flux magnitude was near the system's detection limit. These results were the first in situ verifications of air-sea OVOC transport, and should help to constrain the oceanic impact on the global atmospheric budgets of these compounds.

Directly measuring the atmosphere-ocean transport of OVOCs also provides insight into the physiochemical processes involved in air-sea gas exchange. According to laboratory and theoretical studies, the exchange of OVOCs should be significantly controlled by airside resistance due to the high solubility of these compounds. Our measurements from the two cruises confirm the expected solubility and wind speed dependence in the air-sea transfer of methanol and acetone. The total methanol transfer velocity (in air concentration units) is higher than that of acetone due to its greater solubility in water and diffusivity in air. For both methanol and acetone, transfer velocity scales approximately linearly with wind speed from 1-20 m/s. Lastly, our measurements suggest that chemical enhancement in air-sea acetaldehyde transport (due to aqueous hydration) is likely much smaller than previously estimated.

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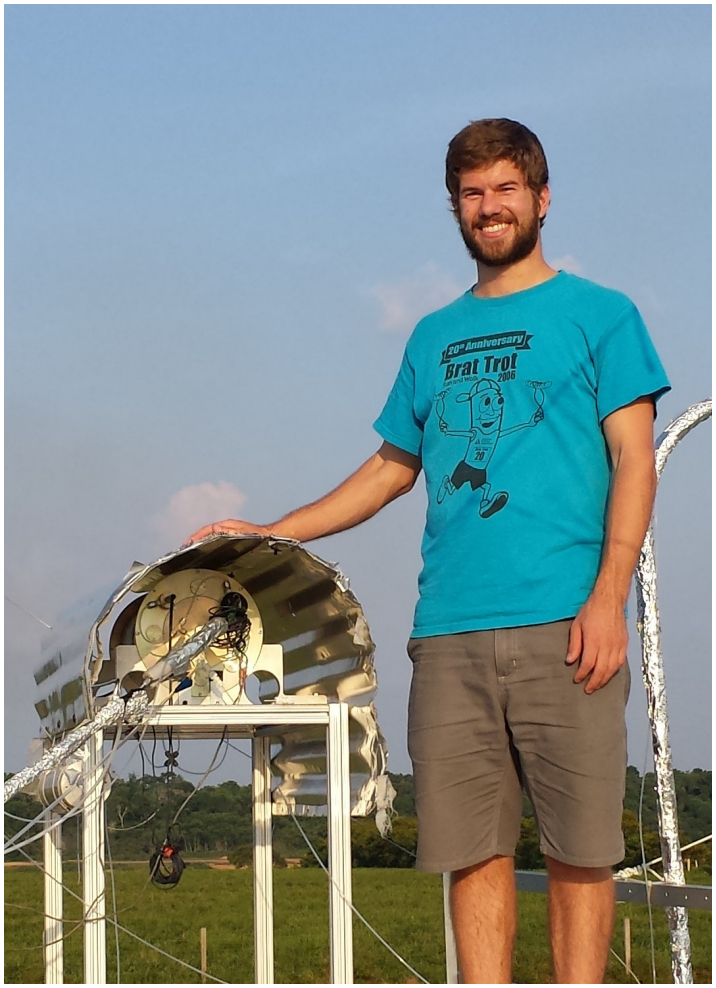
The 14th biennial IGAC Science Conference will be held 26-30 September 2016 in Breckenridge, CO, USA. The Local Organizing Committee is chaired by Christine Wiedinmyer (NCAR, Boulder, CO, USA). The Scientific Programme Committee is co-chaired by IGAC SSC members Claire Grainer (LATMOS, Paris, France and NOAA CSD/CU CIRES, Boulder, CO) and Hiroshi Tanimoto (NEIS, Japan). Please stay tuned for more details at **igac2016.org**!

young scientist spotlight



Brett B. Palm

Best Young Scientist Poster Presentations

Session 2: **Atmospheric chemistry and the coupling between biogenic and anthropogenic emissions**

Poster Title: **Measurements of in-situ SOA Formation and Chemistry Using an Oxidation Flow Reactor at GoAmazon2014 and Other Campaigns**

Brett B. Palm is currently a graduate student at the University of Colorado, USA in the Department of Chemistry and Biochemistry and in the Center for Environmental Sciences Research (CIRES). Brett is from Sheboygan, Wisconsin, US and did his undergraduate degree at Dartmouth College in New Hampshire, USA. His research interest is secondary organic aerosol formation.

What and/or who motivated you to pursue a career in science and more specifically in atmospheric chemistry?

My first exposure to atmospheric chemistry was for a group project in my Environmental Chemistry class as an undergraduate at Dartmouth College. For our semester-long assignment, my group used a UV-Vis spectroscopic method of indirectly measuring tropospheric ozone concentrations. That was the first time I looked up and realized that my reagents could be in the sky instead of in the stock room.

How do you want your career to progress and where do you think you can ultimately have the greatest impact?

I really enjoy the challenges of taking field measurements, so I hope to stay on that path. Ultimately, I think I can have the greatest impact by 1) continuing to stretch the boundaries of our knowledge of atmospheric chemistry through innovative experiments in the lab and field, and/or 2) teach atmospheric chemistry at a school where no atmospheric chemistry had been previously taught, helping to expose more young students to the field. All undergraduate chemistry students learn organic chemistry, for example, but it is rare for them to learn about the atmosphere in much detail.

What advice can you offer to those just starting a masters or PhD program in atmospheric chemistry?

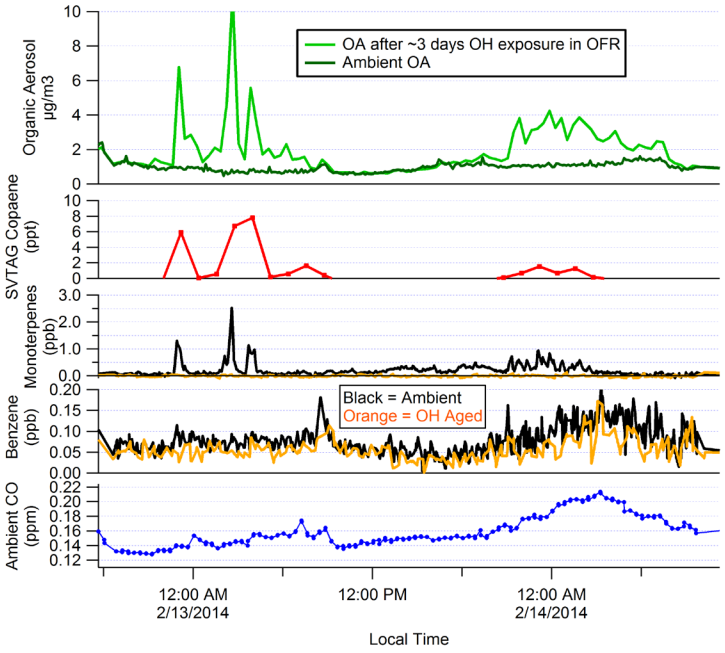
Attention to detail is the key to success, especially when taking field measurements.

What was the highlight of the 2014 iCACGP/IGAC Symposium/Science Conference for you?

Other than having Wednesday afternoon off to go to the beach?! The close interaction between young scientists and established senior scientists was unlike any conference I've been to, especially during the breakout sessions planned for the Young Scientist Program.

Extended Abstract

During several recent field campaigns including GoAmazon2014, ambient gases and particles were exposed to controlled concentrations of OH, O_3 or NO_3 in-situ using a Potential Aerosol Mass oxidation flow reactor. Oxidant exposure in the reactor ranged from an hour to several weeks of equivalent atmospheric residence time, allowing the study of SOA formation and chemistry over long time scales. Oxidized air from the reactor was sampled directly (e.g., HR-AMS, ACSM, PTR-TOFMS, SMPS, CCN), and these results were compared with collocated biogenic and anthropogenic tracers (e.g., SV-TAG sesquiterpenes and PTR-TOFMS aromatics, isoprene, and monoterpenes). In all studies, OH oxidation of ambient air in the reactor led to substantial SOA mass production (often several μg/m^3 of SOA) during times of high precursor gas concentrations, as demonstrated in the accompanying figure from GoAmazon2014. SOA production was larger at night than during the day, likely due to changes in the precursor gas concentrations. While SOA production correlated with measured gas-phase precursors, the total mass formed in the reactor was generally several times larger than could be explained by the aerosol yields of measured VOCs. This suggests that a majority of gases that formed SOA in the reactor were not the measured primary VOCs considered as traditional SOA precursors. The unidentified sources of SOA in the reactor may include partially oxidized products of traditional primary VOCs, other unidentified VOCs, or unmeasured lower-volatility organic gases. Most of the SOA mass formation occurred in the first 1-3 days of equivalent atmospheric aging, suggesting that ambient SOA is predominantly formed close to emission sources of precursors with gas-phase reaction lifetimes of <1-3 day. At a remote Colorado pine forest site (during BEACHON-RoMBAS), the mainly biogenic aerosol formed in the reactor from <1 equivalent day of oxidation had an atomic O:C of 0.54, similar to the existing ambient aerosol O:C of 0.61. As OH exposures increased (up to 10-20 equivalent days), the OA became highly oxidized (O:C>1) and partially revolatilized, demonstrating the competing effects of functionalization/condensation pathways at low exposures vs. fragmentation/evaporation pathways for high exposures. SOA formation from O_3 and NO_3 oxidation correlated with biogenic gas-phase precursors, but led to smaller (<0.5 μg/m^3) SOA production, consistent with the ability for OH to achieve more generations of oxidation than O_3 or NO_3 as well as react with partially oxidized biogenic products that lack double bonds. Measurements taken in a variety of biogenic ecosystems with a wide range of anthropogenic influence were compared, allowing investigation of the effects of anthropogenic pollution on SOA formation. To summarize all results for OH oxidation of ambient air in the flow reactor, the precursors found in nighttime air at CalNex (urban) and SOAS (regionally-polluted forest) led to an average production of 4-6 μg/m^3 SOA, while the nighttime precursors at BEACHON-RoMBAS (rural forest) and GoAmazon2014 (wet season, forest with urban transport) produced an average of 1-2 μg/m^3 SOA.



OA formation from OH oxidation of ambient air in an oxidation flow reactor, along with several collocated ambient gas-phase precursor and tracer measurements. SOA formation in the flow reactor closely followed the availability of precursor gases.

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young scientist spotlight

Patricia Ferrini Rodrigues

Best Young Scientist Poster Presentation

Session 3: **Interactions between aerosols, clouds and precipitation**

Poster Title: **Hygroscopic behavior of aerosols over Sao Paulo metropolitan area**

Patricia Ferrini Rodrigues is from São Paulo, Brazil and received her undergraduate degree from the University of São Paulo. She is currently a graduate student at IPEN-University of São Paulo focusing on remote sensing of the atmosphere using LIDAR-atmospheric physics.

What and/or who motivated you to pursue a career in science and more specifically in atmospheric chemistry?

The challenge of developing new knowledge about this important field related to global warming and climate change.

How do you want your career to progress and where do you think you can ultimately have the greatest impact?

I want to work in the interface between scientists and policy makers (at IPCC, ONU).

What advice can you offer to those just starting a masters or PhD program in atmospheric chemistry?

This is the most important field of research nowadays. Do not forget that everything you are studying has a narrow relationship with the society. Work to improve this dialog.

What was the highlight of the 2014 iCACGP/IGAC Symposium/Science Conference for you?

First, the award itself, because it was the only Brazilian work that was awarded and second the opportunity to meet important scientists from everywhere in the world and open new possibilities of interaction.

Extended Abstract

The determination of the water vapor amount in the atmosphere using LIDAR systems is being demonstrated to be very useful, as LIDARs can operate continuously. The Raman LIDAR has the ability of determining the water vapor mixing ratio (WVMR) using the ratio between the signal backscattered by water molecules and nitrogen molecules in the atmosphere and this information can be used to derive the relative humidity (RH) profile using temperature from other collocated instruments or models. In conditions in which a large increase of the RH is verified in a well-mixed atmosphere, the changes in aerosol backscatter are due to the water uptake and the hygroscopic behavior of the aerosol population can be derived. The Raman LIDAR presents many advantages in this study, because the laser can operate in conditions of relative humidity next to saturation and under unperturbed atmosphere conditions.

In São Paulo, the IPEN Lidar Group is running a Raman LIDAR with three channels since January 2012 and with six channels since June 2013, providing information of the water vapor mixing ratio in two different wavelengths: 532nm, (and the corresponding Raman wavelengths 607nm (nitrogen) and 660nm (water); and 355nm (and the corresponding Raman wavelengths 387nm (nitrogen) and 408nm (water). The values obtained are calibrated using independent lamp calibration and radiosoundings.

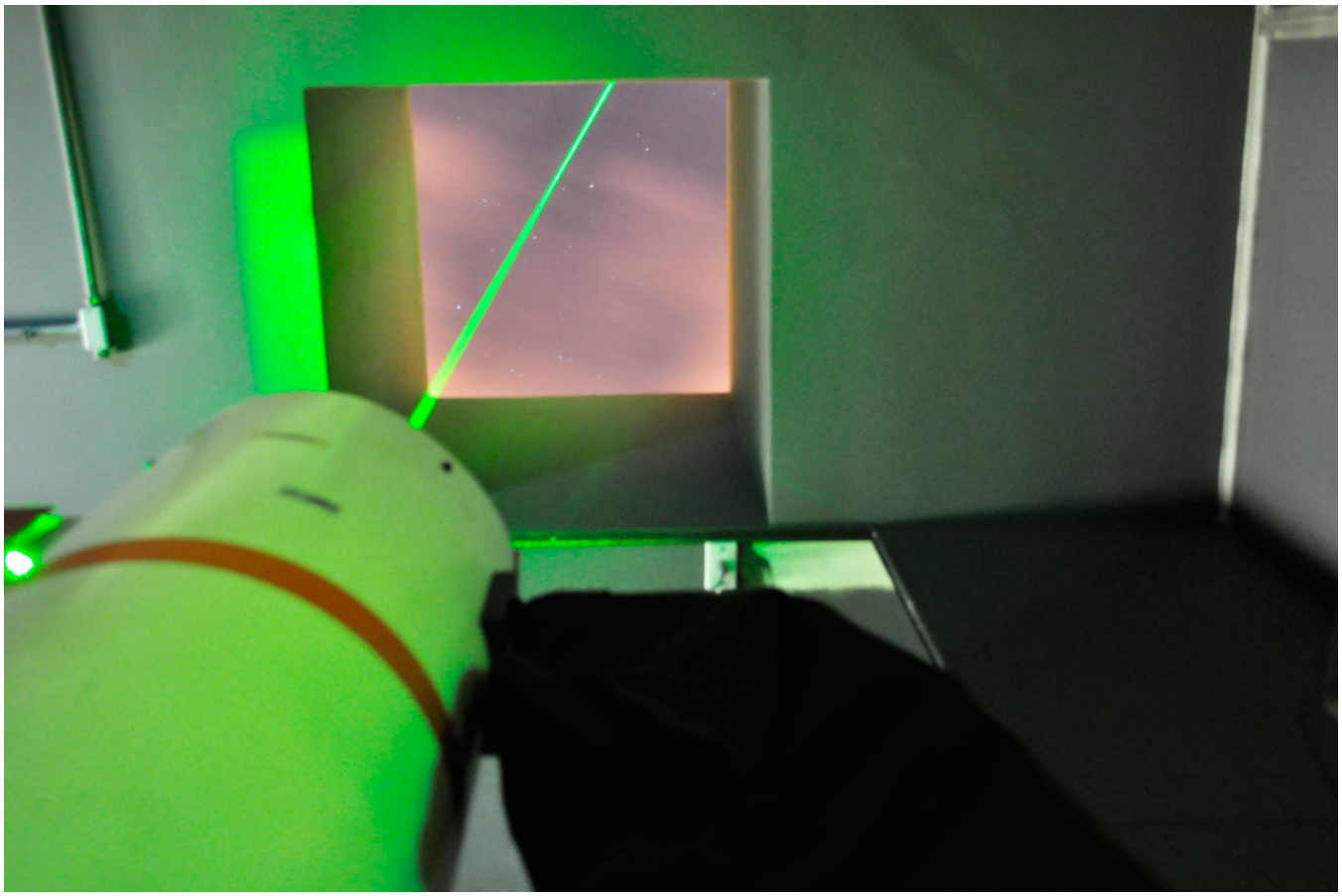

Figure 1. MSP-LIDAR1 operating in 532nm

In this work, we present one day of determination of the hygroscopic growth factor of aerosols over Sao Paulo in September 2012, using a well-known methodology from literature. This methodology includes the determination of a well-mixed atmosphere using the constant water vapor mixing ratio obtained by the LIDAR and by the radiosounding, and increasing levels of relative humidity, so any chance in the backscattering is due to the change in size of the aerosol, not in the aerosol type. The backscattering change is adjusted to a function that calculates the growth of the aerosols at increasing levels of relative humidity, compared to a reference one (hygroscopic growth factor) and then those values are adjusted to an empirical fitting equation. The exponential parameter of this equation is of special interest, because it can give information about the chemical composition of the aerosols.

This methodology has some advantages over the traditional techniques, because it can measure the growth under unperturbed conditions of the atmosphere, but there are advantages, like the difficulty of finding the perfect conditions of the atmosphere.

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young scientist spotlight

Ariela D'Angiola

Best Young Scientist Poster Presentation

Session 4: **Atmospheric chemistry and urbanization: from local to global scales**

Poster Title: **Comparing static and dynamic emission inventories for mobile sources in the Metropolitan Area of Buenos Aires, Argentina**

Ariela D'Angiola recently completed her PhD from San Martin National University in Buenos Aires, Argentina and is now a consultant for UNEP. She received her undergraduate degree from Flores University in Buenos Aires, Argentina. Her research interests are emission inventories, anthropogenic emissions, air pollution and climate change.

What and/or who motivated you to pursue a career in science and more specifically in atmospheric chemistry?

I owe my scientific motivation to Laura Dawidowski, my undergraduate thesis advisor and mentor. She taught and showed me how interesting and challenging it is to do science and participate in an international community pursuing the same goals.

How do you want your career to progress and where do you think you can ultimately have the greatest impact?

I would like to be able to continue in research and to be more involved in the decision-making process at national level or within an international organization.

What advice can you offer to those just starting a masters or PhD program in atmospheric chemistry?

Choose a subject that you love and are passionate about!

What was the highlight of the 2014 iCACGP Symposium/IGAC Science Conference for you?

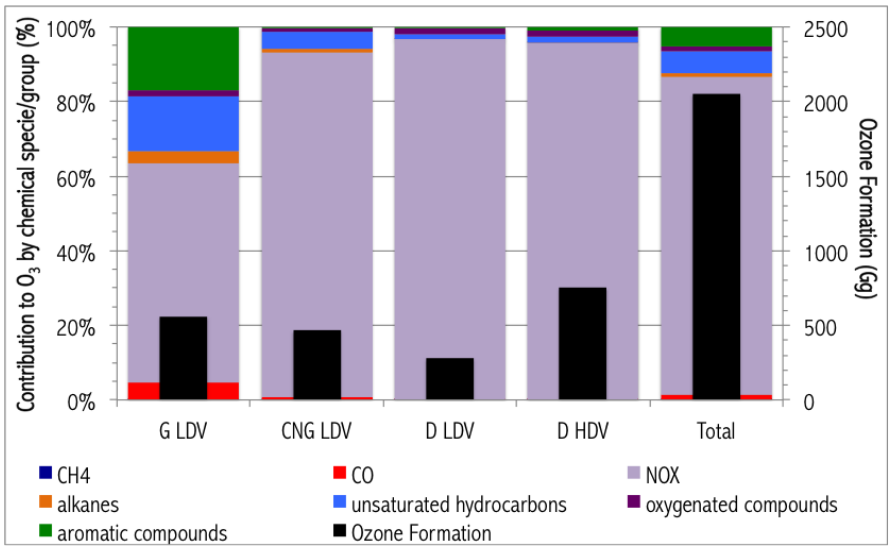
For me, the highlight of the 2014 iCACGP/IGAC Symposium/Science Conference was Impact of atmospheric pollution on Health, which was given special attention and importance in this year's conference.

Extended Abstract

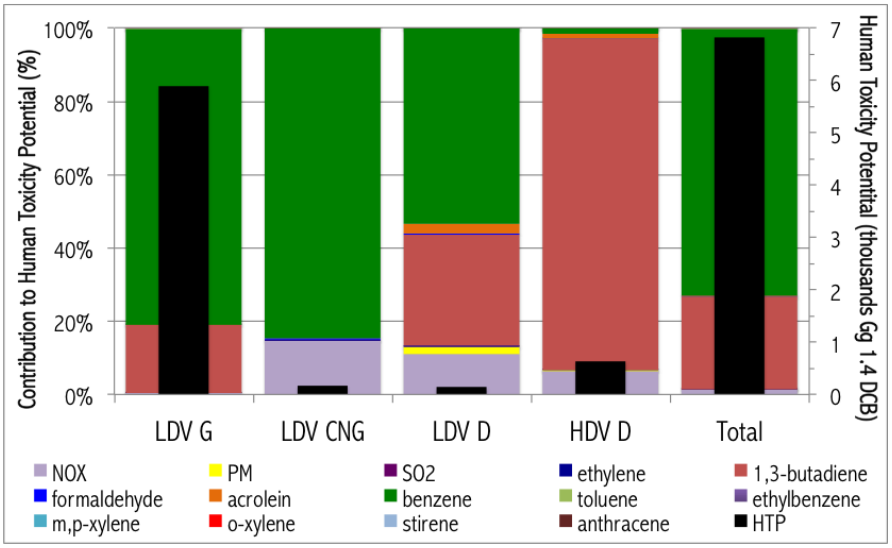
Since 2007, more than half of the world's population lives in urban areas. Transport emissions dominate urban atmospheres and are an important source of pollutants that impact on air quality, climate change and human health. Local and regional emission inventories play an important role in feeding global inventories. There are some regions of the world that are not well represented in global inventories, as it is the case of Argentina and South America, and are generally associated with a high uncertainty.

Within the South American Emissions, Megacities and Climate project (**saemc.cmm.uchile.cl/**), a static bottom-up emission inventory of greenhouse gases and criteria pollutants from on-road mobile sources was developed for the metropolitan area of Buenos Aires (MABA), Argentina, for the year 2006. Based on the IPCC guidelines, the local fleet was obtained from the national registry and local institutions, and emission factors representative of the local fleet and driving patterns of the Latin American region were collected. The effect of vehicle emissions on tropospheric ozone formation was calculated on the basis of Carter's MIR and NMIR scales (1994; 2008; 2010), and their effect on human health by means of Huijbregts' human toxicity potential (1999; 2000) in terms of 1.4-dichlorobenzene (1.4DCB). 2006 MABA vehicle emissions account for the potential formation of ~2,000 Gg of tropospheric ozone (Fig.1a) and a risk on human health equivalent to ~7,000 Gg of 1.4DCB (Fig.1b). NO_X emissions are the main ozone precursor in the MABA atmosphere (~90%), followed by unsaturated hydrocarbons and aromatic compounds, and diesel-oil heavy-duty (D HDV) vehicles constitute the vehicle category with the highest contribution to ozone formation (~40%). Volatile organic compounds impose the highest risk on human health, mainly due to benzene and 1.3-butadiene, and gasoline light-duty vehicles (G LDV) are responsible for 85% of the impact on human health. Uncontrolled vehicles compose 75% of the MABA fleet and account for 65% of potential ozone formation and 90% of the risk to human health. The effect on health of fine particles (PM2.5) from diesel vehicles could not be correctly estimated as the employed scale doesn't provide a factor for this pollutant.

During 2007, an activity data measuring campaign was performed in the City of Buenos Aires with the aim to study local driving patterns of the circulating fleet as well as to comparatively assess the composition and distribution of the in-use and registered fleets (dynamic vs static). The campaign followed the International Vehicle Emissions methodology (**issrc.org/ive/**), designed to estimate vehicle emissions in developing countries. By means of GPS devices placed in circulating vehicles that followed three different routes in distinctive areas of the city, an average circulating speed of 35 km h^{-1} was estimated for



2006 MABA vehicle emissions and associated ozone formation.



2006 MABA vehicle emissions and associated human health risk.

the City of Buenos Aires. The composition and distribution of the circulating fleet was obtained from video analysis and in-situ surveys, and was found to be different from that of the registered fleet. In terms of vehicle type, the distribution of the circulating fleet varied among areas and street types. The registered fleet may be overestimating and underestimating the participation of passenger cars and heavy-duty vehicles, respectively. In terms of fuel distribution, there is a good agreement between the registered passenger cars and light-duty trucks, but presents significant differences for taxicabs. It's worth to highlight that the technology distribution differs significantly among the assessed fleets and the circulating fleet in the City is characterized by a higher presence of lower-emitting vehicles. Surveys to local drivers provided valuable information regarding annual distance travelled for all vehicle types, especially for taxicabs. The campaign should be extended to cover the whole MABA in order to better represent the different conditions found within its boundaries in terms of fleet composition & distribution and driving patterns.

Locally measured and estimated data are the main drivers to improve regional emission inventories.

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young scientist spotlight

Robert Wolf

Best Young Scientist Poster Presentation

Session 5: **Atmospheric chemistry fundamentals**

Poster Title: **Quantification of airborne bacteria by aerosol mass spectrometry in urban and rural environments**

Robert Wolf is currently a PhD student at Paul Scherrer Institute (PSI)/Swiss Federal Institute of Technology in Zurich (ETHZ), Switzerland. Robert is originally from Germany and received his undergraduate degree in chemistry from the Freiberg Technical University. His research focused on the characterization of primary biological aerosol, especially airborne bacteria using aerosol mass spectrometers equipped with a novel inlet that allows for the on-line detection of aerosol particles larger than 1 micrometer in diameter.

What and/or who motivated you to pursue a career in science and more specifically in atmospheric chemistry?

After a rather theoretical diploma work using computer simulations to describe the behavior of surfactants in solution I wanted to switch to a subject that would need experimental work and which has a higher relevance for recent real-life problems such as air pollution and its sources. Starting a PhD in the laboratory of aerosol chemistry (LAC) at PSI was very suitable because this lab additionally offers a broad expertise in aerosol chemistry and state-of-the art aerosol measurement technology.

How do you want your career to progress and where do you think you can ultimately have the greatest impact?

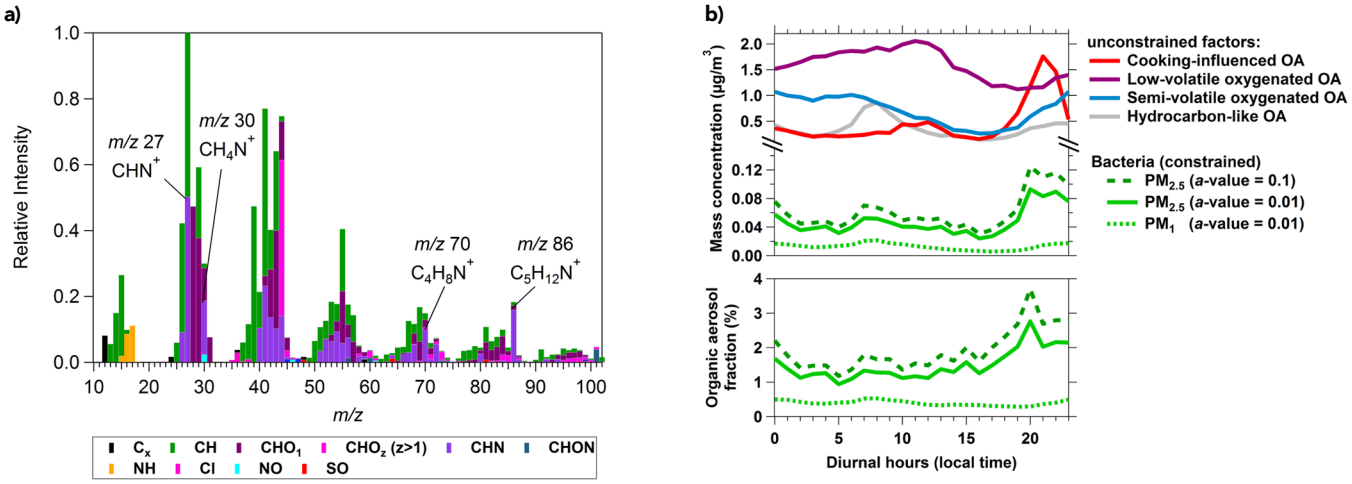
At this moment, I don't see my future in science. I am looking for a challenge in the area of analytical/physical chemistry, or to be more specific, a task that deals with aerosol measurements (especially mass spectrometry), advanced statistical analysis or skydiving.

What advice can you offer to those just starting a masters or PhD program in atmospheric chemistry?

As in any field of studies you might want to pick a topic that you are really interested in (or keep looking for it) to stay motivated. In my case, I really liked to work with various mass spectrometers, troubleshoot them and try out new equipment.

What was the highlight of the 2014 iCACGP Symposium/IGAC Science Conference for you?

I will keep it in mind for the truly exceptional location in terms of sun, temperature and beaches in comparison to other conference locations in the field of aerosols and aerosol chemistry.



a) Characteristic high-resolution mass spectrum of pure Pseudomonas bacteria as identified in the laboratory and b) the estimated contribution of bacteria cells in general amongst other components of organic aerosol (OA) at the Zurich Kaserne urban background site in April 2011.

Extended Abstract

Airborne bacteria may harm human health and certain strains are among the most efficient ice nuclei known so far. Since they can also act as cloud condensation nuclei they potentially influence the local hydrological cycle in pristine regions such as the tropical rainforest. Similarly to primary biological aerosol particles in general, their contribution to the particulate organic nitrogen budget and their ambient organic aerosol mass concentrations are highly uncertain due to a lack of standardization of measurement techniques. For example, recent global annual emission estimates for bacteria span two orders of magnitude: 0.4 to 28.1 Tg/year.

We present a method which facilitates the distinction of airborne bacteria from other constituents of non-refractory organic aerosol employing an Aerodyne high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) equipped with a newly developed PM2.5 aerodynamic lens. The size and the chemical composition of common ice-nucleation active Pseudomonas bacteria were analyzed in chamber experiments at the AIDA facility in Karlsruhe, Germany. The investigated bacterial cells show vacuum aerodynamic diameters of about 900 nm. Residual particles from the agar nutritive medium in which the bacteria were grown as well as bacteria cell fragments have diameters around 300 nm. Nitrogen-containing ions are the most characteristic features of the bacteria mass spectra. Signals at m/z 70 (C4H8N+) and m/z 86 (C5H12N+) are particularly prominent since they are likely the direct decarboxylation products of the corresponding amino acids. It should be noted that a discrimination of different bacteria species is not feasible when employing electron ionization due to heavy fragmentation of the proteins. Therefore, we regard the reported bacteria concentrations as estimates for intact bacteria cells in general.

Positive matrix factorization using the multilinear engine (ME-2) was applied to quantify bacteria in ambient PM2.5 aerosol at an urban background site in Zurich (spring) and during mobile measurements in the Po Valley (summer). At the Zurich site, another co-located HR-ToF-AMS equipped with PM1 inlet as well as an aerosol chemical speciation monitor (ACSM) were available as a reference. The multilinear engine (ME-2) method allows for the quantification of a minor source of organic mass such as bacteria by constraining their factor profile as an additional aerosol component. This constrained bacteria factor profile can vary between predetermined limits given by the so-called a-value to account for variations between mass spectral patterns of bacteria aerosol particles in the laboratory and in ambient.

We estimate that airborne bacteria may contribute up to 1.4 µg m^{-3} (1.5 mass-%) to non-refractory PM2.5 at both sites. In Zurich, contributions were slightly higher at night. In the Po-Valley, higher concentrations were found in the low lands compared to the Apennine Mountains during sea breeze influence. Concentrations within the valley were highest at nighttime when air masses arrived from the northwest during land breeze.

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young scientist spotlight

Lee T. Murray

Best Young Scientist Poster Presentation

Session 6: **Atmospheric chemistry in a changing climate**

Poster Title: **Quantifying feedbacks from lightning in the GISS ModelE2 chemistry-climate model**

Lee T. Murray is currently a Postdoctoral Research Fellow at the NASA Goddard Institute for Spaces Studies in New York, NY, USA. Lee is originally from Niagara Falls, NY, USA and received his undergraduate and graduate degrees from Harvard University in Boston, MA, USA. His research interests are atmospheric chemistry and climate interactions.

What and/or who motivated you to pursue a career in science and more specifically in atmospheric chemistry?

My neighborhood growing up was adjacent to the infamous Love Canal disaster, in which an entire community was built on top of buried industrial toxic waste, and evacuated a few years before I was born. Watching the demolition and remediation as a child strongly motivated my desire to contribute to scientific understanding of the natural world and mitigate further environmental catastrophe. I am very fortunate to have been inspired and mentored by many brilliant advisors, fellow students, and colleagues, but my Ph.D. advisor, Daniel Jacob, was particularly influential in convincing me to pursue physical science over environmental law while an undergraduate researcher in his group.

How do you want your career to progress and where do you think you can ultimately have the greatest impact?

I hope to start a research group of my own, and continue pursuing research while sharing my enthusiasm for the natural world with subsequent generations of students. I love coding and plan to continue developing and using earth system models to study the interactions of atmospheric chemistry with the climate and the biosphere.

What advice can you offer to those just starting a masters or PhD program in atmospheric chemistry?

An introduction to numerical methods or computer science course will help build a strong foundation for efficient analysis of both routine tasks and our field's increasingly "big data" questions and applications.

What was the highlight of the 2014 iCACGP Symposium/IGAC Science Conference for you?

Seeing our field as a collegial and international community, meeting both senior and young scientists, and seeing old friends and colleagues.

Extended Abstract

Lightning is a complex chemistry-climate feedback mechanism. Nitrogen oxides (NOx) produced by lightning greatly perturb global oxidant levels, and thereby reactive greenhouse gases (ozone, methane) and aerosol particles, generating both positive and negative radiative forcing components. These changes in turn affect climate, and thereby lightning production. To calculate the net radiative forcing and feedback from lightning, as well as the magnitude of each individual chemical pathway, we apply the GISS ModelE2 general circulation model with fully integrated tropospheric and stratospheric chemistry. We perform a series of atmosphere-only decadal time slices for the 2000s and 2090s, using the RCP4.5 emission scenario. We prescribe surface concentrations of long-lived greenhouse gases (including methane) and sea surface temperatures archived from the GISS-E2-R CMIP5 ensemble members. In each climate scenario we test three parameterizations of lightning production available from the literature: empirical relationships with convective cloud top height (CT), upward convective mass flux (MF), and convective precipitation rate (PR). Global mean lightning activity generally increases in each simulation at 2090 relative to 2000 (CT: +10%; MF: +0%; PR: +20%), but with

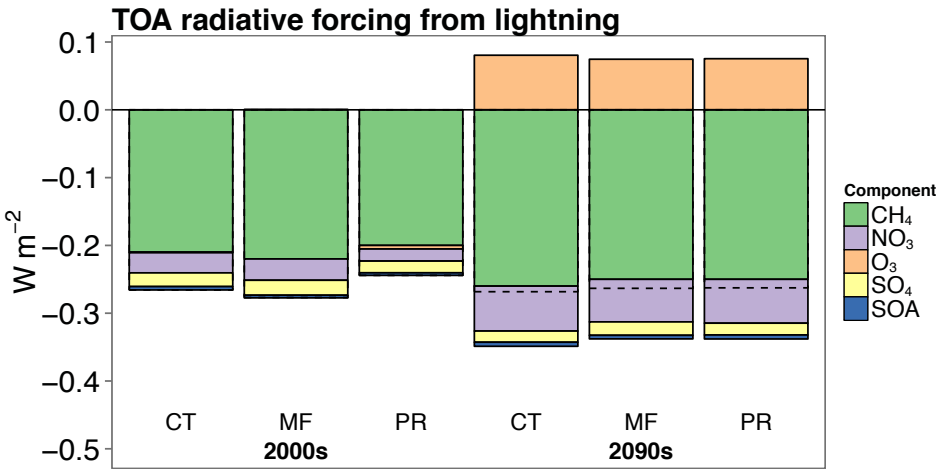

Figure 1. Global total radiative forcing (W m-2) at the top of the atmosphere (TOA) resulting from lightning NOx relative to no lightning, colored by individual component. Shown are the results using three different lightning parameterizations (CT; MF; PR) for the 2000s (left columns) and 2090s (RCP4.5 scenario; right columns). The dashed line shows the net radiative forcing per simulation.

different spatial patterns. However, similar and statistically significant spatial patterns of radiative forcing emerge regardless of the lightning parameterization used. Surface methane concentrations were prescribed in each simulation, so the lightning-methane radiative forcing component is calculated offline following simulated changes in the methane lifetime, taking into account the feedback of the methane lifetime upon itself. We also calculate the effect of the methane burden on the ozone burden offline. We find the globally integrated net forcing from lightning to be -0.26 W m^{-2} at the top of the atmosphere for all climates and lightning distributions, relative to zero-lightning simulations. This is comparable in magnitude to the forcing from present-day anthropogenic NOx emissions (-0.22 W m^{-2}; IPCC, 2013) despite that source being 5 to 10 times greater. This reflects the higher photochemical efficiencies and sensitivity to absorption in the clean and cold tropical upper troposphere where lightning NOx is released. Figure 1 isolates the net radiative forcing by component in each simulation. The net lightning-ozone forcing in the present day is -0.00 W m^{-2}, as an initial NOx-driven enhancement in ozone is offset by subsequent methane-driven reductions in ozone. However, we find a positive lightning-ozone forcing at the end of the century (+0.08 W m^{-2}), as large reductions in anthropogenic emissions in the RCP4.5 scenario lead to higher ozone production efficiencies per unit NOx emitted. However, this positive forcing is offset by the influence of lightning NOx on particle-phase nitrate (as a direct precursor) and sulfate (via nitrate radical oxidation of dimethylsulfide). Therefore, the influence of lightning on climate primarily follows the methane direct effect. Simulated increases in lightning in a warming world while maintaining near constant forcing imply that lightning is a relatively small feedback mechanism within the climate system.

My neighborhood growing up was adjacent to the infamous Love Canal disaster, in which an entire community was built on top of buried industrial toxic waste, and evacuated a few years before I was born. Watching the demolition and remediation as a child strongly motivated my desire to contribute to scientific understanding of the natural world and mitigate further environmental catastrophe.

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calendar

December
Atmospheric Chemical Mechanisms Conference
Fundamentals of Atmospheric Chemistry
10 - 12 December
Davis, CA, USA

Tropospheric Ozone Assessment Report (TOAR) Workshop I
10-11 December 2014
Boulder, CO, USA

2014 AGU Fall Meeting
15 - 19 December
San Francisco, CA, USA
See our recent announcement for IGAC related sessions.

February
Future Directions for Arctic Air Pollution Research
3-5 February 2014
Boulder, CO 80302

March
Radical Photochemistry of Biogenic Hydrocarbons and their Gas-Phase Oxidation Products: Chemical Mechanism Development and Research Needs
Fundamentals of Atmospheric Chemistry
23-25 March 2015
Juelich, Germany

June
The Future of Laboratory Studies in Atmospheric Chemistry
Fundamentals of Atmospheric Chemistry
17-19 June 2015
Boulder, CO, USA

Nitrate Radicals and Biogenic VOCs Workshop
Fundamentals of Atmospheric Chemistry
June 2015
Atlanta, GA, USA

July
Our Common Future Under Climate Change
7-10 July 2015
Paris, France

September
SOLAS Open Science Conference
7-11 September 2015
Kiel, Germany

November
2nd Symposium of the Committee on Space Research
Water and Life in the Universe
9-13 November 2015
Foz do Iguacu, Brazil

2016
14th IGAC Science Conference
26-30 September 2016
Breckenridge, CO, USA

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