



The IGAC biennial science conference "Atmospheric Chemistry in the Anthropocene" took place in Beijing, China 17-21 September 2012. This issue highlights six young scientists who won the Young Scientists Program Poster Competition for each session.

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IGAC News

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IGAC: Young Scientists' Vision

No one really knows what the future will hold (even the modellers in your lab will admit to this). However, for an organization like IGAC it is vitally important to have a constant eye to the future. During the 2012 Open Science Conference in Beijing, China, just such a strategy was in use and in this report we document the thoughts for the future of IGAC from many of the younger scientists who attended the conference.

What is IGAC? Many of you who read the newsletter and have been to the science conferences will have a good feel for what you think IGAC is. But for the younger scientists (YS), for which the Open Science Conference (OSC) may be their first real connection with IGAC, there is an understandable degree of uncertainty about what IGAC is. In essence the majority of the YS see IGAC as a special organization that is specifically interested in the science of Atmospheric Chemistry. This is, in the broadest sense, what IGAC is. But IGAC is surely much more. IGAC is more than an organization interested in atmospheric chemistry; it is (arguably) THE global organization for atmospheric chemistry. Member scientists involved in ideating and furthering our understanding of atmospheric chemistry have been able to bridge the gaps thanks in part to the many fruitful collaborative research programmes that IGAC has been promoting. Although lack-

ing in funds, IGAC more than makes up for this with energy and spirit/enthusiasm. A large amount of that energy and enthusiasm comes from the many grad-students, early career postdocs and many others that make up the young scientist component of the IGAC community. During the IGAC OSC in Beijing, the IGAC Young Scientists community were tasked with thinking about where they see the future of IGAC.

The Beijing Young Scientist Program was one of the best attended in all of the recent IGAC Conferences, with an overwhelming majority of those who participated commenting on the value of the Young Scientists Program for a multitude of reasons. One of the particular highlights of the program was a special talk given to only young scientists by Prof. Daniel Jacob of Harvard University. Prof. Jacob talked about his own experiences as a grad-student and gave a very personal



Professor Daniel Jacob (Harvard University, Boston, MA USA) addresses ~100 young scientists about "Building your career in Atmospheric Chemistry: Be All You Can Be". The presentation is available for download here: <http://acmg.seas.harvard.edu/presentations/powerpoints/djj2012/ysp.ppt>



Many young scientists, such as Brian McDonald (University of California-Berkeley, USA) gave oral presentations during the plenary sessions.

the Beijing Summer Palace and a special networking dinner with the IGAC Scientific Steering Committee before the conference started. These events helped to serve as pre-ice breakers for the young scientists and were seen as a great way for people to get to know each other before the conference began.

During the OSC, the YS were kept busy presenting their research at the poster sessions, answering tough questions from judges of the Young Scientists Program Poster Competition, and also presenting many oral presentations as part of

presentation on his career to date. Having the opportunity to hear Prof. Daniel's advice on topics ranging from when you can say no to your supervisor, to what it is "OK" to be "OK" at, was a tremendous opportunity. In addition to the presentation by Prof. Jacob, a number of other events were organised for the YS throughout the conference. These events included a half-day excursion around

the plenary sessions. Not only were the YS busy with listening, presenting, and challenging the wide range of science that the OCS dealt with, but they were also asked to think about where they see the future for IGAC. During one lunch time session around 50 YS were given the task to think about the good and bad points of IGAC and the OSC and what they would suggest for the future. There was an overwhelming feeling that IGAC should consider some form of training within the network. A range of options were discussed and the idea of an IGAC summer school was seen as a promising way to do this, as was tagging on an extra day or two before the start of the IGAC Biennial OSC. In both cases it was fairly clear that a theme (such as principals of aerosol remote sensing techniques or chemical transport modelling, etc.) would be a good way to organise the training sessions, with the feeling that very broad themes (i.e., general guides to atmospheric chemistry) would not be so appealing. YS also suggested that IGAC put more emphasis on regional issues and start using social networking in order to engage more young scientists.

There are likely to be many challenges in the future and the key to success will be turning those challenges into opportunities. The IGAC YS look forward to the challenge of taking their part as sculptors of a more dynamic and integrated IGAC community.

We would finally like to thank the many YS who contributed to the lively discussions, ground breaking research and general good spirit of the OSC, with a special thanks to the many students from Peking University without whom the smooth running of the meeting would have been impossible. 谢谢!

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IGAC SSC members and liaisons at the 2012 IGAC SSC Meeting in Beijing, China.

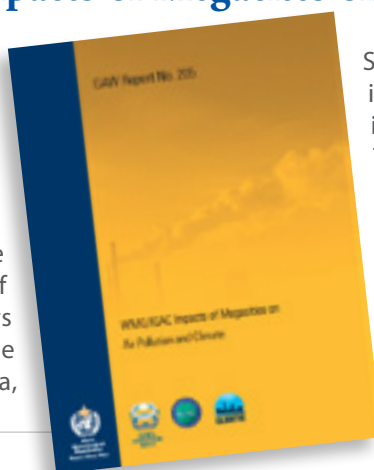
2012 IGAC Scientific Steering Committee Meeting

IGAC held its annual Scientific Steering Committee (SSC) Meeting 15-16 September 2012 in Beijing, China prior to the biennial IGAC Science Conference. The meeting was attended by the majority of the IGAC SSC (www.igacproject.org/SSC) and by liaisons from IGBP (Sybil Seitzinger), iCACP (John Burrows), WMO (Liisa Jalkanen), and iLEAPS (Alex Guenther). The IGAC SSC and its liaisons had a very detailed discussion about the importance of fundamental atmospheric chemistry and how to incorporate fundamentals into IGAC activities and conferences. In essence, without strong roots in fundamental sciences, interdisciplinary sci-

ence will not be fruitful and sustainability cannot be achieved, i.e. a tree without strong root will blow over. In response to the IGAC community and based on the success of the IGAC China Working Group, IGAC is now in the process of forming additional national/regional working groups in the Americas with a focus on Latin America, Southeast Asia, and India. The IGAC SSC was also very enthusiastic about emerging activities such as the SPARC/IGAC Chemistry-Climate Modeling Initiative (CCMI). Visit www.igacproject.org to learn more about all of IGAC's current activities and upcoming events.

WMO/IGAC Report on Impacts of Megacities on Air Pollution and Climate

The WMO/IGAC Report on Impacts of Megacities on Air Pollution and Climate was released in draft version at the 2012 IGAC Science Conference in Beijing, China (http://www.wmo.int/pages/prog/arep/gaw/documents/GAW_205_DRAFT_13_SEPT.pdf). The effort, led by IGAC co-chair Tong Zhu of Peking University, took around five years and involved over 80 co-authors. The report covers megacities in Africa, Asia,



South America, North America, and Europe in addition to chapters on field campaigns in megacities and an outlook to the future. The release of the report was featured in Nature News on 12 October 2012 (<http://www.nature.com/news/megacities-pose-serious-health-challenge-1.11495>). The final version of the report will be available by the end of 2012.

AICI Special Issue

The IGAC activity Air-Ice Chemical Interaction (AICI) has a joint special issue in *Atmospheric Chemistry and Physics/Earth System Science Data* (http://www.atmos-chem-phys.net/special_issue275.html). The special issue, which focuses on new insights to air-ice chemical interactions, was the result of an IGAC sponsored AICI workshop held at Colombia University in June 2011.

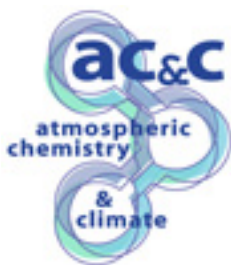


Submit Articles to the Next IGAC Newsletter

The next upcoming IGAC newsletter is now open for article submissions! Workshop Summaries, Science Features, Activity News, and Editorials are all acceptable and desired. Science Features are to be submitted at a recommended length of approximately 1500 words with 1-2 images. All other submissions must be approximately 600 words and have a maximum of 1 image. Images MUST be high resolution and sent as a separate file. The deadline for submissions for the March Issue of the IGAC Newsletter is **28 February 2013**. Any questions concerning content or formatting mail to info@igacproject.org.

ACCMIP Special Issue

The joint SPARC/IGAC Atmospheric Chemistry & Climate (AC&C) Model Intercomparisons Project (ACCMIP), led by Jean-Francois Lamargue (NCAR, Boulder, CO USA) and Drew Shindell (NASA GISS, New York, NY USA) has a joint special issue in *Atmospheric Chemistry & Physics/Geoscientific Model Development* (www.atmos-chem-phys-discuss.net/special_issue176.html). The special issue is the result of two IGAC sponsored ACCMIP workshops that occurred in Arona, Italy in 2011 and Pasadena, CA USA in 2012. More information on ACCMIP can be found at igacproject.org/ACCMIP or www.giss.nasa.gov/projects/accmip/.



IGAC Events Proposal Submissions

If you are interested in receiving support for workshops related to IGAC's Activities and Vision, look no further. IGAC provides financial support and non-financial endorsements of meetings, workshops, symposiums, and conferences. Sponsored events are required to publish an event summary in the IGAC Newsletter and IGAC may request a Science Feature or Young Scientist Spotlight article related to the workshop topic. Please visit www.igacproject.org/igac-events to learn more about how to submit a proposal for an IGAC sponsored event. Any questions regarding proposals or to submit a proposal please mail to info@igacproject.org. The deadline for proposal submissions occurs three times per a year with the next deadline being **28 February 2013**.

IGAC/iLEAPS/WMO Biomass Burning Initiative Announces its Co-Chairs

IGAC, iLEAPS, and WMO are forming a new activity on biomass burning. The first workshop was held at WMO head quarters in Geneva, Switzerland in July 2012. IGAC, iLEAPS, and WMO are pleased to announce the co-chairs of this new activity are Johannes Kaiser (ECMWF, Reading, UK) and Melita Keywood (CSIRO, Melbourne, Australia). This initiative will coordinate and facilitate research on all aspects of biomass burning, in order to better quantify the impact of biomass burning on atmospheric chemistry and climate.

The 12th IGAC Science Conference successfully held in Beijing, China

IGAC's biennial open science conferences are the primary mechanism for dissemination of scientific information across the community. Every two years, IGAC holds its science conference in different locations around the world with a specific theme. The 12th IGAC Science Conference "Atmospheric Chemistry in the Anthropocene" was held at the China National Convention Center in Beijing, China on September 17-21, 2012, organized by the College of Environmental Sciences and Engineering, Peking University.

The theme "Atmospheric Chemistry in the Anthropocene" was chosen to address the critical interactions between the atmosphere and human activities in an era where humans have fundamentally altered the composition and chemistry of our atmosphere. At the opening ceremony on Sept 17, Prof. Paul Monks, ICAC Co-chair, gave opening remarks to about 500 scientists and students from more than 40 countries

to welcome them to the conference. Prof. Allen Goldstein, Co-Chair of the Scientific Program Committee, described the conference theme and sessions, and played an IGBP short movie "Welcome to the Anthropocene" to highlight the theme of the conference. Prof. Tong Zhu, ICAC Co-chair and the Chair of the Local Organizing Committee, announced the web version of the WMO/IGAC report "The

Impacts of Megacities on Air Pollution and Climate". Dr. Dahe Qin, former general director and IPCC WG1 co-chair, gave an opening lecture and reported the recent progress of IPCC WG1 report. The conference had six sessions:

- 1) Atmospheric Chemistry in the Anthropocene;
- 2) Atmospheric Chemistry and Megacities;
- 3) Atmospheric Chemistry and Climate;
- 4) Atmospheric Chemistry and Health;
- 5) Atmospheric Chemistry and Surface-Atmosphere Exchange;
- 6) Atmospheric Chemistry Fundamentals.

Throughout the five days of the conference, Prof. Shaw Liu, Dr. David Parrish, and Prof. John Burrows delivered keynote presentations, along with 12 invited and 60 submitted oral presentations. Every day in the afternoon, the posters session were held for conference participants to discuss the 400 posters on display. The conference included live webcasting of all oral presentations.

To encourage growth in the field of atmospheric chemistry, the conference supported 54 young scientists to participate in the conference. Megan Melamed, Alex Archibald, May Fu, and Sachin Gunthe formed the Young Scientists Program Committee which planned activities including an ice breaker with the IGAC scientific steering committee, young scientist excursion to the Summer Palace, young scientist/senior scientist mixer, and a young scientist visioning meeting. One hundred young scientists attended the Young Scientists Program Keynote talk by Prof. Daniel Jacob. The young scientist poster



Local Organizing Committee Chair and IGAC Co-chair Tong Zhu (Peking University, Beijing China) addresses participants of the 2012 IGAC Conference.



Shaw Liu (Research Center for Environmental Changes, Taipei, Taiwan) gives a keynote address on "Aerosols and Precipitation".



David Parrish (NOAA, Boulder, CO USA) gives a keynote address on "Ozone in the Anthropocene: Lessons from Urban to Remote Measurements at Northern mid-Latitudes".



John Burrows (University of Bremen, Germany) gives a keynote address on "Global Remote Sensing of Tropospheric Trace Gases: GOME, SCIAMACHY, and GOME-2".

competition was held throughout the conference, with six best poster awards presented, each of which is featured in this newsletter.

The conference banquet on Sept 20 featured the Chinese cultural traditions of face change and Beijing opera. Prof. Xiaoyan Tang gave a public lecture "Retrospective of Atmospheric Chemistry Research in China".

At the closing ceremony, the host of the 2014 IGAC/ICACGP conference introduced the lovely host city Natal, Brazil, where our next open science conference will be held in September 2014.

The Chair of the Local Organizing Committee was Prof. Tong Zhu of Peking University. The Co-Chairs of the Scientific Program Committee were Prof. Allen Goldstein of UC Berkeley, and Prof. Yuanhang Zhang of Peking University. More than 30 graduate and undergraduate students from Peking University served as conference volunteers.

The State Key Joint Laboratory of Environmental Simulation and Pollution Control, College of Environmental Sciences and Engineering of Peking University, and the IGAC China Working Group were the local conference organizers. The Chinese Academy of Meteorological Sciences, Chinese Research Academy of Environmental Sciences, and State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry (LAPC) of Institute of Atmospheric Physics of Chinese Academy of Sciences are the conference joint organizers.

The conference sponsors included the National Science Foundation of the United States, National Natural Science Foundation of China, World Meteorological Organization, ACCENT Plus, Monsoon Asia Integrated Regional Study (MAIRS), European Space Agency

(ESA) and companies including Focused Photonics Inc, Guangzhou Hexin Analytical Instruments Co., Ltd., and Agilent Technologies.

More Information about the conference can be found at:
www.igac2012.org

Tong Zhu

Peking University
Chair, Local Organizing Committee

Allen Goldstein

University of California-Berkeley
Co-chair Scientific Program
Committee

Yuanhang Zhang

Peking University
Co-chair Scientific Program
Committee

Atmospheric Composition and the Asian Monsoon: Results from a Side Meeting at the 12th IGAC Science Conference in Beijing

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²National Center for Atmospheric Research, Boulder, CO, USA

A side meeting on Atmospheric Composition and the Asian Monsoon was held at the 12th IGAC Science Conference in Beijing. The meeting was organized by Laura Pan and Jim Crawford as a forum to gather interested scientists, to identify common interests, and to initiate a dialogue that might lead to future collaborative projects, working groups, or workshops. The session was attended by thirty-one scientists representing seven different nations.

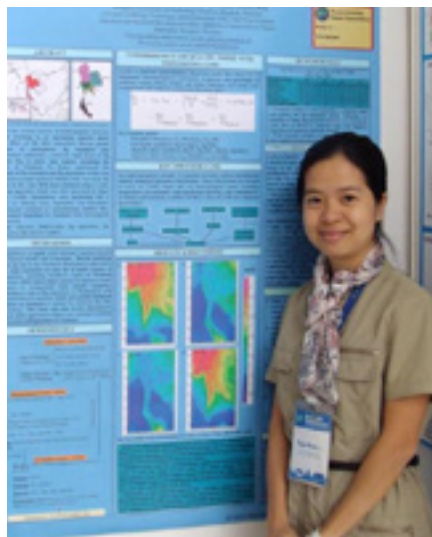
To date, research focused on the interaction between atmospheric composition and the Asian monsoon has largely capitalized on satellite observations and the use of global models. Of foremost importance is the need to observe the full atmosphere over this region where satellites and models indicate that summer monsoon convective transport perturbs UT/LS composition and forms a significant pathway for pollutants to enter stratosphere. Convective transport occurs across a considerable range of surface conditions and diversity in sources, all in close proximity to each other. The terrestrial environment ranges from mega-cities to rainforest, while the marine environment ranges from shallow, biologically-productive waters to some of the densest shipping lanes in the world. Seasonal burning, both natural and human induced, are a major air quality concern with potential climate feedbacks. Add a growing population and economy with increasing energy demands, and it becomes evident that this is a region where much can be learned about processes and trends influencing atmospheric composition and associated impacts.

Progress in understanding these processes can only come from both periodic and sustained activities in this region where observations are sparse and access is difficult. Thus, participants were invited to share relevant research efforts. Ten presentations shared details of ongoing measurements at key ground sites in Mohali, India (Vinayak Sinha) and Hong Kong (Jian Zhen Yu) as well as balloon soundings from Kunming and Lhasa of ozone, water vapor, and cloud particles (Jianchun Bian). Ru-Shan Gao shared details on development of a low-cost, lightweight optical particle counter for balloons and other platforms. Plans for future field studies were presented by Mark Lawrence and Arnico Panday (ground-based and ultralight aircraft observations in the Kathmandu Valley), Hartwig Harder and Hans Schlager (high-altitude airborne observations of the Asian Monsoon UT/LS), and Wolfgang Junkermann (aerosol-cloud studies from ultralight aircraft). Larry Thomason presented analysis of UT/LS aerosol observations from CALIPSO and SAGE, emphasizing the need for validation measurements.

Discussion on community building was initiated by Hiroshi Tanimoto, who

shared his proposal to the IGAC Science Steering Committee (SSC) to establish a Working Group focused on SE Asia. The role of this working group would be to strengthen the links between IGAC and atmospheric scientists in different countries. A report on the feasibility of forming this group will be presented to the SSC in September 2013. As this idea is further developed, Dr. Tanimoto welcomes nominations and suggestions. It was also agreed that the results of this meeting should be shared with the SPARC and iLEAPS communities to establish interest in co-sponsoring workshops and possible initiatives.

The discussion culminated in a consensus that a topical workshop on “Atmospheric Composition and the Asian Monsoon” is a logical next step to promote community interest and synergy. Arnico Panday suggested holding the workshop in Kathmandu with ICIMOD as a local sponsoring organization. This workshop would help build a larger core of scientists in support of the formation of an IGAC/SPARC/iLEAPS joint initiative or working group. Convening a community workshop is particularly important given the significant number of countries and scientists that could not be represented at this IGAC Side Meeting. The publication of this report is intended to help reach those scientists and lead to their input and involvement in this effort. For further information, contact Jim Crawford (James.H.Crawford@nasa.gov) or Laura Pan (liwen@ucar.edu).



Pham Thi Bich Thao received her undergraduate degree from the University of Natural Sciences – Ho Shi Minh city branch in Environmental Science. For her graduate work, Tham Thi Bich Thao moved to Bangkok, Thailand to study at the Joint Graduate School of Energy and Environment (www.jgsee.kmutt.ac.th), where she earned a Masters in Philosophy of Environmental Technology and is currently pursuing a doctorate. Her research focuses on mercury transport and deposition in Thailand.

Pursuing or earning a doctorate degree in the field of atmospheric chemistry is not an easy task. What challenges have you had to overcome to get to where you are now?

I do agree that pursuing or earning a doctorate degree in the field of atmospheric chemistry is not an easy task. One challenge that is quite common is resource limitation. In general, atmospheric chemistry research in most of developing Asian countries is still developing. So technically, we lack courses and monitoring campaigns that are as intensive as those in developed countries. Another challenge of mine is how to harmonize time for studying and taking care of my own family (especially my 2.5 years old

Pham Thi Bich Thao

2012 IGAC Science Conference

Young Scientists Program Poster Competition Winner

Session One: Atmospheric Chemistry and the Anthropocene

Abstract Title: “An Investigation of Atmospheric Mercury Deposition in Thailand”

son) properly. Fortunately, I have full support from my family, especially from my husband, who is also a researcher in atmospheric science and is kind and understanding. I also receive a lot of encouragement from my thesis supervisor and committee team. Though a lot of difficulties still remain, I do feel grateful that I have a chance to pursue my PhD and continue doing research, which in the Asian culture is not a common for a married woman with a young child.

As a young scientist, you have an exciting future ahead of you. What type of career and topic do you hope to be working on in 5 or 10 years from now?

For the next few years, I do hope to graduate and become a researcher/lecturer at a university or research center where I have more chances to work on atmospheric chemistry projects. I wish to contribute on strengthening international collaboration in this field, which I think is very important in order to solve air pollution transboundary issues. In the next 5-10 years, I would like to pay more attention to air quality modeling at different scales and risk assessment on humans and ecosystems. Last but not least, I also hope to transfer knowledge and develop the next generation of scientist in this field.

Outside of science, what are some of your other interests/hobbies?

In my spare time, I love reading. I read various kind of stuff (i.e., book, magazines, news) and some books have really change my life

perspective. I appreciated the concept of “Life changes once you change” from Andrew Mathew’s books that help me to move forward during certain periods of my life. Buddhism textbooks are also a learning resource that I like to spend time with. Besides that, I also regularly spend time with my son in the playground, shopping and dining with my family, or sometimes pamper myself to a local Thai massage.

What was the highlight of 2012 IGAC Open Science Conference for you?

This is the 2nd IGAC Conference I have participated in. The IGAC conferences are a great opportunity to present scientific work. For this conference, thanks receiving an IGAC Young Scientists Travel Grant, I had the chance to join the meeting, discuss with experts, and get to know young scientists from all over the world. The first highlight for me of 2012 IGAC Open Science Conference was that the scientific program covered various aspects under atmospheric chemistry so that I had a chance to broaden my knowledge, consult with experts and to some extent, create good links to my own research. The second highlight for me was that people provided me with good, constructive comments on my work and suggested some future collaboration. Moreover, I have increased my research network with the young scientist community, which is extremely useful for my future collaborations. Perhaps there will be a project contributed mainly by IGAC Young Scientists in the very near future!

An Investigation of Mercury Transport and Deposition: Case Study of Thailand

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Background

Mercury (abbreviation symbol "Hg") is a hazardous substance which deposition can be harmful to human health and ecosystems [US EPA, 1997]. There are several studies about Hg content in contaminated human hair, fish, soil, and water [Suckcharoen *et al.*, 1980, Zhang *et al.*, 2007]. One of the classic examples of Hg exposure to living creatures is Minamata disease in Japan during 1930-1970, which caused fish as well as fish predators including humans to suffer from severe Hg poisoning deformities and even death [Ui, 1992]. Since 1989, Hg has been listed as a hazardous pollutant under US Clean Air Act Amendments of 1990 due to its potentially significant impacts on human health and ecosystems. The concern of Hg is mostly after deposition, where inorganic Hg is converted to organic Hg (i.e., methyl Hg) under the presence of bacteria. Such organic Hg is persistent and accumulates in ecosystems and can cause adverse effects to living creatures and higher-level predators. In order to access or predict organic Hg accumulation in ecosystems, the quantitative amount of inorganic Hg concentration, deposition as well as transformation pathways in the ecosystem is required. Understanding the fate of Hg emissions is important to further investigate emission control policy and risk assessment studies.

To investigate Hg concentration and deposition in one place, monitoring and sampling information are required to obtain measurable values. Such data, however, are not available for some cases due to resource limitation. Air quality modeling systems have been widely used to understand Hg transportation, transformation, and deposition of Hg emissions from one place to other places [Ryaboshapko *et al.*, 2007].

Main sources of Hg contamination originate from anthropogenic sources such as unintentional emissions due to impurity of combusted fuel (e.g., Hg content in coal) or material input (e.g., Hg in mineral or metal ore such as cement, Zn, Pb, and Au) as well as natural sources (i.e., volcanic activities, water surface, and soil surface). Once emitted from these sources, depending on its speciation (GEM-Gaseous elemental mercury, RGM-Reactive gaseous mercury, and PHg-Particulate Hg), each has different characteristic and atmospheric lifetimes. Particularly, RGM is water soluble and reactive. Therefore, RGM is subject to quick transformation and remove/deposit near the emitted sources. Similarly, PHg can interact with other particle sand deposit near the emitted source. In contrast, GEM is insoluble in water and quite inert and therefore it has the longest atmospheric life time (from 0.5 – 2 years) among its speciation. GEM is

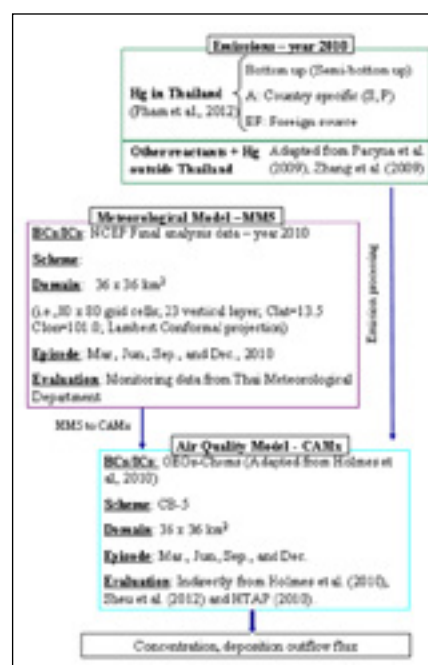


Figure 1: Work flow of this research

also subject to long-range transport, which raises global concern.

According to recent studies of Hg deposition by in the Northern Hemisphere [Travnikov *et al.*, 2010] or over the entire globe [Selin *et al.*, 2007; Holmes *et al.*, 2010; Corbitt *et al.*, 2011], high concentration (i.e., about 2.0 ng/m³) and deposition fluxes (i.e., 50 g/m²/year) were found in many places in Asia including the Northern region of Thailand. It could be caused either by emissions within Thailand or by the emissions transported from nearby

countries [Sheu *et al.*, 2012].

Hg emissions in Thailand are both from anthropogenic (e.g., coal fired combustion, cement, gold mining) and natural sources (e.g., water surface and soil surface). According to a recent study [AMAP/UNEP, 2008], in 2000, Hg emissions of Thailand were 10.1 metric tons, which is the 2nd highest among Southeast (SE) Asian countries and is ranked 9th among Asian countries (after China, India, Indonesia, Korea, Kazakhstan, Taiwan, Turkey, Japan).

Understanding the risk of Hg deposition in Thailand as well as the contribution of emissions inside and outside Thailand to deposition in Thailand is crucial for national Hg risk control strategy. This study aims to use atmospheric modeling as a main approach to figure out seasonal variation of Hg concentration and deposition in Thailand.

Frame work

Figure 1 present a schematic methodology to implement the work. As seen, key input parameters include: (1) emission inventory and its characteristic (spatial, temporal speciation distribution). This information is merged to serve as CAMx input and (2) meteorological output including temperature, precipitation, wind speed/wind direction, solar radiation etc. (3) initial and boundary condition (IC/BCs).

Results and Discussion

Concentration and Deposition

As presented in Figure 2, relatively high concentrations, mostly located in the northern part of Thailand, are found in March and December, 2010. The high concentrations are partly due to the high Hg emissions resulting from biomass burning activity in this region during these two time periods. Monthly mean total Hg concentrations ranged between 0.5-6.0 ng/m³ which

is not far from 1.7-2.0 ng/m³ for mean yearly total Hg concentration from GEOS₅ Chem output [Holmes *et al.*, 2010] and 1.66 and 2.95 ng/m³ from 15 samplings in the northern of Thailand during March and April, 2010 [Sheu *et al.*, 2012]. Deposition is also relatively high in March and December, mostly due to dry deposition of RGM, while in June and September, deposition is less due mostly to wet deposition of PHg. Monthly accumulated Hg deposition is in the 10-20 g/km²/month range whereas Travnikov *et al.* [2010] found the range to be 20-50g/km²/year. Of note, output of this work was not directly compared with observations because there are no long-term records of Hg concentrations or deposition in the study domain. We then based the evaluation of our modeling using limited observation from Sheu *et al.* [2012] and global modeling output.

Transport budget

Transport budget of GEM and PHg is relatively small and positive for all simulation months, indicating net transport of Hg speciated emissions out of the domain while that of RGM is relatively high and negative, indicating net removal within the domain. There is weak seasonal variation of the transport budget, which is more negative (i.e., removal through deposition) in dry seasons (i.e., March and December).

Conclusions

Relatively high concentration of Hg were found in March and December, mostly in northern Thailand, followed by the central and northeastern regions of Thailand, which is possibly partly due to Hg emissions inflow resulting

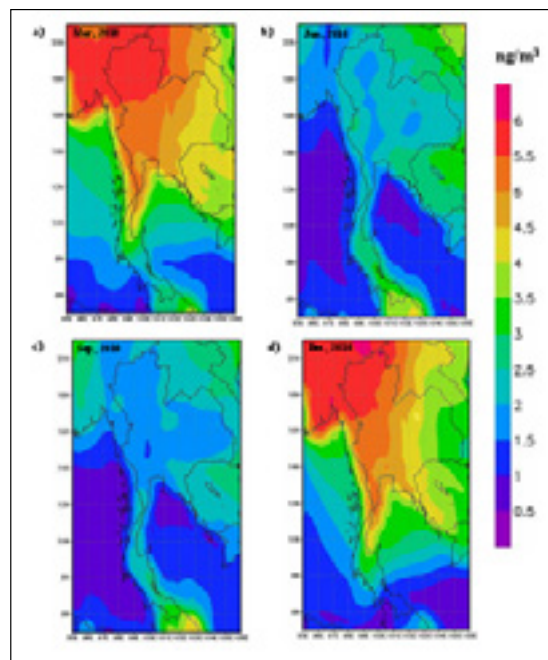


Figure 2: Hg monthly mean concentration in a) March b) June c) September and d) December 2010

from biomass burning activity in these periods. High deposition is found during these periods, mostly due to RGM deposition. There is net transport of GEM and PHg out of domain and net removal of RGM within the domain. Outputs of the models are reasonably compared to sampling from a literature review.

Recommendation

- Long-term simulations are needed to better assess seasonal variation of Hg concentration/deposition as well as emission inflow and outflow.
- Simulation to assess sensitivity to emissions, initial and boundary condition as well as chemical schemes are suggested.
- More long-term sampling/monitoring data on speciated Hg deposition and concentration to better evaluate models' results are needed.

- Need to further investigate Hg deposition in suspected contaminated areas at a high resolution scale to support risk assessment and policy making.

Acknowledgements

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Yong Jie Li

2012 IGAC Science Conference
Young Scientists Program Poster Competition Winner
Session Two: Atmospheric Chemistry and Megacities

Abstract Title: *“Evaluation the degree of oxygenation of organic aerosols during foggy days and hazy days in Hong Kong using High-resolution Time-of-Flight Aerosols Mass Spectroscopy”*

Yong Jie Li is from Guangdong Province in China, which is part of the Pearl River Delta (PDR) region. He received his undergraduate degree in analytical chemistry from Peking University, College of Chemistry and Molecular Engineering in Beijing, China and earned his doctorate from Hong Kong University of Science and Technology in environmental engineering. Yong Jie Li is currently a post doctorate fellow at Hong Kong University of Science and Technology in the Division of Environment. His current research focuses on characterization of organic aerosols.

Pursuing or earning a doctorate degree in the field of atmospheric chemistry is not an easy task. What challenges have you had to overcome to get to where you are now?

I cannot agree more. During my research work, there are two facets from which I learned a lot when I had

to face them and deal with them. The first one is that the fundamentals involved in atmospheric chemistry are truly multi-disciplinary. Engineering mindset was something that I did not have when I first got into this field, and statistics training was limited for me with only some basic concepts used by analytical chemists. The process of thinking outside my little “box” is somewhat painstaking but absolutely beneficial. The second one is a transition from laboratory study to field measurements. This took me a long time, which is still on-going right now, to get used to the situation that making sense out of the messy data from field observations are way more difficult than from the well-controlled laboratory experiments. I have not touched anything to do with modeling yet. I am sure that will be another challenge for me if I do choose to look at modeling. Anyway, what challenges me is really getting out of my comfort zone in search of different knowledge and ways of thinking to tackle the issues in atmospheric chemistry, where traditional boundaries of disciplines seem to blur.

As a young scientist, you have an exciting future ahead of you. What type of career and topic do you hope to be working on in 5 or 10 years from now?

I hope that I will still be in academics. I think I will very likely continue with my current research interests in aerosol characterization and chemical processes that lead to organic aerosol formation. It is really hard to say what will happen in 5 or 10 years, but I will do my best in equipping myself in both advanced instrumentation and aerosol fundamentals so that I can gain a better understanding of aerosol chemistry with these two vital tools.

Outside of science, what are some of your other interests/hobbies?

I enjoy many hobbies such as badminton, dragon boat rowing and guitar. Reading some totally irrelevant books is something I normally do when I want an excuse to not work.

What was the highlight of 2012 IGAC Open Science Conference for you?

This was my first time to IGAC conference and I really enjoyed the sharing spirit during it.

Degree of oxygenation of organic aerosols during foggy and hazy days in Hong Kong

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Division of Environment, Hong Kong University of Science and Technology, Hong Kong

Introduction

Atmospheric aerosols have large impacts on different scales. Globally, they affect the radiation balance by altering the solar energy input/output directly or indirectly, and affect our climatic system. Regionally, light scattering/absorption by fine particles causes visibility reduction. At a local scale such as in urban areas, fine particles induce adverse health effects. Without sufficient knowledge of the physical and chemical characteristics of atmospheric fine particles, our understanding of these impacts is still poor.

Organic aerosols (OA) contribute substantially to atmospheric aerosols and their sources and properties are relatively less understood compared to inorganic aerosol species. Due to the generally oxidative nature of the atmosphere, oxidation in either gas phase or particle phase leads to a large amount of secondary organic aerosol (SOA) formation. It is previously believed that gas-phase oxidation is the only important oxidation process that will result in appreciable amount of SOA. Recent studies showed underestimation of SOA by models with gas-phase oxidation alone, which raises the question of whether gas-phase is the only process that can generate condensable organics to form SOA.

Despite a number of laboratory studies [Ervens *et al.*, 2011] showing that aqueous-phase reactions may contribute significantly to SOA formation, only a few of the field studies have evaluated the importance of aqueous-phase processes in SOA

formation. Elevated SOA production was observed by Hennigan *et al.* [2009] during high relative humidity (RH) days due to enhanced uptake of semi-volatile water soluble organic carbon (WSOC) onto the particle phase and further oxidation. Dall'Osto *et al.* [2009] also observed the production of both inorganic and organic secondary species during a fog event in London. Kaul *et al.* [2011] attributed the enhanced SOA production during foggy days to aqueous-phase chemistry. Sorooshian *et al.* [2010] showed that oxygenated organics, such as individual organic acids and acidic groups as indicated by

m/z 44 in aerosol mass spectrometric (AMS) measurements, contributed more to particulate organic material in the vicinity of clouds. Ge *et al.* [2012] suggested that aqueous-phase processes led to both secondary inorganic and organic aerosol formation during foggy periods.

We conducted a five-week field campaign from April to May 2011 at a coastal site in Hong Kong with an Aerodyne High-Resolution Time-of-Flight Aerosol Mass Spectrometry (HR-ToF-AMS). Measurements were carried out at the Hong Kong University of

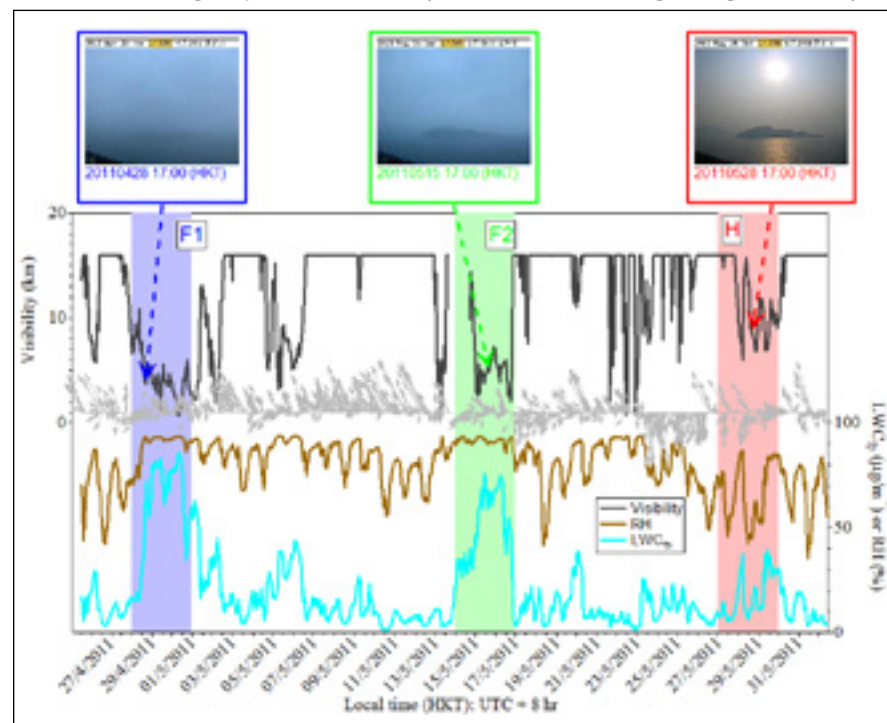


Figure 1. Visibility, wind vector, relative humidity (RH) and estimated liquid water content in fine particles (LWC_{fp}), together with pictures during the three chosen periods. The shaded areas are the chosen periods F1, F2, and H.

Science and Technology (HKUST) Air Quality Research Supersite (<http://envr.ust.hk/supersite/>). The sampling site is strongly influenced by continental outflow during wintertime and oceanic inflow during summertime. Springtime during which our campaign was conducted is a transient period with influences by both continental outflow and oceanic inflow. This provides distinct air mass origin and thus different aerosol composition. The characteristics provide opportunities for comparison of aerosol properties with diverse compositions. Data in two foggy periods and one haze episode was analyzed in detail. We aim at evaluating the degree of oxygenation of OA of aqueous-phase particles and drier particles during foggy and hazy days respectively.

Overview

The foggy weather during *F1* and *F2* and the hazy condition during *H* led to low visibility as shown in the pictures in Figure 1. Also shown in Figure 1 are the visibility, wind vector, RH, and estimated liquid water content in fine particles (LWC_{fp}). Three periods, foggy period #1 (*F1*), foggy period #2 (*F2*) and hazy period (*H*), with each lasting for three days, were chosen for detailed analysis. The two foggy periods *F1* and *F2* had high RH, high LWC_{fp} and relatively high particle mass concentrations. The hazy period (*H*) was the episode during the campaign with high particle mass loadings (up to $60 \mu\text{g}/\text{m}^3$), but the RH and LWC_{fp} during this period were relatively low (Figure 1). On average, the PM concentrations measured by the AMS during *F1*, *F2*, and *H* were respectively 25.8, 19.8, and $32.2 \mu\text{g}/\text{m}^3$, which are all higher than the average concentration during the non-foggy/non-hazy or “other” periods ($11.9 \mu\text{g}/\text{m}^3$). The average organic concentrations during *F1*, *F2*, and *H* were respectively 6.2, 4.2, and $11.0 \mu\text{g}/\text{m}^3$, which are also higher than that in the “other” periods ($3.5 \mu\text{g}/\text{m}^3$).

Degree of oxygenation of OAs

Positive matrix factorization (PMF) resolved organic aerosol factors,

including hydrocarbon-like organic aerosols (HOA), semi-volatile oxygenated organic aerosols (SVOOA), and low-volatility oxygenated organic aerosols (LVOOA), can be used to evaluate the relative contribution of OA factors with different degree of oxygenation. Among them, LVOOA is the most oxygenated factor. The PMF-resolved LVOOA fractions and concentrations were higher (2.95, 2.44, and $6.29 \mu\text{g}/\text{m}^3$, respectively for *F1*, *F2*, and *H*) during the chosen periods than during the “other” periods ($1.49 \mu\text{g}/\text{m}^3$), signifying the large contribution of this portion of most oxygenated organic aerosols in the three chosen periods.

Apart from the relative contributions of OA factors, there are several ways to evaluate the degree of oxygenation of OA based on AMS data. From AMS spectra, Ng *et al.* [2010] used the relationship between f_{44} and $f_{43'}$ as fractions of the two different m/z values in organic spectra, to visualize the relative contributions of the more oxygenated CO_2^+ (m/z 44) and the less oxygenated $\text{C}_2\text{H}_3\text{O}^+$ / C_3H_7^+ (m/z 43) ions (the triangle plot). With high resolution AMS (HR-AMS) measurements, Heald *et al.* [2010] used the hydrogen-to-carbon (H:C) and oxygen-to-carbon (O:C) ratios forming the Van Krevelen diagram (H:C vs. O:C) to infer compositional changes due to different chemical processes. Kroll *et al.* [2011] estimated the carbon oxidation state ($\overline{\text{OS}}_c \approx 2 \times \text{O:C} - \text{H:C}$) to represent the degree of oxygenation of organics. Recently, Ng *et al.* [2011] superimposed the above three ways of representing the degree of oxygenation of OA into one graph. With only OOA factors (SVOOA and LVOOA) around the globe, Ng *et al.* [2011] showed that ambient OOA clustered within the transformed triangle plot with a slope of ~ -0.5 in the Van Krevelen diagram and $\overline{\text{OS}}_c$ of -1.5 to 1.0 in the carbon oxidation state space. The shallower slope (-0.5) compared to that (-1) in Heald *et al.* [2010] indicates that the chemical conversion from less oxidized OA (e.g., SVOOA) to more oxidized OA (e.g., LVOOA) may undergo carboxylic formation with fragmentation of the

carbon backbone [Ng *et al.*, 2011]

During the hazy period (*H*) of our campaign, the organics were the most oxygenated with average $f_{44'}$, O:C and $\overline{\text{OS}}_c$ of 0.15, 0.51 and -0.31 , respectively. The LVOOA fraction (0.57) was the highest in all periods. The high solar irradiance and the high O_x ($\text{O}_3 + \text{NO}_2$) concentration during this period suggest that gas-phase oxidation is probably the dominating process in the oxidation of organics.

In the two foggy periods *F1* and *F2*, the average f_{44} were 0.13 and 0.14 respectively, only slightly lower than that in the hazy period. However, O:C (0.41 and 0.43 for *F1* and *F2*, respectively) and $\overline{\text{OS}}_c$ (-0.50 and -0.38 for *F1* and *F2*, respectively) were substantially lower than those in *H*. The degree of oxygenation indicated by O:C and $\overline{\text{OS}}_c$, which include more ions other than just those of m/z 43 and 44, was still of observable difference between the foggy and hazy periods. Nevertheless, all three chosen periods had degree of oxygenation higher than the “other” periods, which had $f_{44'}$, O:C and $\overline{\text{OS}}_c$ values of 0.12, 0.40, and -0.53 , respectively. These observations suggest that during the two foggy periods *F1* and *F2*, the degree of oxygenation of OA was higher than the “other” periods, and approached that in the hazy period (*H*) even though photochemistry in these two foggy periods were not as active as in the hazy period.

Summary and future needs

We compared the degree of oxygenation of OA in foggy periods and a hazy period using AMS data. Results suggested that during the hazy period when gas-phase oxidation may be still the dominant process that leads to SOA formation resulted in the most oxygenated organic aerosols. Although the gas-phase oxidation is believed to be less effective during the two foggy periods, the degree of oxygenation of OA was still relatively high, compared to the non-foggy/non-hazy or “other” periods. This observation indicates that aqueous-phase processes during the

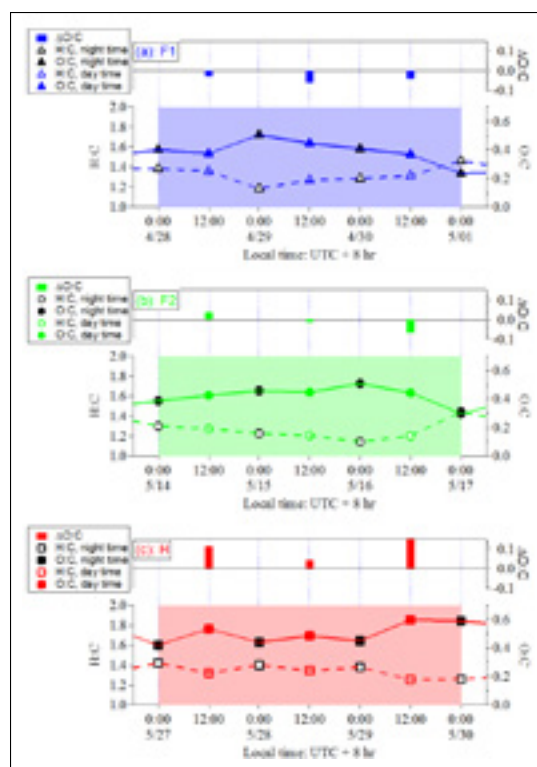


Figure 2. Daytime and nighttime averaged O:C and H:C ratios. The bars representing Δ O:C are the differences between daytime O:C and the O:C at previous night.

foggy periods are also able to incorporate oxygenated organics into particle-phase, contributing to SOA formation, although the extent is not as significant as that during the hazy period.

Figure 2 shows the daytime and nighttime averages of O:C and H:C ratios. During the three days in *H*, the daytime O:C ratios were always higher than those in the previous nights (positive Δ O:C). This further suggests that daytime photochemical reactions in gas-phase may be a dominating process that leads to more oxygenated OA formation. For *F1*, on the contrast, the daytime O:C ratios during the three days were always lower than those in the previous nights (negative Δ O:C). It is also the case for *F2* except for the first day. It is therefore speculated that dissolution of some SVOOA in to wet aerosol droplets during nighttime, when temperature is low and RH is high, may contribute to relatively high O:C ratios observed in *F1* and *F2*. From other evidence such

as the relationship between degree of oxygenation and Ox concentration that represents the oxidative capacity, it is believed that in *F2* the dissolved SVOOA was further oxidized to LVOOA in the aqueous phase, while in *F1* this is not very significant.

It is still difficult to completely distinguish the contribution from gas-phase oxidation and aqueous-phase oxidation during the foggy periods because some oxidants such as O_3 and NO_3 (especially at night time) are still able to oxidize organics in the gas phase. Although the gas-phase oxidation is less effective due to low solar irradiance and relatively low O_x concentration, the contribution of gas-phase oxidation cannot be completely ruled out. Further investigation on the relative contribution from gas-phase oxidation and aqueous-phase oxidation is needed for more accurate model representation of the complicated oxidation processes in the atmosphere.

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Sarah Lawson

2012 IGAC Science Conference
Young Scientists Program Poster Competition Winner
Session Three: Atmospheric Chemistry and Climate

Abstract Title: *"Biomass Burning Emissions from Robbins Island Fire, Tasmania, Australia 41 °S"*

Sarah Lawson originally hails from Hamilton, a modest-sized town in rural Victoria, Australia. She received a Bachelor of Applied Science in Environmental Chemistry from the Royal Melbourne Institute of Technology in Melbourne, Australia. Sarah Lawson is currently pursuing a doctorate at CSIRO and Queensland University of Technology. Her research focuses on the contribution of VOCs to secondary aerosol formation in the background atmosphere of the Southern Hemisphere.

Pursuing or earning a doctorate degree in the field of atmospheric chemistry is not an easy task. What challenges have you had to overcome to get to where you are now?

As an experimentalist, the most challenging aspect of atmospheric chemistry for me is obtaining good quality data in the field. For example, very high instrumental sensitivity is needed to measure VOCs in baseline air at Cape Grim – and this usually requires painstaking attention to detail and a lot of time and patience. Another challenge is dealing with the unpredictability of analytical instruments, which may fail for no apparent reason, at the most crucial

times. When I took the PTR-MS to sea for the first time this year, the possibility of instrument failure weighed heavily upon me – but the PTR-MS actually ran better at sea than it does on land! I have realized this: while you can do everything in your power to coerce your instrument to behave in the field, there is always the ‘uncontrollable’ aspect, the possibility of things going wrong, randomly, for no reason. I am working on being at peace with the uncontrollable aspect.

As a young scientist, you have an exciting future ahead of you. What type of career and topic do you hope to be working on in 5 or 10 years from now?

I see myself continuing in research, with a continued focus on investigating biogenic sources of organic aerosol and trace gases over the ocean. As of next year, Australia will have a new research vessel– the RV Investigator, which will have dedicated atmospheric chemistry laboratories onboard. I hope to contribute to campaigns and long term trace gases and aerosol measurements on the Investigator, which will travel all the way from the ice edge in the Southern Ocean to the tropics. I also hope to have an ongoing role in developing long term VOC measurement capability at our two background sites at Cape Grim and Gunn Point.

Outside of science, what are some of your other interests/hobbies?

I love to spend as much time as possible tending to our vegetable garden, accompanied by our many pets (greyhounds, cats and chickens). On a sunny day, this is my idea of heaven, but even on rainy days I often don the waterproofs and head out for a bout of what my partner calls ‘Extreme Gardening’. I also enjoy cooking produce from the garden, reading, and swimming at the beach (in summer). I have recently discovered that playing guitar gives my brain a much needed break from ‘analysis mode,’ and I have started lessons to improve my self-taught skills and expand my repertoire.

What was the highlight of 2012 IGAC Open Science Conference for you?

This was my first IGAC conference, and there were many highlights for me. The Young Scientists Program was fantastic, and gave me the opportunity to mix with a much larger group of people than I have at other conferences. For an Australian working far away from the centre of the action in Europe and the US, the conference allowed me finally put a face to several familiar names, and allowed me to feel part of the global atmospheric chemistry community. The research presented both through oral presentations and posters was of a very high standard, and extremely relevant to the work I’m undertaking in my PhD. I have already put my hand up for the next one!

Biomass burning emissions – Robbins Island, Cape Grim Australia, 41° S

Sarah Lawson¹, Melita Keywood¹, Ian Galbally¹, Ian Weeks², Simon Bentley², John Gras¹, Jill Cainey³, Mick Meyer¹, Paul Krummel¹, Paul Fraser¹, Paul Steele¹, Suzie Molloy¹, Allen Goldstein⁴ and Zoran Ristovski⁵

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Biomass burning (BB) is globally the second largest source of trace gases (second only to biogenic sources), and the largest source of primary fine carbonaceous particles [Akagi *et al.*, 2011]. BB plumes contain a complex mixture of trace gases and particles, including carbon dioxide (CO₂), methane (CH₄), carbon monoxide (CO), nitrogen oxides (NO_x), ammonia, volatile organic compounds (VOCs) including oxygenated, nitrated and halogenated compounds, carbonyl sulfide, sulfur dioxide and carbonaceous and sulphate-containing particles. As the plume is diluted and undergoes photochemical processing, secondary species such as ozone (O₃), inorganic and organic particles may be formed [Keywood *et al.*, 2011]. The composition of fresh smoke is dependent on many factors including combustion efficiency, local meteorology, terrain, seasonality and fuel (vegetation). Production of secondary pollutants such as ozone in aged plumes depends on precursor emissions, meteorology, the affect of emitted particles on plume chemistry and radiation, and chemical and photochemical reactions [Jaffe and Wigder, 2012].

Reactive gases (for example ozone) and particles in BB plumes can act as short lived climate forcers, and may have a significant impact on global climate. However, the processes that occur in BB plumes which produce ozone and influence particle number and properties

are poorly understood, hampered by difficulties in characterising the complex chemical composition of fresh smoke, and the chemical transformations that occur as the smoke ages. The effect of plume particle transformation on cloud condensation nuclei (CCN) and cloud properties is not well understood, and global climate models do not currently include particle transformations in aging of BB plumes [Hennigan *et al.*, 2012]. The potentially large indirect effect of particle transformations on radiative forcing is therefore not captured by these models. Modelling O₃ production in BB plumes is challenging, and is limited by an incomplete understanding of oxygenated emissions and their photochemical reactions, and scarcity of time resolved data sets of O₃ production in BB plumes [Jaffe and Wigder, 2012]. The interaction of BB plumes with emissions from other sources (such as urban and marine sources) adds a further level of complexity.

There are several regions of the globe where BB emissions, including emission factors, have been sparsely characterised. Emission factors (EF) are a measure of the quantity of gas or particle species emitted during combustion, and are essential for models to reliably determine the affect of BB on climate. While some regions and vegetation types have been relatively well studied, in the temperate forests of Southern Australian, EF data has been published for only a few trace gases [Paton-Walsh *et al.*, 2012; Paton-

Walsh *et al.*, 2008; Paton-Walsh *et al.*, 2005]. The lack of EF data from temperate regions of Australia was also apparent in a recent compilation of EF by Agaki *et al.* [2011], in which all temperate EF reported were from the northern hemisphere from mostly coniferous forests. Species emitted during combustion can be strongly dependent on vegetation type, as highlighted recently by Simpson *et al.* [2011], who observed very high emissions of monoterpenes from boreal forest fires. With this in mind, emission factors from northern hemisphere coniferous forests may not be representative of, for example, Australia's temperate dry sclerophyll forests.

With a number of climate projection studies predicting increased fire severity and frequency as a result of climate change (as summarised in Keywood *et al.* 2011) it is essential to better understand the likely impacts of BB plumes on climate. Here we present emission factors for a range of reactive and long lived gases and particles from a fire plume observed in the marine boundary layer in temperate southern Australia. We also investigate changes in chemical composition with plume aging, with a focus on climatically active species.

The study

Cape Grim is Australia's Baseline Air Pollution Station, located on the north-west tip of Tasmania, 40.683°S latitude and 144.689°E longitude, on a cliff 94 m above sea level. During the intensive



Figure 1. View of the biomass burning plume, looking from the Cape Grim towards Robbins Island.

Precursors to Particles (P2P) campaign at Cape Grim in the Southern Hemispheric summer of 2006 [Cainey *et al.*, 2007] there was a fire on an island some 20 km away. The fire burned through local coastal vegetation (mostly comprised of tea tree and tussock grass) for 2 weeks. Figure 1 shows an image of the plume, looking towards Robbins Island from Cape Grim. An easterly wind advected the BB plume directly across to the station on two occasions: the first occasion for just a few hours, and the second occasion for over 24 hours. This gave a unique opportunity to measure the composition of fresh (~20 minute old) plumes in very clean marine air. When a wind direction change diluted and recirculated the plumes, the changing composition was observed.

The following measurements were made during the fire: VOCs (PTR-MS), particle size distribution 14-700 nm (SMPS), particle number > 3 nm and >10 nm (TSI particle counters), black carbon concentration (aethelometer), CCN number @ 0.5% SS (CCN counter), O₃ (TECO analyser), CH₄ (AGAGE GC-FID), CO and H₂ (AGAGE GC-MRD), CO₂ (CSIRO LoFlo NDIR), N₂O, major CFCs, CHCl₃, CH₃CCl₃, CCl₄ (AGAGE GC-ECD system), minor CFCs, HCFCs, HFCs, PFCs, methylhalides, chlorinated solvents, halons, ethane (AGAGE GC-MS-Medusa) as well as meteorological measurements.

Fresh plume analysis – Modified Combustion Efficiency, Emission Ratios and Emission Factors

The Modified Combustion Efficiency

(MCE) for the whole of the fire was calculated, with an average MCE of 0.89, suggesting the fire was burning with roughly equal amounts of smouldering and flaming [Akagi *et al.*, 2011]. Fire averaged Emission Ratios to CO and Emission Factors (EF) (g/kg) were calculated using the carbon mass balance method for a variety of species, including methane, nitrous oxide, molecular hydrogen and black carbon as well as a variety of VOCs including aliphatic and aromatic hydrocarbons (including ethane, benzene, toluene etc) and a range of oxygen, nitrogen and halogen containing VOCs (including furan, phenol, acetaldehyde, acetone, hydrogen cyanide, acetonitrile and the methyl halides). Background concentrations of gas and particle species were determined during a fire-free period with a very similar air back trajectory to the trajectory during the fire.

An example of calculated EF versus MCE is shown in Figure 2, where each data point is equal to a one hour period. The relationship shown is consistent with other studies, where the amount of emitted VOC species decreases with increasing MCE, as in a more efficient 'flaming' fire, a higher proportion of the fuel carbon is combusted into CO₂.

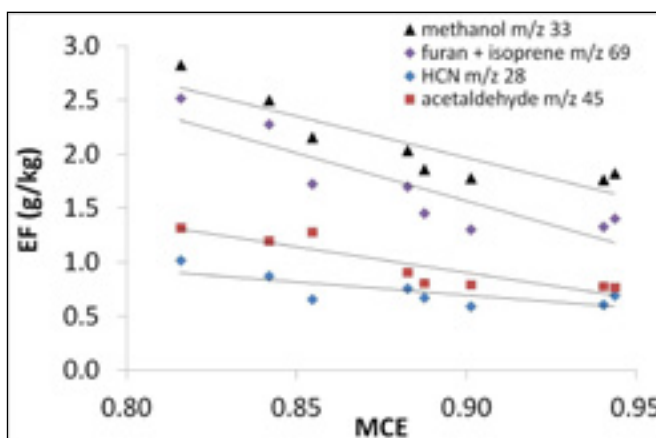


Figure 2. An example of some EF plotted versus MCE for VOCs measured with PTR-MS, where each point is an hourly measurement. $MCE = \Delta CO_2 / (\Delta CO_2 + \Delta CO)$, $EF = \Delta X / (\Delta CO + \Delta CO_2)$, assuming 50% fuel carbon content

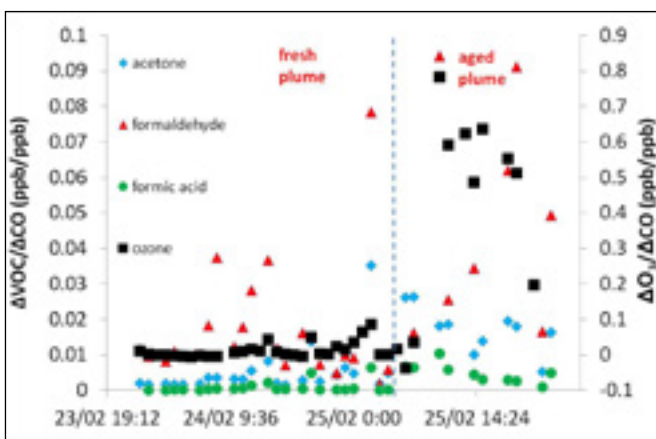


Figure 3. Normalised Excess Mixing Ratios (NEMR) of oxygenated VOCs and ozone, before and after the wind direction change (dotted line)

Aging plume analysis – production of ozone and oxygenated VOCs, particle growth and changes to particle properties

On both occasions when the fresh emissions were impacting the station, the wind changed direction to the north and then the west, diluting the fresh plume and recirculating it over the ocean and mainland Australia, before being returned to Cape Grim. In both cases, this led to ozone formation, with a maximum increase of ~20 ppb observed. Normalised Excess Mixing Ratios (NEMR) of trace gases and particle were calculated, where Δx (the gas or particle species) is divided by ΔCO

concentration to normalise for mixing [Akagi *et al.*, 2011]. The NEMR of a number of oxygenated VOCs increased alongside ozone, including formaldehyde, formic acid and acetone, which suggests they are produced in the plume by photochemical oxidation (see Figure 3). Studies elsewhere in the world have also observed an increase in ozone and oxygenated VOC NEMR in aged BB plumes, including studies in the South African Savanna [Hobbs *et al.*, 2003], in Californian Chaparral [Akagi *et al.*, 2012] Mexican deforestation and crop residue fires [Yokelson *et al.*, 2009] and in chamber studies [Hennigan *et al.*, 2012]. NEMR in this study are relatively high compared to NEMR observed in other aged plumes, suggesting the plume recirculated to Cape Grim is either several days old, and/or has mixed with additional ozone precursors during transport over mainland Australia. We are currently using a chemical transport model set to determine the age of the recirculated plume, and relative contributions from the fire, marine, terrestrial and urban sources to the photochemistry.

The affect of photochemical processing on particle properties was also investigated. The particle size distribution data showed a particle growth event in the aged plume, with particle size increasing over several hours, alongside increasing concentrations of ozone. This suggests that low volatility species may have condensed on to existing particles, with low volatility species either produced from gas phase reactions, or condensation of semi volatile vapours co-emitted with primary organic aerosol. The ability of particles to act as CCN was investigated both in fresh and aged plumes by comparing the ratio of Δ CCN number to Δ CN number, for particles > 80nm (CN80). Because all CN particles > 80nm are at a size capable of acting as CCN, the observed difference in the CCN/CN80 ratio may be due to different chemical composition of fresh and aged particles and/or to different size distributions of fresh and aged particles, as larger particles are more

easily activated to CCN. The ratio of Δ CCN/ Δ CN80 in aged plumes with ozone production was almost twice as high as the ratio in the fresh plumes. There was no evidence that the aged particles had a larger diameter than the fresh particles. Therefore the higher proportion of particles in aged plumes able to act as CCN suggests the aged particles are more water soluble or hygroscopic than fresh particles –perhaps due to heterogeneous oxidation reactions. The significant change in particle properties we observed in aged BB plumes highlights the importance of including these particle transformations in global climate models.

This work provides much needed trace gas and particle emission factors for Southern Australia and demonstrates the substantial changes in BB plume composition that can occur with dilution and aging. A detailed manuscript is in preparation.

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Jing Huang is originally from Jiangxi Province in southern China, one of the revolutionary base areas in the anti-Japanese war and liberation war. Jing Huang received her undergraduate degree from Tianjin Medical University, China in public health and is currently finishing her PhD from the School of Public Health Peking University, Beijing, China. Her current research focuses on exposure assessment of traffic-related air pollutants and health effect related to traffic exposure.

Pursuing or earning a doctorate degree in the field of atmospheric chemistry is not an easy task. What challenges have you had to overcome to get to where you are now?

In the process of pursuing a doctorate degree, many challenges have to be overcome. For example, in the investigation of comparing commuters 'exposure to fine particle and carbon monoxide by different transportation modes in Beijing', I encountered many difficulties including research design, measurements of air pollutants, data analysis and dissertation writing. Each

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2012 IGAC Science Conference
Young Scientists Program Poster Competition Winner
Session Four: Atmospheric Chemistry and Health

Abstract Title: *"Exposure Levels of Fine Particle and carbon Monoxide in Transportation Modes while Commuting in Beijing"*

part of the research is not easy until you have understood and experienced it. However, the research experience is a very precious resource, and people will become stronger after they overcome obstacles.

As a young scientist, you have an exciting future ahead of you. What type of career and topic do you hope to be working on in 5 or 10 years from now?

Thank you for encouragement! In the next 5 or 10 years, I would like to continue doing research on environmental health. Because everyone is exposed to harmful environmental factors, it's important to investigate their related adverse health effects. Meanwhile, exploring the mechanism of adverse health effects and taking appropriate preventive measures have great significance for promoting public health. I would like to apply what I have learned into practice, so continue to do research and application of environmental health is what I wish to pursue in my career.

Outside of science, what are some of your other interests/hobbies?

I like Chinese calligraphy, tourism and music outside of science. Calligraphy is an art dating back to the earliest day of history, and it's widely practiced throughout China.

Practicing calligraphy gives me a good opportunity to appreciate the beauty of art, and enhance my patience because it always needs a lot of practice before the calligraphy looks good. In my spare time, I like to travel. Tourism has enriched my experience and broadened my vision. There is an old saying in China "Read ten thousand books and travel ten thousand miles", which illustrated the importance of tourism. In addition to Chinese calligraphy and tourism, I like music very much because it gives me a relaxing feeling and I can always improve working efficiency after listening to music.

What was the highlight of 2012 IGAC Open Science Conference for you?

Session 4 of the 2012 IGAC Science Conference "Atmospheric Chemistry and Health" was the most instructive part for me because my research mainly concerns air pollutants exposure assessment and their health effects. Nowadays, it is difficult to establish conclusively what components are more responsible for adverse health effects than others because air pollution mixtures are inherently complex. The oral and poster presentation in Session 4 provide some perspectives for the future research in this area. Meeting people who are doing relative research and communicating with them is interesting and meaningful.

Exposure science: The bridge between traffic-related air pollution and health effects

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Introduction

A World Health Organization report on the health effects of traffic-related air pollution pointed out that people spend 1-1.5 h/day commuting in many countries [World Health Organization, 2005]. The concentrations of pollutants in traffic microenvironments are often elevated, thus people may gain a significant contribution to their daily exposure when commuting in traffic [Kaur *et al.*, 2007].

The associations of exposure to traffic-related air pollution and adverse human health effects have been demonstrated in many epidemiologic studies. For example, a study conducted in Germany estimated an odds ratio of 1.85 for prevalence of coronary heart disease in residents living within 150 meters of major roads compared to those living far away [Hoffmann *et al.*, 2006]. And living near a major road increased the risk of cardiovascular mortality with an odds ratio of 1.05 [Beelen *et al.*, 2008]. Even one hour exposure in traffic was reported to be associated with the onset of myocardial infarction [Peter *et al.*, 2004].

Exposure science is the bridge between traffic-related air pollution and health effects. Studies

of exposure are crucial in order to get a better understanding of the health risk posed by traffic-related air pollution in urban traffic microenvironments and for making informed decisions to manage and reduce the health risks.

Exposure assessments

Methods of exposure assessments

Traffic-related air pollutants affect ambient air quality on a wide range of spatial scales, from broadly regional background scales to urban scales, local roadsides and human scale as indicated in Figure 1. Many methods were used to assess the

exposure levels in traffic microenvironments including fixed site monitoring, personal exposure measurement, surrogate approaches such as traffic density and distance to the road, model evaluation methods such as geostatistical interpolation models, land-use regression models, dispersion models and so on.

Personal exposure assessments

Nowadays, studies assessing the commuters' personal exposure in urban traffic microenvironments have steadily increased in number. Compared to fixed site monitoring data, personal exposure data were

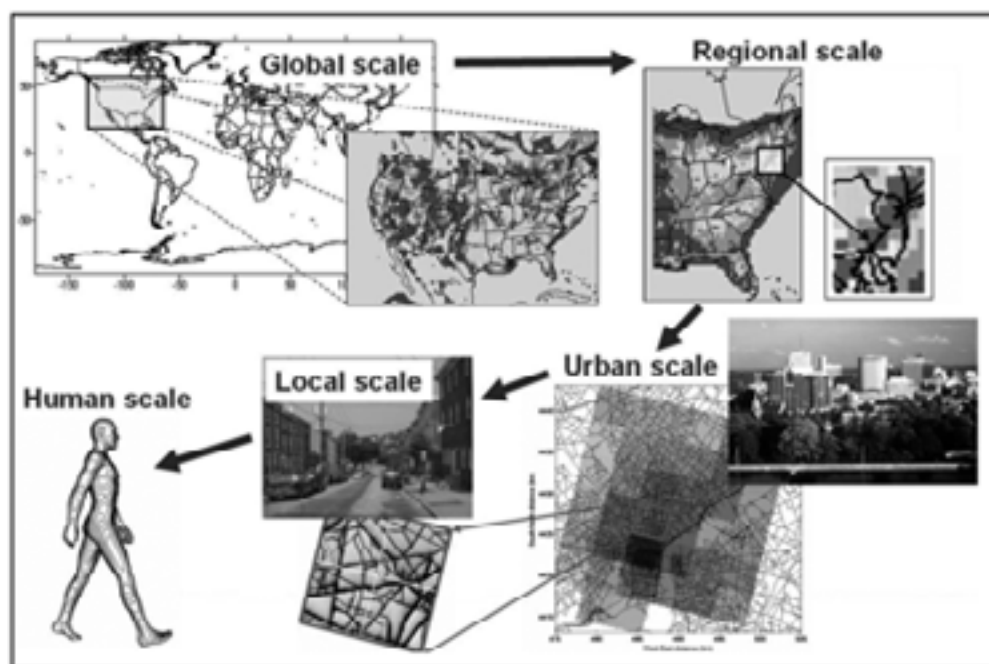


Figure 1. Graphic representation of the scales used in modeling emissions from traffic [Stein *et al.*, 2007].

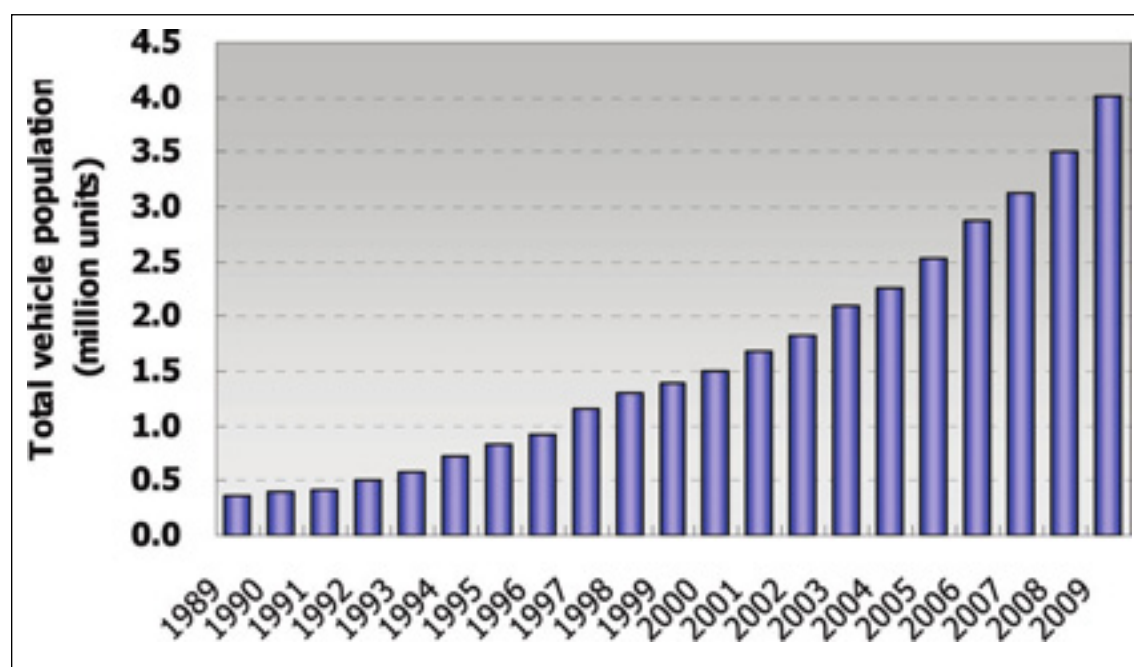


Figure 2. Growth in total vehicle population in Beijing, 1989-2009 [Wu *et al.*, 2011]

considered to be better indicators in traffic microenvironments. Because emissions of air pollutants from vehicles comprise numerous organic and inorganic compounds in both the particle and gas phases, several air pollutants have been used as surrogates to represent the contribution of vehicle emission. The most common used surrogates include PM, PM₁₀, PM_{2.5}, UFP, EC, CO, NO₂ and benzene. In-vehicle concentrations of most traffic-related gases and aerosols are higher than ambient concentrations and were highly variable. For example, concentrations of PM_{2.5} and CO were 2.5 and 6 times higher than concentrations measured at nearby urban fixed sites and had wide ranges [Adams *et al.*, 2001; Kaur *et al.*, 2005]. Although many personal exposure studies have performed, they often did not take inhalation rate and exposure time into account thus the whole trip exposure to traffic-related air pollutants were not clear. In addition, personal exposure levels of common environmental friendly

transportation modes such as walking and cycling were not measured in most investigations.

We carried out a study that compared commuters' exposure to PM_{2.5} and CO in different transportation modes in Beijing. As Figure 2 shows, the growth of on-road vehicles has been very rapid over the past two decades with an increasing rate of 13% in Beijing. The total vehicle population reached 4.02 million in 2009. In 2010, the amount was nearly 5 million and the number is still growing. These vehicles have become a major source of air pollution in Beijing and have caused many health concerns. Through our study, we want to provide some information that can help the public to avoid potential health risk related to traffic exposure. Three commonly used transportation modes were selected, including bus, taxi and bicycle. We found that taxis with windows closed inclined to prevent infiltration of PM_{2.5} into the compartment, thus taxi commuters

were exposed to lowest concentration of PM_{2.5}. Meanwhile, as the main source of CO is in-vehicle pollution, semi impermeable characteristic of taxis lead to accumulation of CO. The complicated situations in traffic microenvironments cannot be elucidate well by fixed site monitoring data. In addition, cyclists' higher inhalation rate and longer trip duration across the same distance lead to their highest whole trip exposure to PM_{2.5} and CO, which indicated they are possibly subject to higher health risk related to traffic exposure compared with bus and taxi commuters. Thus some actions such as reducing vehicle exhaust, relieving traffic congestion, and applying individual protection methods should be taken.

Future Directions

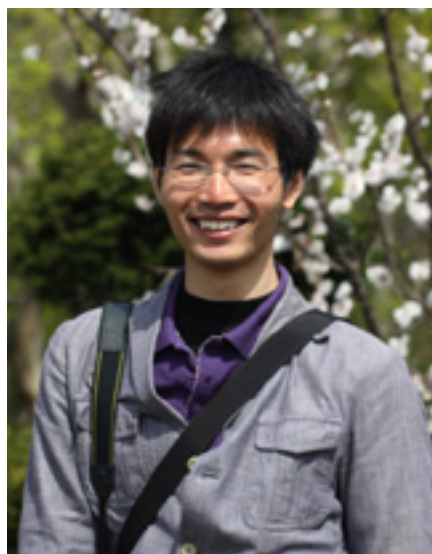
Though the number of personal exposure studies is increasing, it's still insufficient to fully illustrate personal exposure to traffic-related air pollutants in different transportation modes. The levels of personal expo-

sure is influenced by various factors including transportations modes, traffic factors such as proximity to the sources, meteorological factors such as wind, personal/individual factors such as inhalation rate and so on [Kaur et al., 2007]. Given these reasons, assessing commuters' exposure to traffic-related air pollutants poses significant challenges. In future studies, multi-exposure assessments in the traffic microenvironments should be conducted. A large number of factors that can potentially influence personal exposure concentrations, such as traffic factors and meteorological parameters should be measured along side with personal exposure measurements. In addition, exposure time and inhalation rate should be measured to calculate the whole trip exposure. Furthermore, standard and refined equipments should be used in order to make the measurement results comparable.

In conclusion, better understanding of traffic exposure and their determinants in the traffic microenvironments will contribute to the development of more appropriate exposure reductive strategies and have significant public health meanings.

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Chunmao Zhu is originally from Shangqiu, China, which is not far from Shaolin Temple, one of the cradle lands of Chinese Kong Fu. He received his undergraduate degree in horticultural science from Henan Institute of Science and Technology in China and a master's degree from China Agricultural University in the subject of carbon/nitrogen biogeochemical cycling in the soil-plant system. Chunmao Zhu is currently pursuing a doctorate at Hokkaido University in Japan. His research focuses on the sources and sinks of atmospheric CO₂ in East Asia.

Pursuing or earning a doctorate degree in the field of atmospheric chemistry is not an easy task. What challenges have you had to overcome to get to where you are now?

My background in college and my master's course was agricultural science

Chunmao Zhu

2012 IGAC Science Conference
Young Scientists Program Poster Competition Winner
Session Five: Atmospheric Chemistry and Surface-Atmosphere Exchange

Abstract Title: *"CO₂ Effluxes from Seasonal Snow Pack in a Mid-Latitude Forest: Profile Gradient Measurement Through an Automated Tower"*

and ecology. To me, atmospheric chemistry is a cross-disciplinary field. In order to understand one atmospheric phenomenon, for example, I have to replenish myself not only in atmospheric chemistry, but also in ecology, meteorology and physics etc. It is effort consuming but interesting to understand the atmosphere from various aspects.

As a young scientist, you have an exciting future ahead of you. What type of career and topic do you hope to be working on in 5 or 10 years from now?

I would like to continue the research focusing on the study on carbon cycle from local to global scale. In order to achieve a better understanding of the issue, I would like to work toward proficiency in the following three approaches: to estimate carbon balance between the terrestrial biosphere and the atmosphere based on in situ observation, to deduce sources and sinks of atmospheric CO₂ based on surface observation and

reverse modeling, and to evaluate the carbon balance adopting satellite observation.

Outside of science, what are some of your other interests/hobbies?

In my spare time, I often appear on a mountaintop sweating. Plus, I was a fan of photography until I slowed down after noticing that the desire on digital lenses is endless. During the past three years living in Japan, I am getting addicted to hot springs.

What was the highlight of 2012 IGAC Open Science Conference for you?

This was the first time for me to participate in IGAC science conference. It was a great chance to learn what the world is doing in the area of atmospheric chemistry. Moreover, once again I realized the importance of communication in the community.

Non-neglectable emission in winter: soil CO₂ effluxes under seasonal snowpack

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Active soil under the snow

In the context of carbon exchange between the terrestrial biosphere and the atmosphere, around half of the carbon is emitted from the soil by the microbial respiration and organic compounds decomposition [U.S. DOE, 2008]. When studying the soil respiration based on the bottom-up field observations, most of the works focused on the growing season [e.g., Schwendenmann and Veldkamp, 2006]. However, it has been realized since the latest two decades that soil respiration in winter contributes to a large amount of carbon emission when the surface was covered by snow, typically in the mid-to-high latitude and alpine regions [Brooks et al., 2011; Sommerfeld et al., 1993]. Soil temperatures under the snow can exceed 0 °C, although the air temperature reaches minus several tens of degrees. Snow acts as a natural barrier to buffer the cold air from reaching the soil. Meanwhile, as the snow melts at the soil-snow interface, it provides a continuous supply of water to soil microbial communities that thrive in the growing season [Monson et al., 2006b; Schadt et al., 2003; Zinger et al., 2009]. Contrary to previous recognition that the emission in winter was insignificant, it was found that winter accompanied by seasonal snow contributed 10~18% to total annual soil respiration from mid-

latitude subalpine forest to arctic heath [e.g., Monson et al., 2006a; Björkman et al., 2010]. Neglecting winter emissions would result in inaccurate estimation of the annual carbon cycle.

Estimating CO₂ efflux under the snowpack

Several approaches have been developed to estimate CO₂ efflux in the snowing season. Similar to that being applied in the non-snow season, a chamber was installed at the soil surface to estimate CO₂ efflux during the snow season. This approach allows for direct evaluation of winter contribution to annual soil respiration. However, if the chamber is installed within a snow pit, the measurement would also incorporate CO₂ being laterally diffused from the snowpack, causing the so-called “chimney effect”, which frequently resulted in an overestimation of CO₂ efflux [McDowell et al., 2000]. A change to this approach is to install the floating chamber on the snow surface. This allows for direct measurement of CO₂ efflux with little disturbance to the snow and underneath soil. The floating chamber was advantageous and required comparatively few assumptions and is a convenient measurement. However, it was difficult to conduct high-resolution time-series measurements. Meanwhile, the lateral

diffusion and advection within the snowpack that was frequently caused by the formation of ice layer and pressure difference would bias CO₂ efflux [Schindlbacher et al., 2007]. The gas diffusion approach, pioneered by Sommerfeld et al. [1993], estimated CO₂ efflux by measuring the concentration gradient between the snow surface and the soil-snow interface based on Fick’s first law of diffusion. This approach is advantageous in that it is suitable for long-term continuous deployment, applicable to multi-ecotypes and allows for avoiding disturbance to the natural soil beneath the snow.

Major challenges in gas diffusion approach

In light of the above-mentioned advantages, the gas diffusion approach has been used in an increasing number of studies. The estimation was based on the CO₂ concentration gradient and snow property, namely snow porosity, tortuosity, temperature and pressure [Mast et al., 1998]. While the snowpack temperature and pressure could be directly measured, porosity and tortuosity was often estimated indirectly based on the snow density, which was mostly estimated by intermittent measurements of the whole layer mean. Therefore, errors might be introduced since the snowpack was frequently not a



Figure 1. The multi-layer sampling unit used to estimate soil CO₂ efflux under the snowpack in at Rishiri Island, Japan. CO₂ was sampled sequentially through inlets at 120 cm, 90 cm, 60 cm, 30 cm, and 10 cm above the ground to a laboratory ~5 m away for concentration detection. The large photo shows the sampling unit in the mid-winter (February 23, 2011), while the insertion shows that before snow cover development (December 10, 2010).

vertically homogeneous medium. Furthermore, like the floating chamber approach, the possible formation of ice layers could block the diffusion process. While continuously investigating the existence of an ice layer is difficult, it is possible to examine the process

by measuring the gas concentration profile within the snowpack.

Using the gas diffusion approach, we examined soil CO₂ efflux under the seasonal snowpack on Rishiri Island, Japan in the sub-arctic region

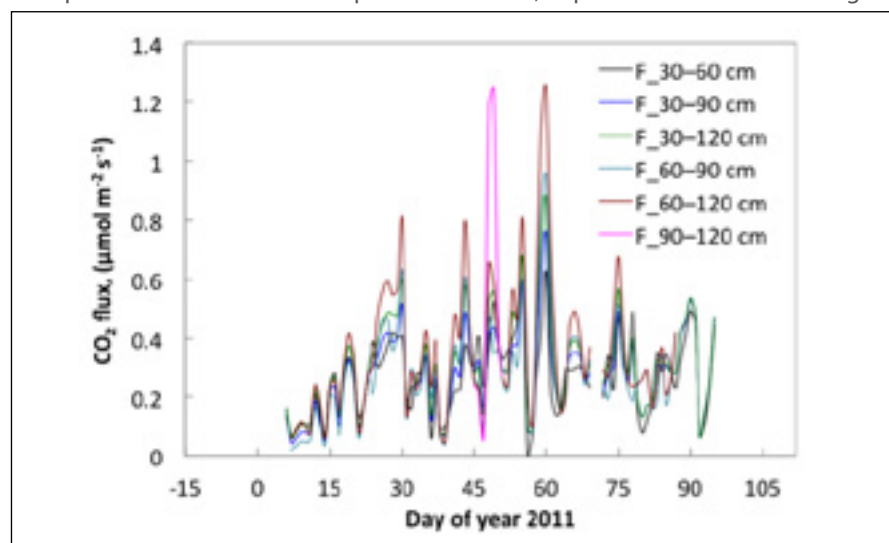


Figure 2. CO₂ flux estimated by inlet combinations within the snowpack based on gas diffusion approach. The accordance among different sampling intervals indicates well-established concentration gradient. The 10 cm inlet was not included because malfunction in the solenoid controlling sampling at this height occasionally occurred.

during the 2010–2011 winter. The major snow season lasted ~80 days from Day of Year (DOY) 7 to 90 with a depth of 65–105 cm. We constructed an automated sampling system prior to the snow cover development. CO₂ was sampled at 10 cm, 30 cm, 60 cm, 90 cm, and 120 cm above the ground (Figure 1). Our estimation indicated that CO₂ efflux among available inlet combinations agreed well for the seasonal variation both in magnitude and pattern (Figure 2). The average linear correlation coefficients between different intervals of bi-hour observations ranged from 0.22 to 0.97 ($p < 0.0001$, $n = 96\text{--}1059$). These results indicated that the concentration gradient was well established. Taking the 30–60 cm inlet combination as representative, we estimated a seasonal mean flux of $0.27 \mu\text{mol m}^{-2} \text{s}^{-1}$. We also found that the CO₂ flux increased by $0.00128 \pm 0.0005 \mu\text{mol m}^{-2} \text{s}^{-1}$ per day in the mid-winter ($R^2 = 0.07$, $p < 0.05$). Investigation on the environmental controlling factors indicated that CO₂ efflux was associated with air temperature ($R^2 = 0.16$, $p < 0.001$). However, it was not significantly influenced by soil temperature, soil water content, or snow depth in the major snow season, since these parameters varied within a short range.

Another challenge that should be considered when using gas diffusion approach is the wind-related pressure pumping effect. Within the snowpack, it was found that the pressure fluctuations caused large pumping gas flows [Massman, 2006]. This pumping effect caused underestimation of soil efflux. We estimated a mean underestimation of soil CO₂ flux of 33% during the entire snow season due to wind-related pumping effects in the above-mentioned observation. Similar phenomenon was also observed by Seok *et al.* [2009] and Suzuki *et al.* [2006] who estimated underestimations by 36% and 30%, respectively. A protocol

for eliminating the pumping effect is needed in CO₂ efflux estimation when applying the gas diffusion approach.

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Shang Liu

2012 IGAC Science Conference
Young Scientists Program Poster Competition Winner
Session Six: Atmospheric Chemistry Fundamentals

Abstract Title: *“Hydrolysis of Organonitrate Functional Groups in Aerosol Particles”*

Shang Liu is originally from Changchun City in Northeast China. He received his undergraduate degree from Jilin University in China in environmental sciences and a Master's degree in atmospheric sciences from Peking University in China. Shang Liu earned his doctorate degree from the University of California, San Diego, USA in atmospheric science and is currently a Postdoc Research Associate at the Los Alamos National Lab in New Mexico, USA. His research focuses on the chemical, physical, and optical properties of atmospheric aerosols.

Pursuing or earning a doctorate degree in the field of atmospheric chemistry is not an easy task. What challenges have you had to overcome to get to where you are now?

I had to overcome many challenges to get the doctorate degree. As a non-native English speaker, I had to spend a large fraction of time on

writing and presenting in English. I also had to overcome the frustration when instruments failed to work and struggled to get papers published. In addition, like every scientist, I sacrificed many weekends for work.

As a young scientist, you have an exciting future ahead of you. What type of career and topic do you hope to be working on in 5 or 10 years from now?

I imagine myself to be an independent research scientist. In 5 to 10 years, there will be great improvements in atmospheric sciences but more questions may emerge; by then I hope I can integrate what I have learned and expand my knowledge, such as to modeling, in order to work on cutting-edge problems. I also hope I can collaborate with other research groups to develop new instruments in order to get a more comprehensive picture of the complicated atmosphere.

Outside of science, what are some of your other interests/hobbies?

I have broad interest outside of science.

I like hanging out with friends and enjoy whatever I do with them. Specifically, I love to travel and do sports such as swimming, skating, skiing. I am also interested in traditional Chinese arts such as calligraphy and seal cutting. And as a Chinese, of course I love Chinese food!

What was the highlight of 2012 IGAC Open Science Conference for you?

The 2012 IGAC Open Science Conference is one of the greatest conferences I have been to. I appreciate the Young Scientists Program during the conference, which provided great opportunities for me to meet many famous scientists as well as other young scientists in our field. I believe I will benefit from the wisdom I learned from other people and the friendships built during the conference for the rest of my academic life.

Hydrolysis of organonitrate functional groups in aerosol particles

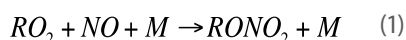
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Introduction

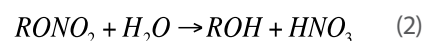
Atmospheric organonitrate (ON) molecules are produced by oxidation of volatile organic compounds (VOCs) in the presence of NO_x. Major oxidants in the atmosphere are OH radicals, ozone (O₃), and NO₃ radicals, and the VOCs responsible for secondary organic aerosol (SOA) formation are largely composed of aromatics, alkanes, and alkenes. The most important step during photochemical oxidation in which ON groups (ONO₂) form is the reaction of peroxy radicals (RO₂) with NO [Roberts, 1990]:



Laboratory studies suggest that reaction (1) is an important sink for peroxy radicals [Lockwood *et al.*, 2010], one of the most common intermediate products of VOC oxidation, suggesting that ON groups could be important products that lead to SOA formation. Yields of gas-phase ON molecules typically range from 5% to 20% in OH radical oxidation reactions [Atkinson and Arey, 2003]. Particle-phase ON molecule production has been observed in reaction chamber studies [Fry *et al.*, 2009], with high molecular weight VOCs having higher ON molecular yields. A model study [Camredon *et al.*, 2007] predicts that 18% of secondarily formed molecules in particle phase contain ON groups, suggesting that ON groups should account for a large fraction of organic mass (OM).

Despite these model predictions,

direct measurements of particle-phase ON concentrations in both laboratory and ambient studies are scarce due to limitations of measuring techniques and ON concentrations often must be inferred. For example, Zaveri *et al.* [2010] inferred up to ~0.4 μg m⁻³ of particulate organonitrates in a nocturnal power plant plume. Using the Fourier transform infrared spectroscopy (FTIR) technique, ON groups were quantified as 3% of OM in fine particles in coastal Southern California [Day *et al.* 2010] and below detection limit in most other regions. The difference between observations and model predictions suggests a significant sink of ON exists that operates on timescales of several hours. One possibility proposed by Day *et al.* [2010] and Russell *et al.* [2011] is that ON groups hydrolyze under ambient conditions to give alcohols and nitric acid:



In this study, we simulated formation of SOA that contains ON groups in a

reaction chamber under controlled conditions. We used an aromatic hydrocarbon, an important compound class that typically accounts for 20% to 30% of VOCs in urban areas [Lim and Ziemann, 2005], as the SOA precursor. We focused on effects of RH on formation and loss of ON groups.

Experimental Methods

Secondary organic aerosols were produced in a temperature-controlled (25°C), 10.6 m³ Teflon reaction chamber at Pacific Northwest National Laboratory (Richland, WA). HONO was used as the NO_x and OH radical initiator and 1,2,4-TMB was used as the VOC precursor. The reaction was initiated by turning on all the 104 UV lights, which photolyzed the HONO generate OH radicals that reacted with TMB. RH was varied from 0-90% in the reaction chamber. Experimental conditions are summarized in Table 1.

One filter sample was collected for each experiment to quantify organic

Date	TMB ₀ (ppb)	NO _{x0}	TMB: NO _x	RH (%)	M _{org} (μg m ⁻³)	Fon (%)	Yom (%)	R _{mole}
3/12/2011	454.8	1483.7	0.31	< 1.5	37.0	19.9	1.7	8.7
3/23/2011	291.8	1799.9	0.17	< 0.3	46.7	19.0	3.3	9.2
3/15/2011	370.1	1639.8	0.24	15.0-20.0	65.7	19.0	3.6	8.5
3/17/2011	366.8	2264.7	0.17	37.8-49.0	70.6	11.9	3.9	21.2
3/21/2011	380.6	1610.0	0.24	53.7-66.8	73.4	7.9	3.9	37.5
3/28/2011	276.8	1854.8	0.17	85.2-86.5	61.0	4.8	4.5	73.1

Table 1. Experimental conditions including initial mixing ratios of TMB and NO_x, RH, total organic loading (M_{org}), mass fraction of organonitrate groups (Fon), yield of OM (Yom), and molar ratio of alkane to ON groups (R_{mole}) in SOA.

functional group mass using a Bruker Tensor 37 FTIR [Gillardoni *et al.*, 2009; Liu *et al.*, 2011]. An Aerodyne HR-ToF-AMS (Billerica, MA) was used to measure SOA mass loadings with ~10 minute time resolution [DeCarlo *et al.*, 2006]. Additional measurements include: 1) O_3 measured by an ultraviolet photometric O_3 analyzer (Thermo Electron Instruments, Model 49C), 2) NO and NO_x monitored by a NO - NO_2 - NO_x Analyzer (Thermo Environmental Instruments, 42C), and 3) 1,2,4-TMB mixing ratio recorded by a Proton-transfer-reaction mass spectrometry (PTR-MS) [Ionicon; Lindinger *et al.*, 1998].

Results and discussion

ON groups were observed in all SOA samples, as indicated by peaks at 1644, 1281, and 849 cm^{-1} in the IR spectra (Figure 1). The FTIR-measured ON groups and AMS-measured nitrate correlated well (Figure 2), suggesting that the AMS-measured nitrate was organic nitrate. The time-dependence of AMS-measured OM and nitrate is shown in Figure 3e and 3f, respectively. The concentration of nitrate increased rapidly at the beginning of the reaction and reached a maximum after ~1 hour. During the first 2 hours of reaction, TMB and NO decayed exponentially (Figure 3c and 3d), suggesting that the majority of ON molecules were formed within 2 hours of the start of the reaction.

3.1 Hydrolysis of organonitrate groups

The average ON group mass fraction measured by FTIR consistently decreased with increasing RH (Figure 4a), especially when RH was greater than 20%. The decrease of ON group mass fraction (as a function of RH), an indication of ON group loss, was supported by real-time measurements of ON group loss under humid conditions (Figure 5). To quantify the

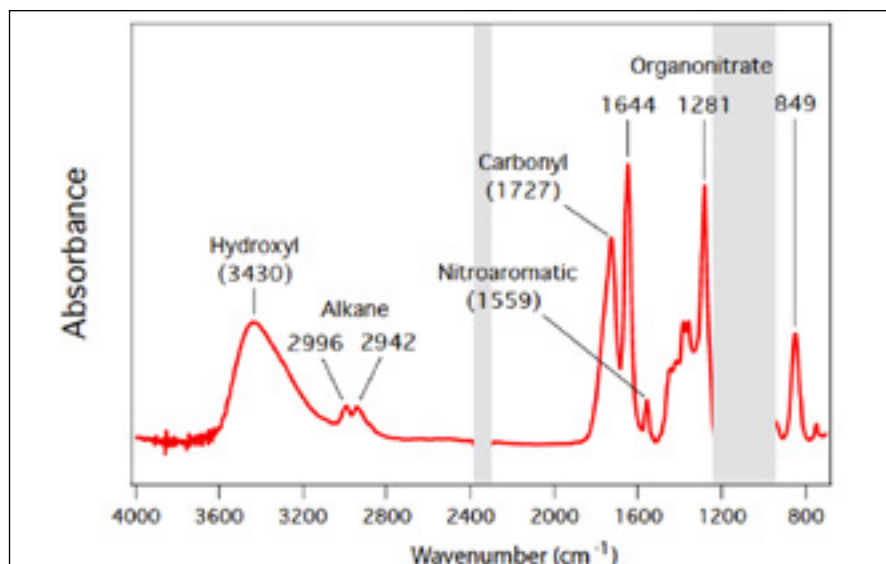


Figure 1. Representative FTIR spectrum for SOA (produced on March 23). Absorptions near 1100 cm^{-1} and 2360 cm^{-1} (grey areas) are not shown due to interferences by Teflon substrates and CO_2 , respectively.

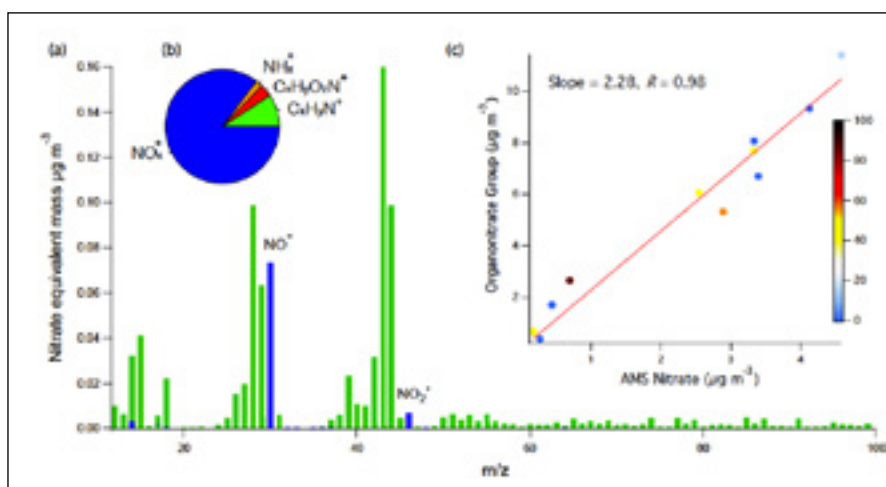


Figure 2. (a) Typical mass spectrum for SOA generated on March 23. (b) Mass fraction of nitrogen-containing fragments (on March 23). (c) Comparison of FTIR-measured ON groups and AMS-measured nitrate for all experiments. The RH (%) is indicated by the vertical scale.

loss rate, particle wall loss and dilution of organonitrate group concentrations by condensation of non-nitrate SOA were taken into account using the number concentration measurements described in Paulsen *et al.* [2005]. After the wall-loss correction, positive values in Figure 4b indicate a net mass production of a species while

negative value indicates net mass loss of a species. The production rate of OM and nitrate show that nitrate loss (at a rate of 4 day^{-1}) occurred when RH was greater than 20%, while the loss of OM (for RH > 20%) was negligible (near 0) after the wall-loss correction. Figure 4b and Figure 5 suggest that the greater loss rate of the nitrate mass fraction at

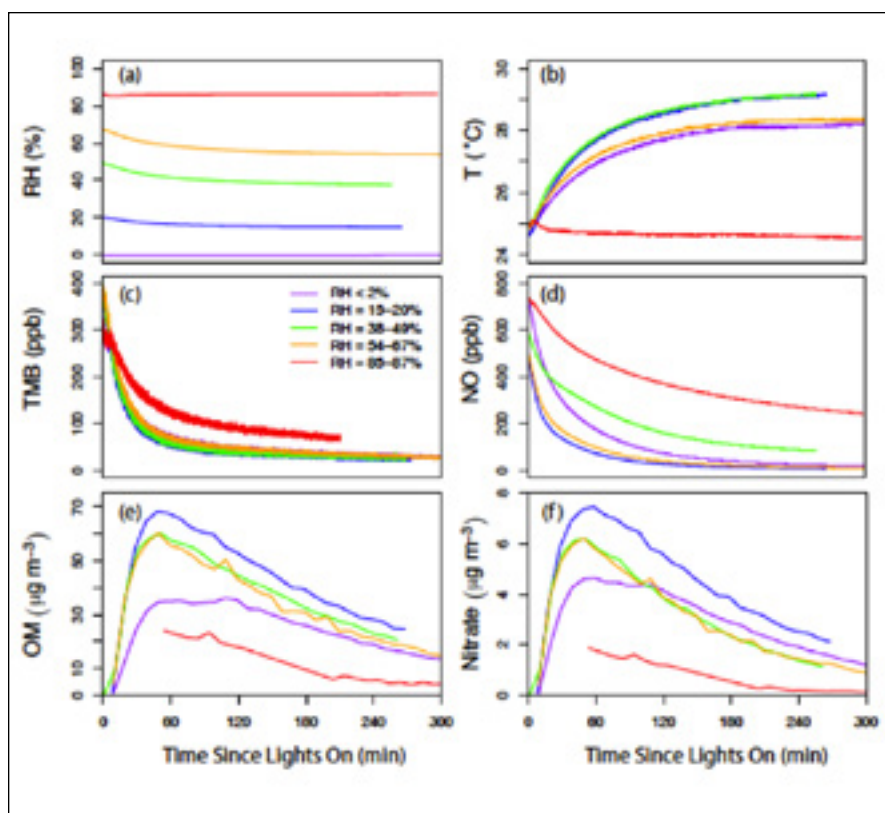


Figure 3. Time-dependence of (a) RH, (b) temperature, (c) TMB, (d) NO, (e) AMS-measured OM, and (f) AMS-measured nitrate. The AMS measurements on March 28 (RH~85%) were only available 1 hour after the lights were on due to improper experimental setup during the first hour.

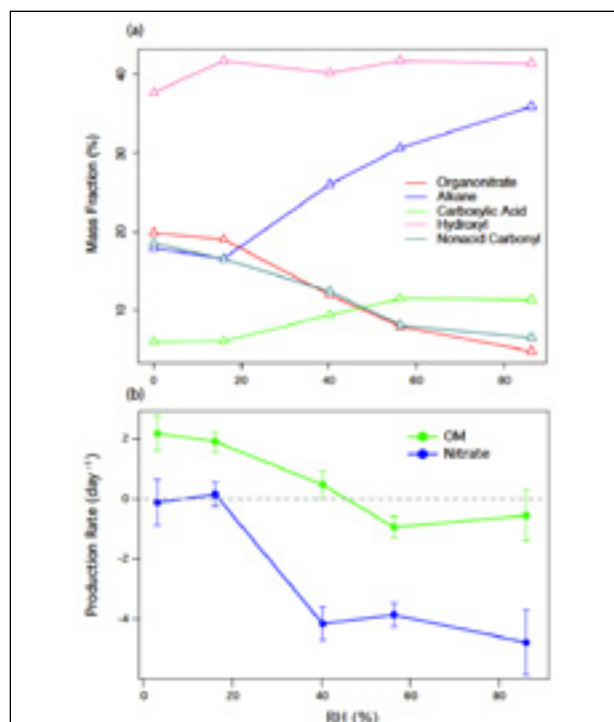


Figure 4. (a) RH dependence of organic functional group mass fraction. The mass fractions are derived from the FTIR measurements. (b) Production rate of AMS-measured OM and nitrate.

RH > 20% resulted from true loss of nitrate rather than from a dilution effect due to continued production of non-nitrate OM. In contrast, the decrease of nitrate mass fraction over time at RH < 20% could be explained by OM production (Figure 4b), which was likely the result of either multi-generational chemistry [Robinson *et al.*, 2007] or polymer formation, a reaction that is typically highly unfavorable when RH is high [Jang *et al.*, 2002; Jang *et al.*, 2004].

Based on the following observations: 1) the only changing variable was RH, 2) water vapor did not affect gas-phase chemistry, 3) condensed-phase water increased with increasing RH [Seinfeld *et al.*, 2001], and 4) the observed loss of ON group mass under humid conditions, particle-phase hydrolysis of ON groups via reaction (2) provides the most consistent explanation for the observations. According to Wyche *et al.* [2009], one likely product of 1,2,4-TMB and OH reaction system is molecule A (Figure 6), which contains a tertiary ON group and is sufficiently nonvolatile to partition into particle phase [Wyche *et al.*, 2009; Johnson *et al.*, 2005].

Each molecule of A has 10 alkane groups and 1 ON group, consistent with the observed molar ratio of alkane to ON groups in SOA particles (Table 1) in dry conditions but much lower than the ratios for high-RH SOA. These observations suggest that product A likely hydrolyzed via reaction (2) under high-RH conditions where the amounts of condensed-phase water was greatly enhanced. Assuming only tertiary ON molecules hydrolyze in aerosols based on the kinetic studies in bulk solutions [Hu *et al.*, 2011], our measured particle-phase tertiary ON hydrolysis rate of 4 day⁻¹ at RH greater than ~20% is a factor of 200 times slower than the measured hydrolysis rate of tertiary ON molecules in dilute solutions [Hu *et al.*, 2011]. The

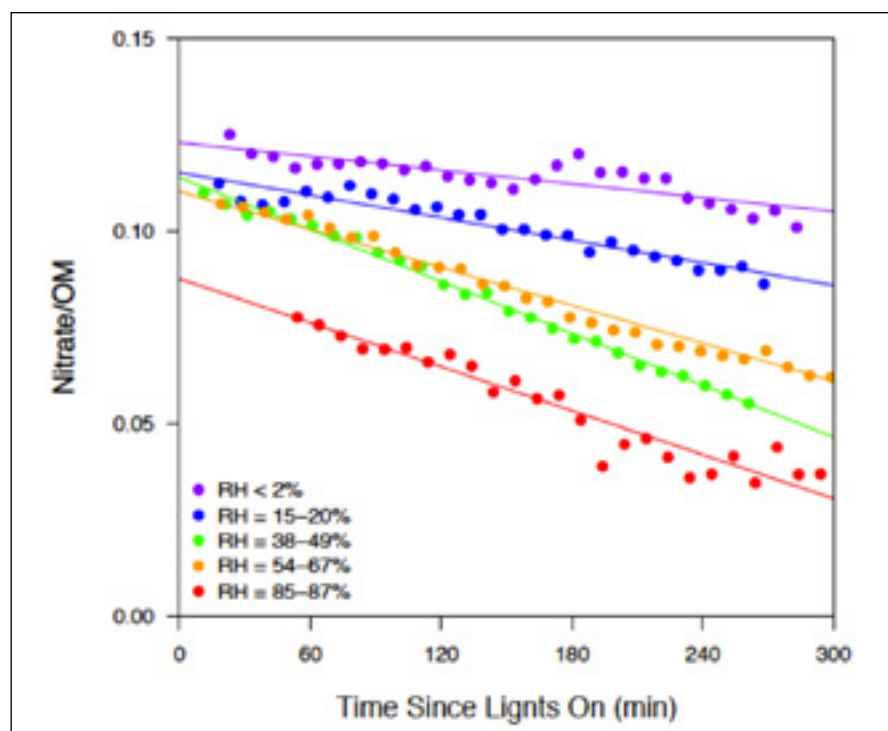


Figure 5. Time-dependence of nitrate-to-OM ratio (measured by the AMS). The lines represent linear fits of the measurements, with slopes of 7.1×10^{-5} , 1.0×10^{-4} , 2.2×10^{-4} , 1.7×10^{-4} , and 2.0×10^{-4} for RH < 2%, RH = 15–20%, RH = 38–49%, RH = 54–67%, and RH = 85–87% experiments, respectively.

slower particle-phase hydrolysis rate likely resulted from a combination of interrelated factors, including limited availability of condensed-phase water and particle phase.

Conclusions

In summary, this study demonstrates that ON groups may comprise up to 20% of the overall organic mass yield, but hydrolysis of ON groups in aerosol particles significantly reduces ON group mass fraction (2–4 times) under typical environmental conditions (RH > 50%). We derive a hydrolysis rate of 4 day⁻¹ (lifetime of 6 hours) from our measurements, which potentially explains the low ON group mass fraction measured in ambient air. In light of these observations, models should take hydrolysis into account to better predict particle-phase ON groups in ambient air, especially in coastal regions with high RH and high

ON group production.

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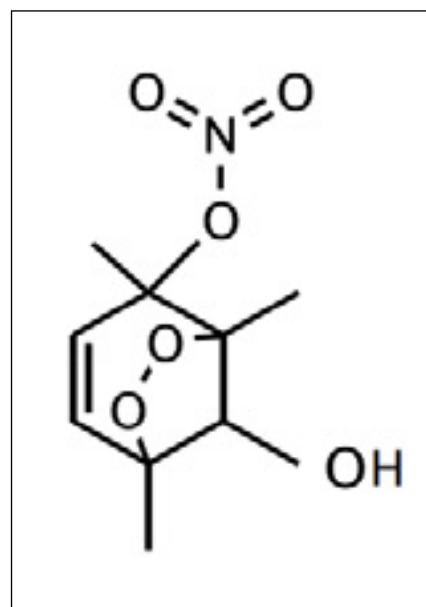


Figure 6. Structure of molecule A—a likely product of 1,2,4-TMB and OH reaction system.

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Greenhouse Gas Observations in the Network for the Detection of Atmospheric Composition Change (NDACC)

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Introduction

The Network for the Detection of Atmospheric Composition Change (NDACC) is a set of more than 70 high-quality, remote-sensing research stations for observing and understanding the physical and chemical state of the stratosphere and upper troposphere. NDACC data is also aimed at assessing the impact of stratosphere changes on the underlying troposphere and on global climate. Recent work, discussed below, has focussed on improving observations of greenhouse gases (GHGs) such as CH₄ and CO₂. NDACC was formerly known as the Network for the Detection of Stratospheric Change (NDSC), which commenced observations in 1991 with the aim of monitoring changes in stratospheric ozone and the substances, which lead to its depletion. It became NDACC in 2007 to reflect the considerable widening of the network's aims (see http://www.igacproject.org/sites/all/themes/bluemasters/images/NewsletterArchives/Issue_36_Jul_2007.pdf).

Information on the NDACC can be obtained from the NDACC home page (www.ndacc.org). This site provides a link to the public ftp database and also includes maps of the NDACC sites, instrument information, available data sets, and contact information. This short

article is to help inform IGAC scientists of the existence of NDACC and the availability of data.

The principal goals of NDACC are:

- To study the temporal and spatial variability of atmospheric composition and structure in order to provide early detection and subsequent long-term monitoring of changes in the physical and chemical state of the stratosphere and upper troposphere; in particular to provide the means to discern and understand the causes of such changes.
- To establish the links between changes in stratospheric ozone, UV radiation at the ground, tropospheric chemistry, and climate.
- To provide independent calibrations and validations of space-based sensors of the atmosphere and to make complementary measurements.
- To support field campaigns focusing on specific processes occurring at various latitudes and seasons.
- To produce verified data sets for testing and improving

multidimensional models of the stratosphere and the troposphere.

These aims require high quality data and, accordingly, since the inception of the NDSC, much effort has been invested into instrument inter-comparison, calibration, and software validation. The observational database is continually being expanded and improved. The result is a self-consistent data set suitable for addressing the above aims. In order to permit the widest possible usage, data is made publicly available.

GHG Observations

The NDACC database consists of ground-based and sonde observations of ozone and other key species in atmospheric chemistry and climate. Ground-based column observations are obtained with Dobson, UV-visible, microwave, and Fourier Transform infrared (FTIR) spectrometers. The list of species observed includes not only typical 'stratospheric' species such as O₃, HCl, ClONO₂, ClO, NO, NO₂, HNO₃, HF etc. but also species of tropospheric relevance such as CO, OCS, HCN and CH₄ and other hydrocarbons. Ozone and temperature profiles are also obtained using lidar and sondes. In addition to these chemical measurements, the NDACC database includes observations of UV flux at the ground and supporting meteorological

data.

There is currently substantial interest in the variations of the growth rate of atmospheric methane, which is again increasing again after a level period during the early 2000s. Example NDACC measurements for column-averaged methane are shown in Figure 1. While earlier studies using surface network data revealed changes of 8.0 ± 0.6 ppb in 2007, 6.4 ± 0.6 ppb in 2008, and 4.7 ± 0.6 ppb in 2009 [Dlugokencky *et al.*, 2011], Figure 1 shows that the renewed methane increase meanwhile has been persisting for more than 5 years (mid 2006 to Sept. 2011). This is either the longest and largest positive trend anomaly since the beginning of systematic observations more than 25 years ago or the onset of a new period of strongly increasing CH_4 levels in the atmosphere [Sussmann *et al.*, 2012].

To allow the study illustrated in Figure 1, the strategy for retrieving column-averaged methane from NDACC mid-IR FTS measurements were revised as part of a network-wide review and homogenisation process for retrieval techniques and parameters. It was found that retrievals at humid NDACC sites were dominated by water-vapour-methane spectral interference. The revised retrieval strategy avoids erroneous H_2O and CH_4 spectral line data [Sussmann *et al.*, 2011] and thereby agree with the near-IR retrievals of the Total Carbon Column Observing Network (TCCON) at the sub-percent level [Forster *et al.*, 2012]. The way is therefore open to complement the newer TCCON network with the longer NDACC time series for the purpose of joint trend studies, satellite validation, or the

inversion of sources and sinks. Despite the mature status of column-averaged methane data, however, the potential of NDACC FTIR measurements to separate tropospheric and stratospheric methane is still not fully exploited: Improved CH_4 and H_2O spectral line parameters in the mid-IR will allow adding further spectral micro windows as a pre-requisite for reliable altitude-resolved NDACC retrievals of methane. These might be key to understanding stratospheric water vapour trends in the future.

Accessing the Data

NDACC data is available through an anonymous ftp server (details on www.ndacc.org). Users of these NDACC data should consult the on-line documentation and reference articles to fully understand the scope and limitations of the instruments and data. Scientific users of the data are encouraged to contact directly the appropriate NDACC Principal Investigator (listed in the data documentation on the web page) to ensure the proper use of

specific data sets.

The PI can also be contacted if you wish to use data not yet posted to the archive.

Acknowledgments

Because of its worldwide dimension, the NDACC has been recognised as a major component of the international atmosphere research program. As such, it has been endorsed by national and international scientific agencies, including the United Nations Environmental Programme (UNEP) and the International Ozone Commission (IOC) of the International Association of Meteorology and Atmospheric Physics (IAMAP). It has also been recognised by the World Meteorological Organization (WMO) as a major contributor to WMO's Global Ozone Observing System (GO3OS) within the frame of its Global Atmosphere Watch (GAW) Programme.

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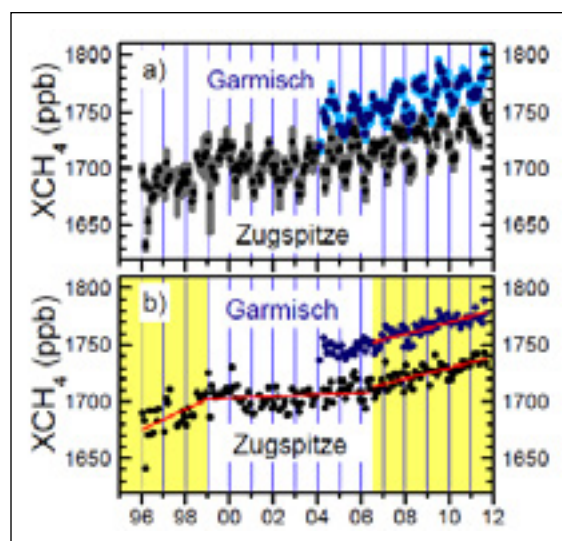
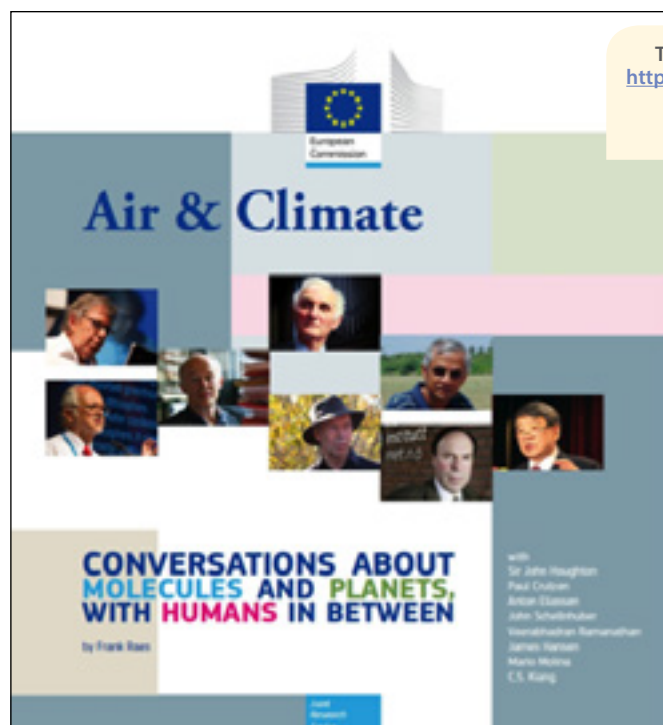


Figure 1. a) Time series of methane column-averaged mole fractions above the NDACC Zugspitze and TCCON/NDACC Garmisch stations (monthly means). Shaded bars indicate the statistical error of the monthly means calculated from the individual measurements ($\pm 3 \sqrt{n}$), where n is the number of FTIR measurements per month. **b)** De-seasonalised time series and linear trends (red lines). Taken from Sussmann *et al.* [2012].



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During the past three years, Frank Raes has interviewed some of the “fathers” of air pollution and climate science.

I have had the chance to meet our illustrious colleagues on various occasions, also informal ones. They are truly inspiring people and I thought that sharing our conversations with colleagues might be useful. These people have disclosed, through careful observation and a mix of intuition and critical thought some of the workings of our Planet: its atmosphere and climate. They were most often driven by curiosity and gradually by a concern that mankind might indeed have a devastating impact on our planet and the life it hosts. Many of these initial concerns: the loss of ozone in the stratosphere, climate change, air pollution did in fact realize and they are now the concerns of policy makers throughout the world.

The Joint Research Centre, where I work since 25 years, is set up to link science with the policies that are developed by the European Commission. It is clear that the way we do so is very different from the way Noble Prize winners Paul Crutzen and Mario Molina have done. They anticipated problems and felt they needed to communicate their findings straight away with top level policy makers and politicians. In the early days there were no Greenpeaces or World Wild Foundations that could help them with this. On the other hand, Sir John

Houghton, Anton Eliassen and C.S. Kiang managed to set up long-lasting institutional structures, most notably the Intergovernmental Panel on Climate Change, that link science with policy. James Hansen and Veerabhadran Ramanathan stay very much out of the IPCC and fight successfully their own battle, based on their own top notch research, but are not shy about reaching out to politicians and people when needed. Sir John Houghton directly advised his Prime Minister, and John Schellnhuber and Mario Molina still advise their Chancellor and President respectively.

Society is diverse and the interaction between science and society can only be diverse as well. The conversations shed light on the many ways that interactions between science and society can take place, and on how these are often shaped by the personalities involved. The conversations further show that, even for the brightest minds, it takes effort and time, often decades, to make society aware and respond to environmental threats. This is worrisome, as we might not have that much time to avoid climate change that disrupts the normal functioning of the Earth system including human societies.

We held our conversations between 2009 and 2011, before and after the failure of the international climate negotiations in Copenhagen. It was a time when scientists and policy makers were struggling to raise awareness among politicians and the general public about the severity of the climate change problem. It was also a time during which scientific research fully embraced the inter-connectedness between many environmental, economic and social problems, leading to the merging of individual sciences into a coherent Earth System Science. These dynamics are reflected in the frustration and hope that emerge from the conversations. Frustration about the difficulty to bring scientific evidence to the forefront, but also hope that the scientific method, i.e. critical thinking without ever being complacent, does play an unique role in guiding the world towards a sustainable future.

*Frank Raes,
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 Research Centre of the European Commission, Italy*

U.S. – Japan Workshop on the Tropical Tropopause Layer: State of Current Science and Future Observational Needs

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From October 15 – 19, 2012, about 50 participants gathered at the East-West Center, University of Hawaii, Honolulu, Hawaii to discuss the Tropical Tropopause Layer (TTL). Nearly 20 of the participants were graduate students

and young scientists. The workshop had several purposes (1) to summarize the current state of understanding of the TTL with tutorial presentations, (2) to summarize and formulate key science questions, and (3) to discuss

and coordinate observations planned over the next few years in the tropical Pacific region.

Several critical science areas were identified. The **boreal summer**



Asian Monsoon, marked by a large anti-cyclone in the TTL, has profound implications both regionally and globally. Transport in the monsoon region affects the global tropopause and the entry of air into the stratosphere, and is not fully understood or quantified. **Wave processes** in the TTL, important to quantify mixing and alter temperatures, occur at many scales, from horizontal, planetary-scale Rossby waves to vertical planetary and gravity waves. Waves, combined with **convective motions**, make up **large-scale transport** in the TTL, and determine the transit time of air from the troposphere to the stratosphere. Transport is a large piece of the **TTL chemical budget**, important for understanding stratospheric chemistry, especially with short-lived halogen species that affect stratospheric ozone. **Cirrus clouds** in the TTL impact stratospheric climate and tropospheric cloud radiative effects. Cirrus microphysics, formation, and maintenance are not well characterized. Understanding these processes is important for understanding and projecting long-term changes to the TTL as a result of the changing composition of the atmosphere.

In order to address these questions, the workshop participants discussed

past and current observational tools, models, and analysis techniques that have enabled us to make progress, and plans for the future. In-situ balloon instruments have been a staple of sensing the TTL for temperature, water vapor, and ozone. New small sensors for clouds and aerosols are also being deployed. In situ-aircraft observations are now undergoing a revolution as unmanned research platforms for high altitude research in the TTL are becoming available. A wide array of satellite platforms are now available for studying the TTL, but the participants lamented the fact that there are still not coherent plans for future missions, and monitoring long-term climate of the TTL is endangered by lack of sustained support for ground-based or satellite measurement programs.

The participants outlined and described a number of the field projects in the TTL planned for the next several years. These include a mix of balloon payloads, ground-based sensors, and coordinated multi-aircraft campaigns in several seasons, focused on many of the science questions identified above. A unique feature of the workshop was to have young scientists assist in mapping and synthesizing the science questions for the field campaigns using the tutorial and campaign overview information

that was presented. Their work formed the basis of a discussion during the closing session of how the different campaigns could best work together to achieve the maximum scientific impact for studies in Asia and the Tropical Western Pacific over the next few years.

The participants agreed to continue to share information with each other and with the broader scientific community. All the tutorial presentations and discussion are being archived for future use by educators and researchers. In addition, a community science tool will be made available to encourage communication and sharing of plans for joint experiments over the next few years in the TTL over the Asia-Pacific region in several seasons. Interested researchers are urged to visit the Workshop Web pages at <http://physics.valpo.edu/ttlworkshop/>. This site contains more information and the entire proceedings of the workshop, including links to workshop presentations, planning documents and maps, and community discussions of upcoming activities.

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CALENDAR

Visit igacproject.org for updates to the calendar

November

**Capacity Building Workshop on Modeling of
Regional Climate and Air Quality for West Africa**
19-24 November 2012
Abidjan, Cote d'Ivoire

Regional SPARC Workshop
**Focus on Southern Hemisphere and South
America**
26-27 November 2012
Buenos Aires, Argentina
www.cima.fcen.uba.ar/SPARC/

December

AGU Fall Meeting
3-7 December 2012
San Francisco, CA USA
[Fallmeeting.agu.org/2012/](http://fallmeeting.agu.org/2012/)

**Workshop on the Climatic Effects of Ozone
Depletion in the Southern Hemisphere:
Assessing the Evidence and Identifying the
Gaps in Current Knowledge**
3-7 December 2012
Buenos Aires, Argentina
<http://www.uca.edu.ar/index.php/site/index/es/uca/investigacion/pepacg/wcrp-special-workshop/>

**4th International Workshop on Air Quality
Forecasting Research (IWAQFR)**
12-14 December 2012
Geneva, Switzerland
http://www.wmo.int/pages/prog/arep/gaw/IWAQFR_4.html

SOLAS/IGAC Workshop
**Role of Marine Gel for the Emission of Primary
Organic Aerosols from the Ocean**
11-13 December 2012
Kiel, Germany

SOLAS/IGAC HitT Workshop
Climate Impact of Seasalt-derived Cl Atoms
17-19 December 2012
Kiel, Germany

January

First IGAC Americas Working Group Workshop
28-30 January 2013
Bogotá, Colombia

March

**International Workshop on Changing
Chemistry in Changing Climate (C4): Monsoon
Focus**
11-13 March 2013
Pune, India

**IGBP/IGAC Air Pollution & Climate Initiative
Workshop**
Developing a Strategic Plan for an Integrate
Program on Air Pollution and Climate Change
20-22 March 2013
Denver, CO USA

May

**The 6th International GEOS-Chem Meeting
(IGC6)**
6-9 May 2013
Boston, MA USA

**SPARC/IGAC Chemistry Climate Modeling
Initiative (CCMI) Workshop**
13-17 May 2013
Boulder, CO USA

Italics: IGAC Sponsored Event



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Application Deadline
1st February 2013

<http://mel.xmu.edu.cn/solassummerschool>

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