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IGACnews

coordinating and fostering atmospheric chemistry research towards a sustainable world

issue 55
aug/sept 2015

Asian Monsoon

Furthering our understanding through scientific collaborations

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The History of IGAC

» EARLY CAREER PROFILE
Fatimah Ahamad on why science is like a jigsaw puzzle

GLOBAL IGBP CHANGE

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On the Cover

The German High Altitude – Long-range research aircraft (HALO) at Gan airport, Addu Atoll, Maldives after returning from the first flight into the Asian monsoon anticyclone as part of the OMO mission. (Photo courtesy of Hans Schlager)

(Left) HALO flight track during the Oxidation Mechanism Observations (OMO) mission 23 August 2015, Global CO Tracer (ppbv) at 150 hPa. (Image courtesy of Hartwig Harder & the Copernicus Atmosphere Monitoring Service, CAMS; **http://copernicus-atmosphere.eu**) (Center) Balloon launch for the Sounding Water vapor, Ozone, and Particle (SWOP) campaign in Kunming, China (Photo courtesy of Ru-Shan Gao and Jianchun Bian)

(Right) Balloon launch preparation in Hyderabad (India) during the Balloon measurement campaign of the Asian Tropopause Aerosol Layer (BATAL) in August 2015. Payloads include University of Wyoming's Optical Particle Counters and a COBALD backscatter sonde. Balloon and Communication devices were provided by the Tata Indian Institute for Fundamental Research Balloon Facility. (Photo courtesy of Murali Natarajan)

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Editor: Megan L. Melamed
Newsletter Design: Allison Gray

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

Building Capacity

Fostering international collaborations

A primary goal of IGAC is to build scientific capacity by engaging the next generation of scientists and scientists from developing countries. As you will see from this IGACnews, IGAC is putting a lot of effort toward building scientific capacity in Monsoon Asia. In June 2015, three IGAC events occurred in Bangkok, Thailand highlighting IGAC's efforts in Monsoon Asia. I was fortunate to be able to participate in all three events.

The first event was the second workshop of the IGAC/SPARC Atmospheric Composition and Asian Monsoon (ACAM) activity. Scientists from 22 different countries, 16 from Monsoon Asia, came together to share their research. For me, the highlight of the ACAM workshop was seeing presentations from atmospheric scientists in countries who often don't get to present their research to an international audience. The ACAM workshop truly set the stage for building scientific collaborations between Monsoon Asia countries and with the international community.

The next event following the ACAM workshop was the first ACAM training school. ACAM has a strong commitment to sponsor training schools for early career scientists. The training school focused on how to use satellite and model data for aerosol and air quality research. I met the 33 participants of the training school and I was very impressed with their enthusiasm. Our hope is that these 33 early career scientists learned valuable skills and also created connections with each other that will foster scientific collaborations for years to come.

The third event in Bangkok, Thailand was the formation of the Monsoon Asian and Oceania Networking Group (MANGO). The MANGO workshop brought together scientists from 19 countries in the Monsoon Asia and Oceania region to determine the structure of MANGO and its goals. One of the best parts of my job is seeing scientists who have never met each other before, but are from the same region of the world, come together and decide to work toward creating a cohesive community of scientists.

IGAC's sponsor for the past 25 years, the International Geosphere-Biosphere Programme (IGBP), is coming to an end December 2015 as the global environmental change community transitions to Future Earth. With any transition, it is important to not only look forward to what may come, but to also look back at our history. Therefore, the Science Feature in this issue of IGACnews tells the history of IGAC. The history demonstrates the roots of IGAC date back many years, include many great scientists and are strong for the upcoming transition to Future Earth.

Happy reading! IGAC

MEGAN L. MELAMED
IGAC Executive Officer
megan@igacproject.org

Megan Melamed received her PhD in 2006 in Environmental Engineering from the University of Colorado. She then received the National Science Foundation International Research Fellowship to work at the Universidad Nacional Autónoma de México (UNAM) in Mexico City for two years. Upon completion of the NSF Fellowship, Megan became an American Association for the Advancement of Science (AAAS) Science & Technology Policy Fellow at the U.S. Environmental Protection Agency. She has been the IGAC Executive Officer since January 2011.

The IGAC Community is deeply saddened by the unexpected loss of Professor Roland von Glasow

The announcement of the sudden death of our colleague and friend, Professor Roland von Glasow of the University of East Anglia in Norwich UK, is with great regret and sadness.

Trained in Physics at the University of Heidelberg and the Max Planck Institute for Chemistry in Mainz, Roland's interest in the physics and chemist of the atmosphere and earth system has led him to becoming one of the leading and internationally respected scientists in surface ocean and lower atmosphere research with foci on halogen chemistry, polar regions and the impact of volcanic eruptions on atmospheric chemistry. He has not only been an outstanding researcher but he has also worked hard for our community, taking a leading role in the international facilitation of science. I also knew him to be reliable colleague and a very pleasant and charming man to deal with. He will be sadly missed by his iCACGP, IGAC and SOLAS colleagues.

– John Burrows

If you would like to contribute your memories of Roland, please do this via the following site: **https://rolandvonglasow.wordpress.com**

IGAC SSC Member Colette Heald is Awarded the AGU James B. Macelwane Medal

The James B. Macelwane Medal is given annually to honorees in recognition for "significant contributions to the geophysical sciences by an outstanding early career scientist." IGAC SSC member Colette Heald from the Massachusetts Institute of Technology is one of five recipients of this medal in 2015. IGAC congratulates Colette for this honor.

Submit Articles to the next IGAC newsletter

IGAC is now accepting article submissions for the next IGACnews. Workshop Summaries, Science Features, Activity News, and Editorials are all acceptable and desired. Science Features should have an approximate length of 1500 words with 1-2 images. All other submissions should be approximately 500 words and have a maximum of 1 image. Please provide high-resolution image files. The deadline for submissions for the January/February issue of the IGAC Newsletter is 15 Dec. 2015. Send all submissions to **info@igacproject.org**.

IGAC moves to e-bulletins

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

YESS community

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EARTH SYSTEM
SCIENTISTS
community

YESS is a platform for early career researchers to shape the future of Earth system science.

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www.yess-community.org

Second TOAR Workshop

28-30 APRIL, 2015
MADRID, SPAIN

IGAC Sponsored

AUTHOR
Owen Cooper, CU/CIRES and NOAA/ESRL/CSD, USA

HOST INSTITUTION AND FUNDING

AEMet
Agencia Estatal de Meteorología

FUNDING

WMO GAW

PARTICIPANTS
Australia, Austria, Belgium, Canada, Chile, China, Czech Republic, France, Germany, India, Italy, Japan, Norway, Pakistan, Spain, Switzerland, United Kingdom, United States

BACKGROUND
This workshop was financially sponsored by IGAC in order to support the IGAC activity TOAR, which is writing a report on the global distribution and trends of tropospheric ozone that will include metrics for research on the impacts of tropospheric ozone on climate change, human health and crops/ecosystems.

The Royal Palace in Madrid, Spain

Tropospheric Ozone Assessment Report (TOAR): Global metrics for climate change, human health and crop/ecosystem research, is one of IGAC's newest activities, with a mission to provide the research community with an up-to-date scientific assessment of tropospheric ozone's global distribution and trends from the surface to the tropopause. In fulfilling this mission, TOAR has two primary goals: 1) Produce the first tropospheric ozone assessment report based on the peer-reviewed literature and new analyses. 2) Generate easily accessible, documented data on ozone exposure and dose metrics at hundreds of measurement sites around the world (urban and non-urban), freely accessible for research on the global-scale impact of ozone on climate, human health and crop/ecosystem productivity.

TOAR Workshop 1.02 (second workshop of the first TOAR initiative) was held at Agencia Estatal de Meteorología (AEMET – Spanish Meteorological

Workshop Participants

Agency) in Madrid, Spain, April 28-30, 2015. The workshop was funded by the World Meteorological Organization and AEMET, with logistical support provided by AEMET's Francisco Espejo. The workshop was coordinated by Owen Cooper (University of Colorado/NOAA ESRL, Boulder) and attended by 70 scientists from 18 countries in Europe, East Asia, South Asia, The Middle East, North America, South America and Australia.

The workshop had several goals:

1) Develop a detailed outline of the assessment report

2) Select lead authors and co-authors for each chapter of the assessment report

3) Identify unique and high quality ozone time series around the world

4) Continue the development of the TOAR database

5) Identify the ozone metrics that will be calculated from the data uploaded to the database

6) Further develop the idea for a special issue and ancillary papers.

The workshop delivered on all of its goals and the workshop summary, along with the detailed assessment report outline, can be downloaded from **http://www.igacproject.org/TOAR**. Excellent progress was made on the design and scope of the TOAR database, hosted by Forschungszentrum Jülich, Germany. Importantly, the workshop participants reorganized the assessment report structure to allow for three chapters that will display the present-day distribution and trends of tropospheric ozone based on observations. Chapters 4, 5 and 6 will focus on the ozone metrics most relevant for research on ozone's impact on human health, crop/ecosystem productivity and climate change. The eight chapters of the report along with several more detailed ancillary papers will be published as stand-alone manuscripts in a special issue of a yet-to-be-determined journal open-access, peer-reviewed journal.

The next steps for TOAR are to produce first drafts of all chapters by December 2015, followed by a third and final workshop in early 2016. The target date for completing the assessment report is December 2016.

8-10 JUNE, 2015
BANGKOK, THAILAND

IGAC Sponsored

AUTHORS
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Laura Pan, National Center for Atmospheric Research, USA

Narisara Thongboonchoo,
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Sachiko Hayashida, Nara Women's University, Japan

HOST INSTITUTIONS

FUNDING

PARTICIPANTS
Bangladesh, China, France, Germany, India, Indonesia, Italy, Japan, Korea, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Saudi Arabia, Singapore, Switzerland, Taiwan, Thailand, United Kingdom, United States, Vietnam

BACKGROUND

IGAC financially sponsored this workshop to support the jointly sponsored IGAC/SPARC Atmospheric Composition and the Asian Monsoon (ACAM) activity, which aims to build strong international collaborations to obtain the diverse expertise, resources, and access to the monsoon region for international research team.

Second Workshop on Atmospheric Composition and the Asian Summer Monsoon (ACAM)

Workshop Participants

One hundred and seventy scientists representing 22 countries recently gathered in Bangkok, Thailand for the Second Workshop on Atmospheric Composition and the Asian Summer Monsoon (ACAM). Building on progress from the initial workshop held two years earlier in Kathmandu, ACAM connects scientists with diverse expertise and interests in understanding the complex interplay between monsoon dynamics and atmospheric composition, which is changing rapidly due to economic development and high population density. ACAM interests span impacts from local to global scales, including air quality, aerosol-cloud interactions, convective transport of pollutants, and impacts on the upper troposphere and lower stratosphere.

The three day meeting included talks, poster sessions, working group discussions, and reports on the status of ongoing and future field activities. The meeting agenda and links to materials presented at the meeting

Bangkok, Thailand

are available at **http://www2.acom.ucar.edu/acam/bangkok2015**. Two overview presentations provided a strong start to the meeting with Guy Brasseur emphasizing the importance of Asian emissions and monsoon meteorology to global chemistry and climate. He was followed by Bill Lau, who provided an assessment of current understanding of aerosol impacts and feedbacks on the Asian monsoon, highlighting areas of uncertainty needing attention. Oral and poster sessions provided an excellent opportunity for ACAM scientists to highlight their research. Sessions were organized into three topical areas: Emissions and Air Quality, Aerosols and Clouds, and Convection and UT/LS.

Working Group discussions and reports were a critical element of the workshop that allowed scientists to discuss how to promote ACAM science and collaboration. The group for Data Sharing reported growing membership and an increasing number of datasets relevant to ACAM science including surface, airborne, and satellite datasets. Development of a web site to assist in data discovery is a major goal. The group for promoting partnership with CCMI (Chemistry-Climate Model Initiative) emphasized that efforts to improve climate models require input from a broad perspective that includes more than just modelers. They also suggested that the group expand to connect ACAM with other community modeling projects (e.g., AEROCOM, MICSAsia, HTAP, SSiRC). The group for Field Campaigns shared an impressive list of activities including surface measurements, sounding programs, and planned airborne campaigns that will provide much needed information and will benefit from coordination. Finally, the group for Training emphasized the training school taking place in association with the workshop and discussed other suggestions on how to best serve the ACAM community.

The ACAM workshop enabled leveraging to participate in related activities of common interest. These included the first ACAM Training School, the IGAC-MANGO Workshop, and a side meeting on Winter Fog sponsored by ICIMOD. The first two events are also described in this edition of IGACnews.

Applications to attend the ACAM workshop far outpaced the capacity that could be accommodated. Many worthy applicants had to be turned away, but achieving the goals of ACAM depends on participation beyond the workshop. Joining the ACAM mailing list and becoming an active member of one of the working groups is encouraged. Interested researchers are invited to send an email to **acam-request@acd.ucar.edu** to join the mailing list, and to contact relevant working group leaders found at **https://www2.acom.ucar.edu/acam/working-groups**.

11-12 JUNE 2015
BANGKOK, THAILAND

IGAC Sponsored

1st Atmospheric Composition and the Asian Monsoon Training School on "Satellite and Model Data Use for Aerosols and Air Quality"

AUTHORS

Mary Barth, National Center for Atmospheric Research, USA

Ritesh Gautam, Indian Institute of Technology – Bombay, Mumbai, India

Federico Fierli, ISAC-CNR, Italy

Nguyen Thi Kim Oanh, Asian Institute of Technology, Thailand

HOST INSTITUTION

FUNDING

PARTICIPANTS

China, Thailand, Pakistan, Bangladesh, Malaysia, India, Singapore, Vietnam, Myanmar, Taiwan, Philippines, and Nepal

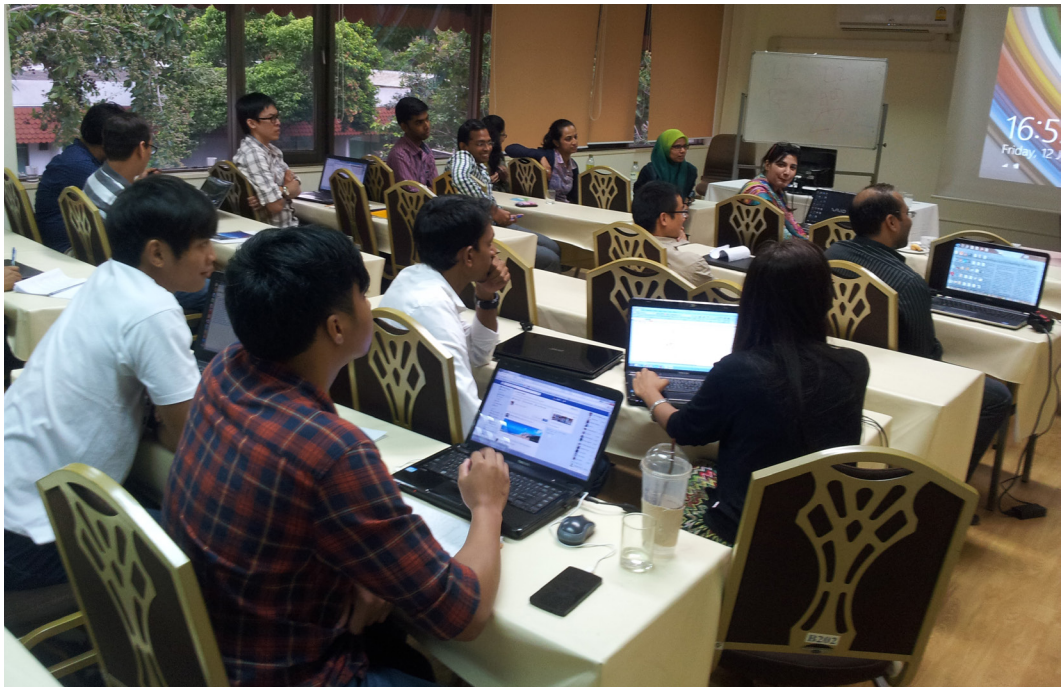
BACKGROUND

A primary goal of the IGAC/SPARC ACAM activity is the sponsorship of training schools on model use for ACAM regional young scientists. This was the first ACAM training school and IGAC was a proud financial sponsor of this event.

ACAM Training School Participants

The "Satellite and Model Data use for Aerosols and Air Quality" training school was held at the Asian Institute of Technology, Bangkok, 11-12 June 2015. This training event was organized within the framework of the Atmospheric Composition and Asian Summer Monsoon (ACAM) initiative, sponsored by IASS, IGAC, SPARC, ICIMOD, NSF /China, and NASA. Specific goals of the event were to build the capacity and training of early career scientists in Asia for effective utilization of satellite and model data relevant to studying aerosols and air quality in Asia, particularly in connection with the Asian monsoon. The training school was held after the second ACAM workshop in Bangkok, 8-10 June 2015.

From the nearly 100 applications submitted for the school, 33 participants were selected, representing 12 Asian countries, with one-third female participants. The school not only reached out to multiple countries but also to multiple institutions. Participants were either current students (graduate/undergraduate) or early career scientists within seven years of Ph.D.,



Participants during the training school

with interest in learning about satellite data and modeling tools, in general, and applications to aerosols/air quality research, in particular.

The 2-day event brought together international experts in satellite remote sensing and modeling to provide focused tutorials on aerosols, air quality, trace gases, emissions and transport. After an opening lecture by Dr. Mark Lawrence (IASS, Germany) providing an overview of general pollution transport patterns in the Asian Monsoon region, remaining lecturers spent two hours each combining lecture material and practice exercises with a specific tool. These lectures included modeling transport and processes, remote sensing of trace gases and aerosols, atmospheric science data analysis tools, and combining modeling and satellite data to better characterize trace gas emissions. The lecturers were Gabriele Stiller (KIT, Germany), Cathy Clerbaux (LATMOS/IPSL, France), Prabir Patra (JAMSTEC, Japan), Pawan Gupta (USRA/NASA-GSFC, USA), Sachin Ghude (IITM, India), Mary Barth (NCAR, USA), Ritesh Gautam (IIT-Bombay, India) and Federico Fierli (ISAC-CNR, Italy).

A highlight of the school was the "Science Café" discussion after dinner on the first day. Small groups (6-8 students and lecturers) put together ideas of ACAM-related science projects with a theme of "Climate and Air Quality in Asia: Processes, Impacts, Mitigation." Each group presented their research objective and how they would achieve that objective through measurements and modeling. The discussion was beneficial in allowing the participants to get to know each other more and fostering relationships for potential future interdisciplinary collaborations.

Focused tutorials in a collaborative and collegial environment helped participants and lecturers engage in spirited discussions, with positive feedback from participants. They were especially enthusiastic about the hands-on training, with specific tools among the most helpful aspects of the school; and found the "Science Café" to be a great experience for developing projects in their research career. Connected with the ACAM web site is a Training School webpage where the lectures have been posted, **https://www2.acd.ucar.edu/acam**, which is made publicly available to reach out to a wider audience. The ACAM Training Working Group plans to continue interactions amongst the ACAM community via a web page listing research tools and training schools relevant to ACAM.

SEE
Fatimah Ahamad
Early Career Scientist Profile
on p. 24

11-12 JUNE 2015
BANGKOK, THAILAND

IGAC Sponsored

AUTHORS

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Nguyen Thi Kim Oanh, Asian Institute of Technology, Thailand

Mark G. Lawrence, Institute for Advanced Sustainability Studies, Germany

HOST INSTITUTION

FUNDING

National Institute for Environmental Studies, Japan

PARTICIPANTS

Japan, Thailand, Myanmar, Malaysia, Bangladesh, Indonesia, Vietnam, Pakistan, Lao PDR, Philippines, Singapore, Taiwan, Nepal, Australia, Myanmar, India, Sri Lanka, Bhutan, South Korea, Germany, Switzerland, USA, and Italy

BACKGROUND

IGAC sponsored this workshop to foster the development of an atmospheric science community in Asia as part of its effort to create National/Regional Working Groups.

Workshop for Developing Priority Themes and Activities for IGAC Monsoon Asia and Oceania Networking Group (IGAC-MANGO)

Workshop Participants

As a kick-off toward the formation of an IGAC Working Group in Asia, a workshop entitled "Planning Workshop for Developing a Framework for Cooperation Between IGAC Activities in Asia" was held on 2-3 March 2015 at Asian Institute of technology in Bangkok. This workshop brought together 18 atmospheric scientists from 16 different countries across Asia, and concluded with a clear and strong expression of the community need for an IGAC regional community in Asia, associated with a variety of links to IGAC activities *(for more details, see IGACnews issue 54, April/May 2015)*.

In June 2015, the second workshop to establish an IGAC Working Group in Asia, entitled "Workshop for developing priority themes and activities for IGAC Monsoon Asia and Oceania Networking Group (IGAC-MANGO)" was held on 11-12 June 2015 at Asian Institute of Technology in Bangkok, by inviting further participants from the countries missing in the first workshop and project leads working on the monsoon Asia region.

Asian institute of Technology

The workshop was planned adjacent to the Second ACAM Workshop. It brought together 45 participants from 23 different countries including South Asia, Southeast Asia, Northeast Asia, and Oceania. The first day of the workshop started from presentations by IGAC and its parent organizations, International Geosphere-Biosphere Programme (IGBP) and Future Earth, and International Commission on Atmospheric Chemistry and Global Pollution (iCACGP), and its collaborating project Stratosphere-troposphere Processes And their Role in Climate (SPARC). Then, atmospheric chemistry activities in Korea, Bhutan, and Sri Lanka, which were missing at the first workshop, were presented.

Following these introductory presentations, current and developing IGAC activities were introduced to enhance collaboration swith IGAC-MANGO scientists. In addition, representatives from six non-IGAC cross-country science projects and even societal partners (including national agencies, international organizations, and non-profit organizations) made presentations on their activities in order to foster collaborations in the region.

The second day was devoted to breakout sessions followed by a plenary discussion. The first breakout session was held to discuss "scientific questions and needs". A variety of scientific questions were highlighted, including changes in atmospheric composition and the resulting impacts, biomass burning, and biogenic and anthropogenic emissions, air quality and health, interplay of Asian monsoon and atmospheric chemistry, fundamental sciences, mitigation options, etc. It was strongly recognized that funding and infrastructure are needed to foster scientific research, capacity building, and regional collaborations.

We believe that IGAC-MANGO will build a cohesive network and foster the next generation of atmospheric scientists in Asia.

The second breakout session involved sub-regional groups to discuss "the formation of the IGAC-MANGO." The discussion reached a framework called "MANGO-3" that consists of one IGAC-MANGO committee with three co-chairs representing Northeast Asia, Southeast Asia, and South Asia. The other MANGO committee members will be country representatives from the regions. The participants agreed that Hiroshi Tanimoto will act as the first lead co-chair of IGAC-MANGO (and a co-chair from Northeast Asia), and Nguyen Thi Kim Oanh will act as a co-chair from Southeast Asia. A co-chair from South Asia will be decided in the near future. The IGAC-MANGO full committee will meet every one-to-two years to discuss current issues and future directions.

Overall the workshop was a great success. We believe that IGAC-MANGO will build a cohesive network and foster the next generation of atmospheric scientists in Asia. The workshop was financially sponsored by National Institute for Environmental Studies, Japan, and IGAC.

9-11 JUNE 2015
BOULDER, CO, USA

IGAC Sponsored

Workshop on the Future of Laboratory Studies in Atmospheric Chemistry

AUTHORS

James M. Roberts, NOAA Earth System Research Laboratory, USA

James B. Burkholder, NOAA Earth System Research Laboratory, USA

Jonathan Abbatt, University of Toronto, Canada

Ian Barnes, University of Wuppertal, Germany

HOST INSTITUTION AND FUNDING

PARTICIPANTS

USA, Canada, UK, Germany, Israel, Switzerland, France, Finland, China, Taiwan, Japan

BACKGROUND

FUNDAMENTALS
ATMOSPHERIC CHEMISTRY

As part of the IGAC activity on Fundamentals of Atmospheric Chemistry, IGAC sponsored this workshop to better define the linkages between key issues in atmospheric chemistry and fundamental laboratory-based studies.

Boulder, Colorado

Thirty six participants from 10 different countries met for two and half days in June 2015 to discuss the Future of Laboratory Studies in Atmospheric Chemistry as part of IGAC's "Fundamentals of Atmospheric Chemistry" initiative. The overarching goal of the workshop was to better define the linkage between the key issues in atmospheric chemistry and the need for fundamental laboratory-based studies (see **http://igacproject.org/Fundamentals**). The participants brought a broad range of expertise to the discussion covering the diverse fields involved in the investigation of atmospheric processes. The workshop was a resounding success in providing numerous ideas and concepts that can be used to move the laboratory community forward.

Historically laboratory studies have provided important information on the chemical and physical processes that are intimately related to key societal issues such as: climate change, air quality, ecosystem processes, and stratospheric ozone. As atmospheric chemistry research has progressed towards

Workshop Participants

larger, more comprehensive studies that have field and modeling components, it is often the perception that the underlying fundamental chemistry, e.g. rate constants and mechanisms, are well established or can be calculated/modeled with high precision. The reality is that such projects usually reveal fundamental aspects of the chemistry that are not well understood. An example of this is HO_X-cycling in regions that have high biogenic VOC concentrations. A more inclusive approach needs to be maintained where it is recognized that laboratory studies are essential and should be provided in the project planning.

In addition to collaborations within the community, laboratory studies are vital contributors to interdisciplinary research on subjects of importance to the broader environmental research community. Examples of those areas include health effects of air pollution, indoor air pollution and industrial hygiene, and ecosystem processes, (e.g. nitrogen cycle, oxidant chemistry). There are often barriers to such interdisciplinary collaborations, as they need to be mutually beneficial and rewarding, and often involve diverse research cultures and language. Workshop participants shared experiences with such efforts and were unanimous in their assessment that strong common science driven goals are vital to the formation and success of such endeavors.

The atmosphere is a complex chemical system and complementary experimental approaches are required to develop an adequate understanding and predictive capability. It was recognized that in some highly complex systems, strict reductionist approaches are not possible. For example, it is not practical to measure all the chemical species involved in all the chemical reaction steps in the formation of secondary organic aerosol (SOA). Nevertheless, insights into the fundamental chemistry obtained in laboratory studies helps us to explain and predict the properties of SOA that are important to the atmospheric chemistry community (e.g. optical properties, CN and CCN properties, and health effects).

The workshop outcomes will be summarized in a journal article detailing the challenges of maintaining a strong laboratory research enterprise within the current atmospheric chemistry research climate, and recommendations for how to meet those challenges, e.g. the establishment of interdisciplinary communities for promoting cross collaborations and projects, the initiation and participation in assessments of atmospheric properties and effects requiring interdisciplinary expertise, and open discussion town halls at science meetings. IGAC

Nitrate Radicals and Biogenic Volatile Organic Compounds (VOCS) Workshop

22-24 JUNE 2015
ATLANTA, GA, USA

IGAC Sponsored

ORGANIZERS

Nga Lee Ng, Georgia Institute of Technology, USA

Steven S. Brown, NOAA ESRL, USA

HOST AND FUNDING

FUNDING

PARTICIPANTS

Canada, France, Germany, Israel, UK, USA

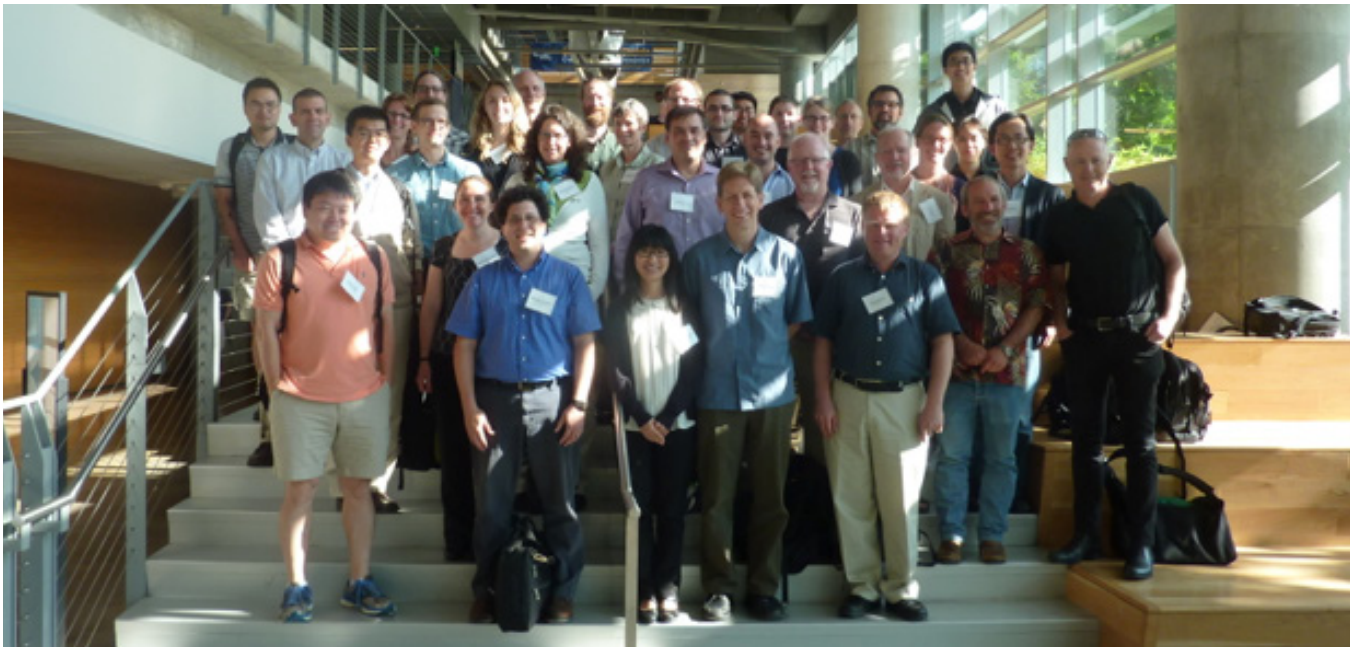
BACKGROUND

As part of the IGAC activity on Fundamentals of Atmospheric Chemistry, IGAC did a call for proposals for workshops. This workshop was awarded funding based on the excellent proposal and the contribution the workshop has toward addressing a fundamental issue within atmospheric chemistry.

The Georgia Institute of Technology Campus in Atlanta, Ga., USA

The IGAC sponsored workshop, "Nitrate Radicals and Biogenic Volatile Organic Compounds," took place on June 22-24 2015 at the Georgia Institute of Technology in Atlanta, Georgia, USA. The organizers were Nga Lee ("Sally") Ng of the School of Chemical and Biomolecular Engineering at Georgia Tech and Steven Brown of the NOAA Earth System Research Laboratory. The U.S. National Science Foundation (NSF) provided additional sponsorship to support travel for participants. The 30 meeting participants from six countries represented the academic research, national laboratory and government agency communities, including the U.S. Environmental Protection Agency (EPA) and National Oceanic and Atmospheric Administration (NOAA).

As the title suggests, the goal of the workshop was to discuss current research and future directions the area of biogenic volatile organic compound (BVOC) oxidation by nitrate radicals (NO_3). Nitrate radical oxidation reactions take place primarily at night due to its photochemical instability, and NO_3 reactions are preferential toward BVOCs since they



Workshop Participants

are unsaturated hydrocarbons. This reaction represents a direct interaction between anthropogenic pollutants and the biosphere, since the primary source for NO_3 is anthropogenic emissions of nitrogen oxides (NO_x). The interaction may be an important source of organic aerosol that affects visibility, climate and human health, and it is therefore of significant interest to both the scientific research and public policy communities. The workshop included both experimentalists and modelers, with the explicit goal of fostering collaboration between field measurements, laboratory studies and atmospheric models.

The workshop organization followed three themes, which included 1) Observations of nitrogen oxides and nitrate radicals; 2) Biogenic hydrocarbons and organic nitrogen; and 3) Nitrate radicals and secondary organic aerosol. Although the themes provided an organizing structure for the workshop, the organizers and participants recognized at the outset that there is considerable overlap between them, such that none of them can be discussed outside of the context of the others.

Key points in the scientific discussion included (but were not limited to) the following:

- The study of NO_3-BVOC oxidation reactions within a poorly mixed nighttime atmosphere is scientifically challenging.
- Field measurements need to take account of substantial vertical gradients that occur at night, and models must accurately characterize mixing, transport and dispersion with sufficient vertical resolution.
- Chemical mechanisms for NO_3-BVOC reactions are not as well studied as those from other oxidants (e.g., O_3 and OH) such that there is considerable uncertainty in models regarding reaction products, such as organic nitrogen, and yields of organic aerosol.
- Emissions changes that have occurred in the U.S., Europe and Asia within the last 20 years have almost certainly shifted the chemical regimes that drive NO_3-BVOC reactions, but likely in opposing directions in different regions.
- There is insufficient data in the developed world to characterize these changes and even less in the developing world.

The participants agreed to write a review paper on NO_3-BVOC interactions, with the goal of submission in January 2016. The participants initiated a discussion on the future directions of NO_3-BVOC research, but there was insufficient time during the workshop to develop concrete plans for such collaborative research. An application has been submitted for a follow-up town hall meeting to take place at the AGU meeting in San Francisco in December 2015.

Information about the workshop, agenda and participants is available at: **http://www.atmosphere.eas.gatech.edu/no3workshop/program/**.

22-27 JUNE 2015
LA PAZ, BOLIVIA

IGAC Sponsored

AUTHOR

Marcos Andrade-Flores, Universidad Mayor de San Andrés, Bolivia

HOST INSTITUTION AND FUNDING

FUNDING

PARTICIPANTS

Argentina, Bolivia, Brazil, Chile, Colombia, Cuba, El Salvador, France, Peru, Puerto Rico, and Venezuela

BACKGROUND

This school was supported by IGAC to help the IGAC Americas Working Group achieve one of its main goals, to train and foster the next generation of scientists. This is the first training event for early career scientists to take place under the IGAC-AWG.

Latin American and Caribbean Aerosol Measurements School: From Measurements Technologies to Applications

La Paz, Bolivia

One of the outcomes from the second meeting of the International Global Atmospheric Chemistry – Americas Working Group (IGAC-AWG) held in La Paz in July 2014 was the decision to organize a school focused on aerosols with special emphasis on black carbon aimed at early career scientists in the Latin American and Caribbean (LAC) region. The Laboratory for Atmospheric Physics (LFA by its acronym in Spanish), part of the Institute of Physical Research at Universidad Mayor de San Andres, Bolivia, was in charge of the organization of this winter school. The strong collaboration with European research institutions, already in place thanks to a joint effort at the Chacaltaya/GAW station, helped with the organization of this event by bringing an important number of lecturers to it.

The winter school named as "Latin American Aerosol Measurements School: From measurements technologies to applications" was held in La Paz, Bolivia from June 22nd to June 27th of this year. Thirty six students

School Participants

from 11 countries attended the school, 18 of them women and 18 men making a perfect gender balance. At the same time, the school had 16 lecturers, four from the LAC region (three of them part of the IGAC-AWG), one from the USA, and the rest from Europe (seven are part of the Chacaltaya consortium). Most lecturers used their own funding for coming to La Paz and took time out of their own busy schedules for making the course possible.

The course received funding from several institutions. The main contributors were IRD, OSUG, LGGE from France, the WMO, and the IAI. In addition we got support from the Molina Center, Sunset Lab., Magee Scientific and Droplet Measurement Technologies which generously provided some funds or sponsored the participation of lecturers at the school. Twenty three students received some type of financial support whereas six attended with funding from their own institutions. Eleven students in total received a full waiver of the registration fee.

The school took place from Monday to Friday and there was a lot of enthusiasm and participation. Besides regular lectures there were two sessions where students presented their research orally and in posters (a committee selected 10 of these posters for oral presentations). Wednesday morning was a scheduled session with stakeholders where people representing governmental institutions, academy, international collaboration and the civil society exchanged ideas and experiences with early career scientists attending the course. An interesting and fruitful discussion was the result of this event. Wednesday night there was the official dinner of our event. Bolivian food and music were part of the menu. All students, lecturers and other people involved with the organization attended this event. Some of them even ventured out dancing with the band. Finally, Saturday was devoted to visiting the Chacaltaya GAW station – located at 5240 m asl – and the archaeological ruins of Tiwanacu near La Paz. Almost all attendees participated in this activity. In spite of some initial fear due to the altitude at Chacaltaya – the summit is just below 5400 m asl – everybody walked half an hour to the summit in order to enjoy the landscape and take pictures. People had a lot of fun!

As a summary, based on comments and some informal (and more formal) surveys we believe that winter school was a success. Students were particularly pleased with the lectures/talks and the level at which they were conducted. Even logistics went very smoothly. The goal is now to keep in touch with this new generation of atmospheric scientists and to organize more schools on topics of interest in the LAC region.

23-25 March 2015
Jülich, Germany

IGAC Endorsed

AUTHORS

Andreas Hofzumahaus, Institut für Energie und Klimaforschung: Troposphäre (IEK-8), Germany

Dwayne Heard, University of Leeds, UK

HOST INSTITUTION AND FUNDING

JÜLICH FORSCHUNGSZENTRUM

PARTICIPANTS

Germany, Ireland, USA, France, UK, Japan, China, and Finland

BACKGROUND

FUNDAMENTALS ATMOSPHERIC CHEMISTRY

This workshop was endorsed by IGAC as part of the IGAC activity Fundamentals of Atmospheric Chemistry, which emphasizes the importance of and fosters fundamental research in advancing the field of atmospheric chemistry.

Assessment of local HO_X and RO_X Measurement Techniques: Achievements, Challenges, and Future Directions

Forschungszentrum Jülich

Measurements of HO_X and RO_X radicals are an important tool for the investigation of tropospheric chemistry in field campaigns and simulation chamber experiments. The measured data allow us to test chemical models simulating the atmospheric concentrations of OH, HO_2 and RO_2, and help to improve chemical mechanisms used in regional and global models for predictions of the atmospheric chemical composition. The measurement of these radicals is highly challenging and requires persistent care.

From March 23-25 2015, an international, IGAC-endorsed workshop took place at JUFA, Jülich, and hosted by the Forschungszentrum Jülich, Germany, to assess the performance and reliability of current HO_X measurement techniques. Fifteen international groups from Germany, UK, Ireland, France, Finland, USA, China and Japan came together to discuss achievements, challenges and future directions of techniques based on laser-induced fluorescence spectroscopy, chemical ionisation mass spectrometry, and chemical techniques. There were 35 participants at the workshop, including Principal Investigators, Postdoctoral Fellows and Postgraduate Students, with representatives from virtually all groups world-wide undertaking field measurements of HO_X and RO_X. The

Workshop Participants

workshop follows a number of other workshops dedicated to the measurement of HO_X that were held at Leeds (2005), SRI International (1992 and 1985) and NASA (1982). The major topics for discussion were an assessment of how well we can measure OH, HO_2 and RO_2; how instrumental performance can be improved in terms of sensitivity, calibration and artefacts; and how the reliability of HO_X and RO_X measurements can be demonstrated to the international community. An important feature of the meeting was the presence of three rapporteurs consisting of two field scientists and one modeler, who although internationally leading in their own disciplines, are not practitioners of HO_X measurements.

In order to set the scene, the workshop began with invited talks giving overviews of the state-of-the-art for HO_X and RO_X radical measurement techniques. There then followed a number of contributed talks from individual groups regarding potential measurement artefacts, and a talk about the development of a new laser-based method. Following each talk there was ample time for questions and discussion. The remainder of the meeting was dedicated to discussion based around four themes, each led by a Chair, and facilitated by the rapporteurs, who summarized the main topics both from the earlier talks and also from the discussion sessions. After the workshop the rapporteurs submitted unbiased summaries of the various themes. Following the discussions, a working group was established to guide the community in the near future in making progress on continued improvement in HO_X measurements. Three goals will be pursued: the development of a common calibration unit, the development of procedures to investigate and, if necessary, eliminate possible measurement artefacts, and planning for future instrumental intercomparisons.

Three goals will be pursued: the development of a common calibration unit, the development of procedures to investigate and, if necessary, eliminate possible measurement artefacts, and planning for future instrumental intercomparisons.

We are very grateful to Forschungszentrum Jülich for financial support. A fuller report of the workshop, including individual contributions from each group and a summary of the discussions, outcomes and rapporteur reports, will become available at a later date (Please contact the authors if you would like a copy.)

Southeast Atmosphere Studies Workshop 2015

8-10 June 2015
Princeton, NJ, USA

IGAC Endorsed

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Annmarie Carlton, Rutgers University, USA

Larry Horowitz, Geophysical Fluid Dynamics Laboratory/National Oceanic and Atmospheric Administration, USA

Ronald C. Cohen, University of California – Berkeley, USA

Havala Pye, U.S. Environmental Protection Agency, USA

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Michael Trainer, Earth System Research Laboratory/National Oceanic and Atmospheric Administration, USA

Loretta Mickley, Harvard University, USA

Eric M. Leibensperger, SUNY Plattsburgh, USA

Rohit Mathur, U.S. Environmental Protection Agency, USA

HOST INSTITUTION

FUNDING

NSF, EPA, NOAA, AC4, Princeton

PARTICIPANTS

USA

BACKGROUND

FUNDAMENTALS
ATMOSPHERIC CHEMISTRY

This workshop was endorsed by IGAC as part of the IGAC activity Fundamentals of Atmospheric Chemistry, which emphasizes the importance of and fosters fundamental research in advancing the field of atmospheric chemistry.

GFDL, NOAA

Concentrations of atmospheric trace species in the United States have changed dramatically over the past several decades in response to pollution control strategies, shifts in domestic energy policy, and economic development (and resulting emission changes) elsewhere in the world, in particular developing countries. Reliable projections of the future atmosphere require models to not only accurately describe current atmospheric concentrations, but do so for the right reasons. Only through incorporation of the correct chemical mechanisms can models reliably project the impacts of future policy, energy, and climate scenarios. Efforts to properly identify and implement the fundamental and controlling mechanisms in atmospheric models benefit from intensive observation periods (IOPs), during which co-located measurements of diverse, speciated chemicals in both the gas and condensed phases are obtained. The summer of 2013, in particular the Southeast Atmosphere Studies, provides an unprecedented opportunity for the atmospheric modeling community to come together to evaluate, diagnose, and improve the representation of fundamental climate and air quality processes in models of varying temporal and spatial scales.

On June 8-10, 2015, more than sixty scientists from across the United States attended a workshop at NOAA GFDL to share their understanding of the interactions between human activities, terrestrial vegetation, air quality, and climate over the Southeast U.S. The major focus of this workshop was the ozone and particulate matter (PM) modeling constraints provided by recent measurements of gas- and aerosol-phase species during the Southeast Atmosphere Studies (SAS, including SENEX, SOAS, NOMADSS and SEAC4RS). This effort is expected to improve understanding of the regional cooling over the Southeast U.S., which has been tentatively attributed to secondary organic aerosols formed by the

Workshop Participants

interactions of biogenic emissions and anthropogenic pollutants. Recommendations were developed in each of the four workshop themes for atmospheric chemistry modeling over this region:

Gas-phase chemistry (1) Up-to-date "standard" chemical mechanisms represent OH chemistry well over the observed range of NO_x concentrations. Detailed mechanisms based on recent laboratory chamber studies (mostly at Caltech) and theoretical studies (Leuven) for isoprene chemistry result in predicted OH that is in reasonable agreement with observations. Condensed mechanisms that approximate the detailed ones are expected to do the same. (2) Given the large emissions and high chemical reactivity of isoprene, its chemistry should be treated fairly explicitly, including more detail than for most other hydrocarbons. (3) NO_3 chemistry contributes significantly to both VOC oxidation and aerosol production. (4) The regions of peak NO_x and BVOC emissions are not collocated. As a result, the model resolution can impact the predictions.

Aerosol chemistry (1) There is high confidence that a pathway of SOA formation from isoprene epoxydiol (IEPOX) should be included in models. However, since many of the parameters needed to predict IEPOX-SOA are uncertain, different modeling approaches could be beneficial. (2) There is high confidence that models should include SOA formation from nitrate radical oxidation of monoterpenes (with or without explicit nitrate functionality). Sesquiterpenes and isoprene may also contribute SOA through nitrate radical oxidation, but the contribution is expected to be smaller. (3) Models can help determine how important glyoxal (produced from isoprene, as well as from anthropogenic VOCs) is as a SOA precursor.

Natural and anthropogenic emissions (1) Biogenic emissions from BEIS are generally lower and those from MEGAN, generally higher than from measurements for all campaigns. (2) Observations confirm a rapid decrease of ozone precursor emissions over past few decades. Thus, use of the correct scaling of anthropogenic emissions for a particular year is important for accurate simulations. (3) National Emissions Inventory (NEI) 2011 likely overestimates NO_x emissions from mobile sources based on fuel based estimates.

Regional climate and chemistry interactions (1) Annual mean temperatures during the 1930-1990 timeframe decreased by ~1°C over the central and southeastern United States. Several studies have argued that patterns of sea surface temperatures in the North Atlantic may have caused this large-scale cooling. Trends in aerosol forcing may have also played a role. (2) Pollution episodes in the southeastern United States are correlated with high temperatures, low wind speeds, clear skies, and stagnant weather. Surface air quality over Southeast U.S. may be to some extent modulated by large-scale circulations, such the Bermuda High or Atlantic Multi-decadal Oscillation (AMO).

The workshop also identified a few open questions that are best addressed by the community of experimentalists and modelers working together. Detailed findings and recommendations will be presented in a final report to be delivered to the larger atmospheric chemistry and climate community.

Disclaimer: Although this document has been reviewed by U.S. EPA and approved for publication, it does not necessarily reflect U.S. EPA's policies or views.

Fatimah Ahamad

Fatimah Ahamad is currently pursuing a PhD in Environmental Science at the National University of Malaysia, Selangor. Fatimah is originally from Malaysia and completed her undergraduate studies in chemistry and biology at a local college in Kuala Lumpur, Malaysia, which has a sister program with Campbell University in North Carolina, USA. Fatimah earned a MSc in Energy and Environment at Malaysia University of Science and Technology in Selangor. Fatimah's current research interest is the influence of ENSO and monsoonal modulation on ozone variability in Malaysia. Her research looks at both tropospheric and ambient ozone measurements.

See ACAM workshop and training school summaries on pages 8 and 10.

What was the highlight for you of the ACAM workshop?
Meeting the people behind the science. I learned a lot particularly from scientists who shared their experience overcoming the technical and even personal challenges when working in this field. Some of the senior scientists were very generous with their encouragements and suggestions for my research. It really motivated me.

During the ACAM Training School, what was the most interesting thing you learned?
I've only worked on localized ground based measurements before this so I found the application of satellite data to observe global pollutant transport really interesting and it's something I would like to explore further.

What motivated you to pursue a career in atmospheric chemistry? Is there a goal or dream you want accomplish in your career?
I wasn't particularly focusing on atmospheric chemistry when I decided to pursue my studies but I always knew that I wanted to work in a research field related to air quality. I was still in high school when the severe 1997 haze episode occurred in South East Asia. It literally made a strong impression on me. In the future I would like to work on mitigation measures to improve air quality. I've had the opportunity to be involved in research projects that involved policy makers. I'm not sure how much of the science helped influence policy decisions but I hope I will be able to work on more projects like that.

What aspect of your research are you most excited about?
I enjoy answering research questions. It's like completing a jigsaw puzzle, except that you don't really know what the picture will finally look like.

What is your favorite hobby?
I love hiking!

Save the Date!

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

AUTHORS

Jeff Jennings, formerly IGAC IPO, USA

Megan L. Melamed, IGAC IPO, USA

Allen Goldstein, IGAC Co-Chair, University of California-Berkeley, USA

Mark Lawrence, IGAC Co-Chair, IASS, Germany

FIGURE 1. **Participants of the 1988 meeting in Dookie, Australia that was the formative IGAC meeting.**

BACKGROUND

GLOBAL IGBP CHANGE

As the International Geosphere-Biosphere comes to an end in December 2015, the global environmental change community will transition to Future Earth. To celebrate IGBP's legacy, each of the former core projects of IGBP have written a synthesis paper that will be published as a special collection in *Anthropocene* fall 2015. This science feature is an abbreviate version of the IGAC synthesis article and celebrates the rich 25+ year history of IGAC. Publications and more information on IGAC activities throughout the years can be found on the **IGAC website**.

A History of IGAC

The origins of the International Global Atmospheric Chemistry (IGAC) project date back to the 1950's when the International Association of Meteorology and Atmospheric Sciences (IAMAS) of the International Union of Geodesy and Geophysics (IUGG) initiated the Commission on Atmospheric Chemistry and Radiation (CACR), which was later renamed the international Commission on Atmospheric Chemistry and Global Pollution (iCACGP).

At the fifth iCACGP Symposium in 1983 a committee was appointed to explore the sponsorship of an international research program on atmospheric chemistry. Committee members included Dieter Ehhalt, Tony Cox, Henning Rodhe and Sherry Rowland. A parallel effort began in 1981 when a number of atmospheric chemists and meteorologists wrote a letter to the U.S. National Science Foundation urging the government to support the development of a coordinated study on global tropospheric chemistry, which resulted in a 1984 U.S. National Research Council Report entitled *Global Tropospheric Chemistry: A Plan for Action* [NRC, 1984], chaired by Robert Duce and Ralph Cicerone. The report recommended "The US undertake a cooperative research effort with other countries in investigating the chemistry of the global troposphere."

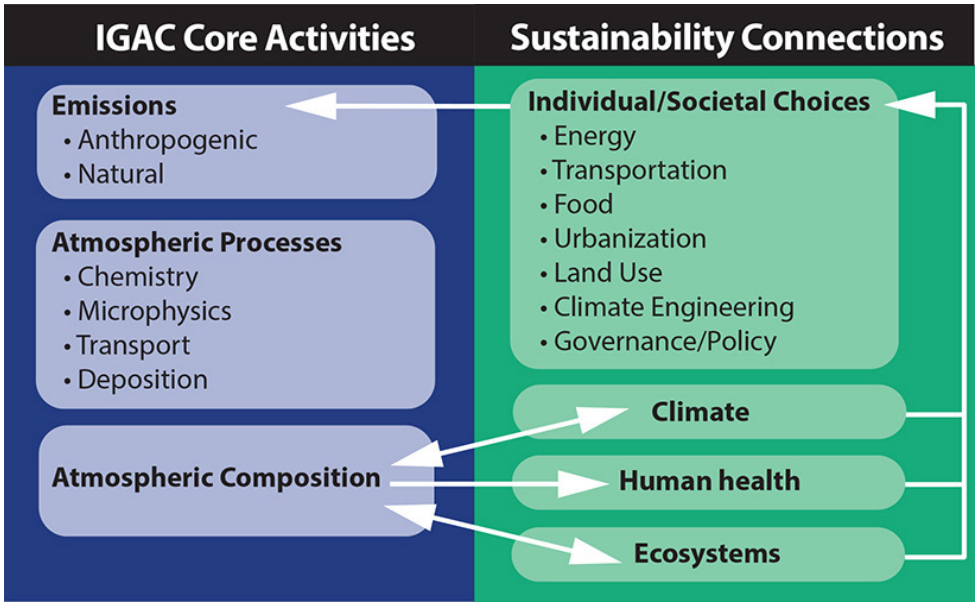

FIGURE 2. **IGAC Vision diagram**

As a result of these two simultaneous efforts, in 1988 a meeting was held in Dookie, Australia on the formation of the International Global Atmospheric Chemistry (IGAC) Project *(Figure 1)*. Participants defined the initial six foci that would serve as the basis for the foundation of the first phase of IGAC. The six foci were: (1) Natural variability and anthropogenic perturbations of the marine atmosphere; (2) Natural variation and anthropogenic perturbation of tropical atmospheric chemistry; (3) The role of polar regions in the changing atmospheric composition; (4) The role of boreal regions in changing atmospheric composition; (5) Global distribution, transformations, trends and modeling; and (6) International support activities. In 1990, IGAC officially became a core project of the International Geosphere-Biosphere Programme (IGBP) and iCACGP [Galbally, 1989] with its International Project Office (IPO) located in and funded by the US National Science Foundation (NSF), National Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA). Throughout IGAC's 25-year rich history, the focus of IGAC has evolved. The first phase of IGAC, 1990-1999, focused on fostering research that led to quantifying the pre- and post-industrial distributions of reactive trace species and determining the chemical, physical, and optical properties of aerosols. In its second phase, 2000-2010, IGAC fostered the scientific collaborations that led to research that greatly increased our understanding of the chemical composition of the troposphere, the fluxes of chemical species into and out of the troposphere, and the processes controlling the transport and transformation of chemical species within the troposphere. In its third phase, IGAC's mission is to "facilitate atmospheric chemistry research towards a sustainable world". This is achieved through IGAC's vision of linking emissions, atmospheric processes and atmospheric composition to global change and sustainability issues such as climate, human health, ecosystems and how individual and societal responses feedback onto the core research-led foci of IGAC *(Figure 1)*.

Over the course of 25 years, IGAC has facilitated atmospheric chemistry research to understand how atmospheric composition impacts air quality, climate change and nutrient flows in ecosystems. This has been achieved through IGAC facilitating activities on:

- Synthesis and integration
- International field measurement campaigns
- Atmospheric chemistry at the Earth system interfaces
- Fundamental science
- Capacity building

Among the results of these efforts are four books, 32 special issues and numerous peer reviewed journal articles showing that IGAC has helped defined the goals, objectives, and priorities, and has acted as initiator, catalyst and coordinator for the international atmospheric chemistry community.

Synthesis and Integration

The synthesis and Integration efforts of IGAC have resulted thus far in five significant publications. *Global Atmospheric-Biospheric Chemistry* [Prinn, 1994] greatly improved the understanding of the chemical and biological process that determine the composition of the Earth's atmosphere. *Atmospheric Chemistry in a Changing World* [Brasseur et al., 2003] is considered to be the first international assessment of global tropospheric chemistry. Monks et al. [2009] brought to the forefront that long-range transport of air pollutants have a significant impact on regional air quality demonstrating that air pollution is not a local, but a global issue. As the percentage of the world population living in urban areas surpassed the 50% mark in 2008, IGAC released the extensive report *WMO/IGAC*

Impacts of Megacities on Air Pollution and Climate [Zhu et al., 2012] that summarized the current state of knowledge regarding air pollution and climate in megacities across Africa, Asia, South America, North America and Europe. In response to a call from policymakers to understand the climate impacts of black carbon, an IGAC led effort published a hallmark synthesis on *Bounding the Role of Black Carbon in the Climate System: A Scientific Assessment* [Bond et al., 2012].

International Field Measurement Campaigns

IGAC has cultivated international scientific collaborations that have led to the coordination of field measurement campaigns on intercontinental transport and chemical transformations, aerosol characterization, biomass burning and ozone, all of which included substantial international cooperation for *in situ* observations, remote sensing, data analysis and modelling efforts. From the early 1990s through the mid 2000's, IGAC played an important role in five international field campaigns on intercontinental transport and chemical transformations; East Asia-North Pacific Regional Experiment (APARE), which included Pacific Exploratory Mission-West A (PEM-West A) and B (PEM-West B), North Atlantic Regional Experiment (NARE), Pacific Exploration of Asian Continental Emissions (PEACE), Intercontinental Transport and Chemical Transformations (ITCT-2k2), and New England Air Quality Study – ITICT 2004. Throughout the late 1990s, four international field campaigns on aerosol characterization were organized by IGAC; First Aerosol Characterization Experiment (ACE-1), Tropospheric Aerosol Radiative Forcing Observational Experiment (TARFOX), North Atlantic Regional Aerosol Characterization Experiment (ACE-2), and Asian Aerosol Characterization (ACE Asia). In 1992 IGAC organized the overarching Biomass Burning Experiment: Impact on the Atmosphere and Biosphere (BIBEX), which coordinated three different international efforts on biomass burning; South Tropical Atlantic Regional Experiment (STARE), Transport and Atmospheric Chemistry near the Equator-Atlantic (TRACE-A) and Southern African Fire/Atmospheric Research Initiative (SAFARI). Other biomass bringing field campaigns included Fire of Savanas/Dynamics and Atmospheric Chemistry in the Equatorial Forest (FOS/DECAFE 91) and Experiment for Regional Sources and Sinks of Oxidant (EXPRESSO). Similarly to the biomass burning field campaigns, a series of three field campaigns on ozone were coordinated in the early 1990s under the Global Atmospheric Chemistry Survey (GLOCHEM). The Field campaigns involved in GLOCHEM were Mauna Loa Observatory Photochemistry Experiment (MLOPEX), Second Tropospheric Ozone Campaign (TROPOZ-II) and Measurements of Ozone in Airbus in-Service Aircraft (MOZAIC).

Atmospheric Chemistry at the Earth System Interfaces

IGAC has also played an important role in coordinating research on atmospheric chemistry at the interfaces including atmosphere-biosphere, atmosphere-ocean and atmosphere-cryosphere interactions. IGAC led activities on atmosphere-biosphere interactions include Bisophere-Atmosphere Trace Gas Exchange (BATREX), Trace Gas Exhange: Mid-latitute Terrestrial Ecosystems and the Atmosphere (TRAGEX), Biosphere-Atmosphere Trace Gas Exchange in the Tropics: Influence of Land Use Change (BATGE), High-latitude Ecosystems as Sources and Sinks of Trace Gases (HESS), Emission of Methane form Wetland Rice Fields, and the Interdisciplinary Biomass Burning Initiative (IBBI). Atmosphere-Ocean interaction activities included Marine Aerosol and Gas Exchange (MAGE), Atlantic Stratocumulus Transition Emxperiment (ASTEX), Air-Sea Gas Exchange (ASGAMAGE), Halogen in the Troposphere (HitT). Atmosphere-cryosphere interactions include Polar Atmospheric and Snow Chemistry (PASC), which included special issues on tropospheric chemistry of the Antarctic and Arctic regions, the Polarstern Expedition, and the Polar Sunrise Experiment in addition to the Air-Ice Chemical Interactions (AICI) activity.

Fundamental Science

In addition, IGAC has facilitated scientific activities focusing on the fundamental science of emissions, aerosols, gas phase and modeling. Understanding emissions is essential to understanding how atmospheric composition changes, this is recognized in the IGAC activities, Reactive Chlorine Emissions Inventory (RCEI), Methane fluxes from Landfills and Rice Cultivation, and the Global Emissions Initiative (GEIA). Aerosol characterization has been a key component of IGAC and has involved several activities on this topic in addition to international field campaigns such as Focus on Atmospheric Aerosols (FAA), Direct Aerosol Radiative Forcning (DARF), Aerosol Characterization and Process Studies (ACAPS) and Aerosols, Clouds, Precipitation and Climate (ACPC). IGAC has also had several activities underpinning gas phase atmospheric chemistry such as Global Tropospheric Ozone Network (GLONET), International Tropospheric Ozone Years (ITOY), Jülish Ozone Intercomparison Experiment (JOSIE) and Global HO Systematic Tests (GHOST). IGAC has also organized model intercomparison activities such as Nonmethane

TABLE 1. IGAC Scientific Conferences

Conference	Location	Conference	Location
1993 IGAC	Eilat, Israel	2002 IGAC/ iCACGP	Crete, Greece
1994 IGAC/ iCACGP	Fuji-Yoshida, Japan	2004 IGAC	Christchurch, New Zealand
1995 IGAC	Beijing, China	2006 IGAC/ iGACGP/ WMO	Cape Town, South Africa
1997 IGAC/ SPARC/GAW	Toronto, Canada	2008 IGAC	Annecy, France
1997 IGAC/ iCACGP/ IAPSO	Melbourne, Australia	2010 IGAC/ iGACGP	Halifax, Canada
1998 IGAC/ iCACGP	Seattle, WA, USA	2012 IGAC	Beijing, China
1999 IGAC	Bologna, Italy	2014 IGAC/ iCACGP	Natal, Brazil

Hydrocardon Intercomparison Experiment (NOMHICE), Global Integration and Modeling (GIM), and Atmospheric Chemistry and Model Intercomparison Project (ACCMIP).

Capacity Building

A primary role of IGAC is to build scientific capacity in the field of atmospheric chemistry around the globe. IGAC has a strong focus on engaging the next generation of early career atmospheric scientists and scientists from developing countries. Arguably, IGAC's Science Conference is a primary mechanism for IGAC to build cooperation and disseminate scientific information across its international community. The first IGAC Science Conference was held in 1993 in Eilat, Israel. Since then, IGAC has successfully held fourteen science conferences, consistently becoming a biennial conference starting in 2002 *(see Table 1)*. The conference is jointly held with the iCACGP Symposium every four years. The biennial IGAC Science Conference is regarded as ***the*** international conference on atmospheric chemistry and participation in the conference is typically in the range from 350-650 participants. Since 2004, IGAC has included an Early Career Scientists Program as part of the conference to foster the next generation of scientists. The IGAC conferences and the Early Career Program have shown that helping young scientists to form an international network of colleagues enhances future international collaborations in atmospheric chemistry.

The last 25 years of IGAC as a core project of IGBP have been very successful. As IGAC transitions to Future Earth, with continued sponsorship by iCACGP, IGAC aims to continue to represent the international atmospheric chemistry community by fostering activities that underpin fundamental scientific research on emissions, atmospheric processes, and atmospheric composition in ways that link to global change and sustainability, making a central contribution to the overall mission of Future Earth. As a project of Future Earth, IGAC will be part of a global platform for international scientific collaboration that will promote the development of knowledge knowledge required for the world's societies to face risks posed by global change and to seize opportunities in its efforts to transition towards global sustainability.

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Interaction Between Indoor and Atmospheric Chemistry Workshop

15-16 May 2015
Lille, France

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HOST INSTITUTION AND FUNDING

Université de Lille 1 SCIENCES ET TECHNOLOGIES

FUNDING

ADEME Agence de l'Environnement et de la Maîtrise de l'Energie

cnrs

Alfred P. Sloan FOUNDATION

NSF

PARTICIPANTS

Canada, France, USA, UK, Finland, Germany, Norway, and Jordan

BACKGROUND

The field of atmospheric chemistry has primarily focused on outdoor air quality over the years. However, as humans spend more and more time indoors, air quality indoors may play a large contribution to human health. As IGAC considers a new activity related to human health, the linkages between atmospheric chemistry and indoor air quality cannot be ignored.

Centre Lille

On 15-16 2015, the Interactions Between Indoor and Atmospheric Chemistry workshop (**ibiac.fr**) was held in Lille, France at the Université de Lille- Sciences et Technologies. This workshop, supported by the Alfred P. Sloan Foundation and the National Science Foundation, brought together 40 atmospheric and indoor air chemistry researchers to present and discuss contemporary research in both fields, pose and answer key research questions and define future indoor air chemistry research objectives. The workshop was co-organized by Glenn Morrison of the Missouri University of Science and Technology, Maxence Mendez of Université de la Rochelle and Coralie Schoemaecker of Université de Lille- Sciences et Technologies. One of the main objectives of this workshop was to develop a list of questions, barriers and opportunities that would help guide short-term and long-term research in the area of indoor chemistry and shared indoor/atmospheric topics, approaches and tools.

In four technical sessions, speakers discussed the similarities and differences between the chemistry taking place in buildings and in the atmosphere. The sessions focused on gas-phase oxidation processes,

Workshop Participants

heterogeneous chemistry, aerosol composition and aging, characterization of indoor environments and health effects. Each session included time for break-out discussions of topics relevant to the session.

A common theme in presentations was the use of advanced instrumentation not previously used in buildings. Recent discoveries included observation of OH and HO_2 radicals in buildings at concentrations similar to outdoors. Oxidation products of human skin lipids have been observed in indoor air and occupation increases the concentration of sulfuric acid. Further, an aerosol mass spectrometer has been deployed to investigate aerosol composition in a classroom and the secondary organic aerosols formed during ozonolysis of terpenes from household products. Highlighting the importance of surfaces in indoor environments, several presentations reported on surface chemistry and characterization including the use of DART-MS to observe oxidation and composition of surface films. Application of atmospheric chemistry models to field (building) data was also discussed, along with models describing aerosol and film composition and aging.

During break-out discussion, several key questions and recommendations for future research were identified.

Indoor and outdoor chemistry investigations have different motivations and "framing" this question is key to developing resources for the future research. Health is the key motivator which will help us improve buildings in light of chemistry influenced not only by photochemical oxidants in indoor air, but also considering the chemistry taking place on and in building materials and furnishings. Field campaigns in buildings are tricky to design and interpret because the composition of building air, materials of construction, construction methods, occupancy, use and operation can vary greatly. Participants recommended mining of existing databases of building information, developing a standard set of building measurement tools (such as air exchange rate) and developing a standard set of building materials, surfaces and surface films. Given the gulf between what can be measured with advanced instrumentation and what has been measured, field campaigns are likely to continue to yield new discoveries. But targeted laboratory and full-scale model-building experiments will be key to understanding the underlying phenomena resulting in occupant exposure to products of indoor chemistry. IGAC

The Inaugural "ACCORD" Workshop

30 March – 1 April 2015
Boulder, CO, USA

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HOST INSTITUTION

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

FUNDING

NSF

PARTICIPANTS

USA

BACKGROUND

ACCORD is a community effort to address critical, emerging questions in *in situ* observational atmospheric chemistry amongst NCAR and other University partners. IGAC feels it is important for the international community to be aware of these types of community efforts and to provide input when appropriate.

NCAR Center Green Campus

The inaugural ACCORD workshop was held in Boulder, Colo., 30 March – 1 April 2015, bringing together more than 100 scientists to discuss the future of U.S. *in situ* observational atmospheric chemistry, with an additional 50 people attending remotely. ACCORD – the Atmospheric Chemistry Center for Observational Research and Data – is a new partnership between NCAR's Atmospheric Chemistry Observations and Modeling Laboratory (ACOM), NCAR's Earth Observing Laboratory, NSF Atmospheric Chemistry, and the University community. Its mission is to build a better alliance between ACOM and University partners to address critical, emerging questions in in situ observational atmospheric chemistry, and to provide a vehicle for community input into ACOM's role in answering these questions.

The ACCORD Science Committee (consisting of 6 University and 3 NCAR scientists, and an NSF representative, **https://www2.acom.ucar.edu/accord/science-committee**) was formed in spring 2014, and put forward the idea of this community workshop, designed to obtain a bottom-up consensus on major science questions facing our field and the facilities needed to answer these questions. To help structure the workshop, a survey was first distributed to the community. Survey results were

used to generate the workshop discussion themes, and to provide a starting point for discussions.

Seven workshop discussion themes were identified, including five science themes: Secondary Organic Aerosol, Aerosol Optical and Physical Properties, Reactive Nitrogen, Biosphere-Atmosphere Interactions, and Regional and Global Oxidants. A major goal was to bring early career scientists to the workshop to allow them a platform to present their ideas – more than 30 attended – and a separate theme on early-career scientists was included. The final discussion topic was related to general facilities.

The workshop consisted of a series of breakout discussions, and plenary presentations and discussions. Potential activities associated with each of the seven themes were identified and are outlined in the workshop summary, **https://www2.acom.ucar.edu/accord/accord-2015-workshop**.

Some central ideas brought forward in the discussions are as follows:

1) The need for a community engineering center, in particular to provide support for aircraft instrumentation was strongly articulated.

2) The need for well-characterized ground site(s) for scientific study and instrument testing, and/or a mobile laboratory that can be deployed at a ground site, was expressed.

3) The community expressed a desire for an increased focus on re-analysis of previous field campaign results. Topics for study via 'virtual campaigns' included global HO_X budgets, ozone production in biomass burning plumes, the evolution of Arctic composition, BVOC fluxes, and SOA formation.

4) The need for training (particularly for early-career scientists and newcomers to the field) on all aspects of instrumentation development and field deployment was communicated.

5) The continuing (and expanding) need for standards, calibration, and intercomparison exercises was prevalent.

6) A field campaign in a terpene-dominated landscape was discussed as part of multiple science themes (HO_X budgets, biosphere-atmosphere exchange, and SOA formation).

7) There was a desire to develop a chamber collaboration network, with a focus on a centralized data repository.

Key ACCORD activities, many associated with developing a better infrastructure for carrying out *in situ* observational atmospheric chemistry research, are currently under discussion and development. Stay tuned!!

calendar 2015-2016

Visit **igacproject.org** for updates to the calendar

SEPTEMBER

PACES Workshop
IGAC Sponsored
29-30 September 2015
Helsinki, Finland

OCTOBER

2015 CCMI Workshop
IGAC Sponsored
5-9 October 2015
Rome, Italy

Atmospheric Chemistry and Dynamics Summer School
12-16 October 2015
Jülich, Germany

International School on Atmospheric Chemistry
19-30 October 2015
Shanghai, China

2015 Acid Rain Conference
19-23 October 2015
Rochester, NY, USA

NOVEMBER

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

13th Annual UNU & GIST Joint Programme Symposium
Environmental Challenges in Urban Cities
11-12 November 2015
Manila, Philippines

2015 Atmospheric Composition and Chemistry Observations and Modelling Conference
11-13 November 2015
South Durras, NSW, Australia

The 13th International Conference on Atmospheric Sciences and Applications to Air Quality (ASAAQ13)
11-13 November 2015
Kobe, Japan

17th GEIA Conference
IGAC Sponsored
18-20 November 2015
Beijing, China

DECEMBER

AGU Fall Meeting
14-18 December 2015
San Francisco, CA, USA

JANUARY

European Research Course on Atmospheres
6 January - 4 February
Grenoble, France

AMS 96th Annual Meeting
10-14 January 2016
New Orleans, LA, USA

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