

# 2009-2012 Final Report

## International Global Atmospheric Chemistry Project

NASA Award #NNX09AQ95G



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Report Prepared By: Current IGAC Staff

## 1 Background and Objectives

The International Global Atmospheric Chemistry (IGAC) Project 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). IGAC’s mission is to *coordinate and foster atmospheric chemistry research towards a sustainable world* by integrating, synthesizing, guiding, and adding value to research undertaken by individual scientists through initiating new activities, acting as a hub of communication for the international atmospheric chemistry research community, and through building scientific capacity. IGAC accepts there is a need to develop a multi-disciplinary approach to address global sustainability and embraces this challenge by integrating IGAC’s core activities that focus on emissions, atmospheric processes, and atmospheric composition with sustainability issues such as climate, human health, ecosystems, and how individual and societal responses feed back into the core IGAC research-led activities.

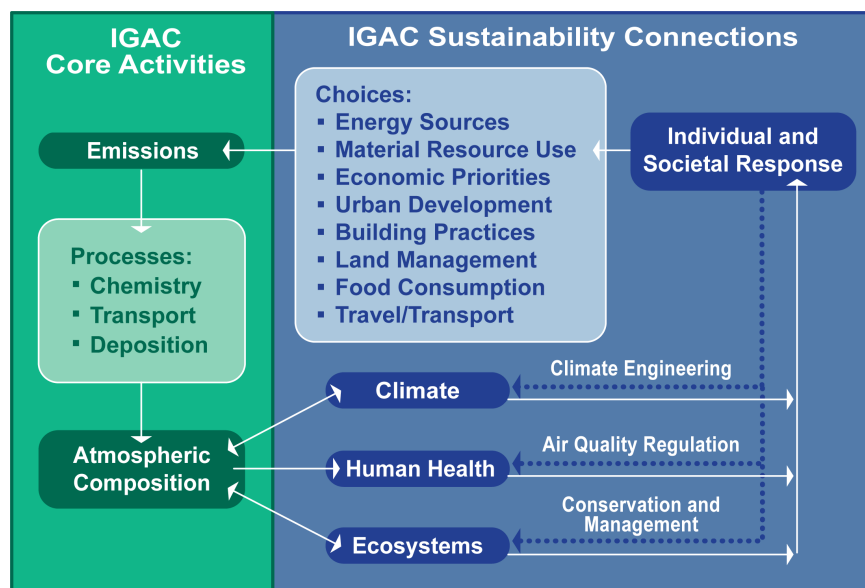


Figure 1: IGAC’s role in Earth System Sustainability Science

## 2 Participants

The International Global Atmospheric Chemistry (IGAC) Project's Core Project Office is located at the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado, Boulder. The IGAC Core Project Office is funded equally by the U.S. National Science Foundation (NSF), NOAA, and the National Aeronautics and Space Administration (NASA). Six different employees have been supported within the IGAC Core Project Office from 2009 to 2012. From 2009 to 2011, Sarah J. Doherty was working 75% time as the IGAC Executive Officer, 25% time on research. In January 2011, Sarah J. Doherty stepped down and was replaced by Dr. Megan L. Melamed, who currently works 100% time as the IGAC Executive Officer. From 2009 to 2011, Collen Marquist worked 40% time as IGAC Administrative Specialist. From 2011 to 2012, Steven Brey and June Landenburger worked 10-15 hours per week as part-time student assistants. Since 2012, Jeff Jennings has worked 10-15 hours per week as part-time student assistant. In addition to the permanent IGAC staff, IGAC also works with a graphic designer and web developer on an as needed contractual basis.

However, there is a much wider participation in the IGAC project than just those whose pay is covered under this grant. The project activities are guided and in many cases implemented by an international Scientific Steering Committee (SSC), which acts on a volunteer basis. IGAC SSC members serving between 2009 and 2012 are listed below.

Table 1: IGAC SSC Members 2009-2012

Name	Years	Country	Institute
Law, Kathy (co-chair 2007-2009)	2003-2009	UK	University Pierre et Marie
Monks, Paul (co-chair 2010-present)	2008-present	UK	University of Leicester
Zhu, Tong (co-chair 2009-2012)	2007-present	China	Peking University
Abbatt, Jonathan	2012-present	Canada	University of Toronto
Barth, Mary	2010-present	USA	National Center for Atmospheric Research (NCAR)
Beig, Gufran	2008-2012	India	Indian Institute of Tropical Meteorology (IITM)
Chen, Jen-Ping	2006-2009	China-Tapei	National Taiwan University
Drummond, Jim	2008-2011	Canada	Dalhousie University
Elansky, Nikolai	2006-2009	Russia	A.M. Obukhov Institute of Atmospheric Physics
Facchini, Maria Cristina	2008-2011	Italy	University of Bologna
Feingold, Graham	2008-2012	USA	NOAA
Goldstein, Allen	2009-present	USA	University of Berkeley
Granier, Claire	2011-present	France	Laboratoire Atmosphères, Milieux
Griffith, David	2007-2010	Australia	University of Wollongong
Kanakidou, Maria	2006-2010	Greece	University of Crete
Keyword, Melita	2011-present	Australia	CSIRO
Konare, Abdourahamane	2008-2012	Côte d'Ivoire	University of Cocody Abidjan
Kondo, Yutaka	2007-2011	Japan	University of Tokyo
Lawrence, Mark	2010-present	Germany	Max Planck Institute for Chemistry
Longo, Karla	2009-present	Brazil	National Institute for Space Research
Lung, Shih-Chun Candice	2010-present	Taiwan	Academia Sinica
Mari, Celine	2007-2009	France	UMR CNRS
Mayol-Bracero, Olga	2009-present	Puerto Rico	University of Puerto Rico
Pandis, Spyros	2012-present	Greece	University of Patras
Park, Rokjin	2010-present	South Korea	Seoul National University
Pienaar, Kobus	2009-present	South Africa	North-West University
Rasch, Philip	2003-2009	USA	Pacific Northwest National Laboratory
Rudich, Yinon	2011-present	Israel	Weizmann Institute of Science
Sharma, Chhemendra	2012-present	India	National Physical Laboratory
Tanimoto, Hiroshi	2012-present	Japan	National Institute for Environmental Studies (NIES)

In addition to SSC members, IGAC relies on the involvement of the entire international atmospheric chemistry community in order to carry out its activities. Leads of IGAC activities active between 2009 and 2012 (described under Activities and Findings) are listed below. All activities are current, unless otherwise stated.

Table 2: International Leaders of IGAC Activities

Activity	Name	Country	Institute
AC&C [Concluded 2012]	Phil Rasch	USA	PNNL
	Martyn Chipperfield	UK	University of Leeds
AC&C Hindcast [Concluded 2012]	Peter Hess	USA	Cornell University
ACCMIP (Previously under AC&C)	Jean Francois Lamarque	USA	NCAR
	Drew Shindell	USA	NASA-GISS
AC&H	<i>Shi-Shun Candice Lung</i>	Taiwan	Academia Sinica
ACPC	Graham Feingold	USA	NOAA
	Meinrat O. Andrea	Germany	Max Planck
AICI	V. Faye McNeill	USA	Colombia University
	Thorsten Bartels-Rausch	Switzerland	Paul Scherrer Insitut
Air Pollution & Climate	<i>Paul Monks</i>	UK	University of Leicester
	Kathy Law	France	CNRS
AMMA-AC [Concluded 2012]	Abdourahame Konaré	Côte d'Ivoire	University of Cocody Abidjan
Biomass Burning Initiative	Johannes Kaiser	UK	ECMWF
	<i>Melita Keywood</i>	Australia	CSIRO
Bounding the Role of Black Carbon in Climate	Tami Bond	USA	University of Illinois
	Sarah Doherty	USA	University of Washington
	David Fahey	USA	NOAA
	Piers Forster	UK	University of Leeds
Chemistry-Climate Model Initiative	Veronika Eyring	Germany	DLR
	Jean-Francois Lamarque	USA	NCAR
DEBITS	<i>Kobus Pienaar</i>	South Africa	North-West University
GEIA	Greg Frost	USA	CU/CIRES and NOAA/ESRL
	Leonor Tarrason	Norway	NILU
HiTT	Roland von Glasow	UK	University of East Anglia
	Ulrich Platt	Germany	University of Heidelberg
ITCT [Concluded 2011]	Kathy Law	France	CNRS
Fundamentals in Atmospheric Chemistry	<i>Jonathan Abbatt</i>	Canada	University of Toronto
Megacities-Asia [Concluded 2012]	<i>Tong Zhu</i>	China	Peking University
Megacities Assessment	<i>Tong Zhu</i>	China	Peking University
China Working Group	<i>Tong Zhu</i>	China	Peking University

*Current IGAC SSC members listed in italics*

### 3 Activities and Findings

IGAC carries out its activities via four main pathways:

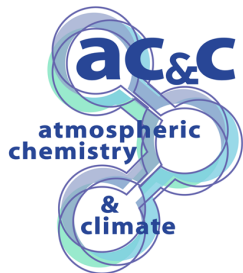
1. **Activities:** The IGAC community identifies issues in fundamental and sustainability research requiring synthesis and integration of research across disciplines and/or geographical boundaries, and facilitates their implementation. In 2011, IGAC Tasks and IGAC Activities were merged and are now unilaterally referred to as Activities.
2. **National/Regional Working Groups:** IGAC sponsors national/regional working groups that aim to facilitate the coordination of research both within the nation/region and between the nation/region and the international atmospheric chemistry community.
3. **Events:** IGAC co-sponsors small, focused meetings, workshops, and conferences that kick-start new directions in atmospheric chemistry research or support planning, data analysis/synthesis, or assessments related to current IGAC Activities or IGAC's Vision. IGAC also holds a biennial open

science conference that is the primary mechanism for dissemination of scientific information across the IGAC community.

4. **Communications/Networking:** This covers a myriad of activities including a newsletter (mailed to over 3,000 researchers around the world), webpage, and miscellaneous networking activities conducted throughout the year.

## Initiatives

- **Atmospheric Chemistry & Climate (AC&C) [Concluded 2012]**



AC&C sought to improve the representation of chemistry/climate interactions in models. Activities within AC&C were coordinated with modeling activities such as SPARC's Chemistry-Climate Model Validation Activity (CCMVal), the Aerosol Comparisons between Observations and Models (AeroCom) project, and the Task Force on Hemispheric Transport of Air Pollution (HTAP) to assure maximum efficiency in model runs, meeting planning, and resources. AC&C consisted of four efforts: Bounding the Role of Black Carbon in Climate, the Model Intercomparison Project (ACCMIP), Hindcast, and Vertical Distributions. The former two efforts have evolved into standalone activities that are currently active, while the latter two remained under AC&C until its conclusion in 2012.

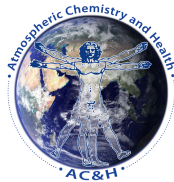
- **AC&C Hindcast [Concluded 2012]**

This modeling activity sought to test and diagnose global chemistry models using the past few decades of observations to quantify and reduce uncertainties when these models were used in climate system models to project conditions in the 21st century. Through this process, more objective measures of uncertainty in modeling atmospheric chemistry and transport and thus in projecting future composition resulted. This effort focused on atmospheric oxidants, in particular ozone and OH, but also included aerosols.

- **AC&C Model Intercomparison Project (ACCMIP)**

ACCMIP is providing extensive coordinated model simulations, diagnostics, and evaluations of the effect of short-lived species on climate, in coordination with the climate model intercomparison effort (CMIP5). The main focus is on the role of tropospheric ozone and aerosols, which both have substantial climate forcing that varies widely in space and time. The first set of model runs for ACCMIP were completed in 2011 and a first workshop was held in April 2011 in Toulouse, France (see Workshops below). A follow-up workshop was held in February 2012 in Pasadena, CA, USA in conjunction with an HTAP meeting. The model evaluation is expected to be completed in time to support the International Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5) and will result in 13 peer-reviewed publications. Visit <http://www.giss.nasa.gov/projects/accmip/> for more information.

- **Atmospheric Chemistry & Health (AC&H)**



Research on atmospheric chemistry is motivated by the possible impacts on climate, ecosystems, and human health caused by the changes of atmospheric composition. Research ranges from laboratory measurements on the formation of pollutants, field campaigns on detailed gas and aerosol composition, long term observations at background stations (trend detection), satellite observations, regional and global scale modeling, focusing on short-term periods (weeks) to multi-decadal composition change. Research on health effects of atmospheric pollutants focuses on the relationships between exposure to outdoor air pollution and a range of acute and chronic health effects. This research comprises epidemiologic studies of the effects of short- and long-term human exposure to air pollution and toxicological experiments in animals as well as in-vitro studies of tissues and cells. Epidemiologic studies generally use ground-level measurements of air pollution at a limited number of locations, either alone or as part of spatial and or temporal models, to estimate the exposure of study populations, while toxicological studies use controlled experiments to evaluate toxicity and to understand the mechanism of air pollutants. Despite many shared issues, the atmospheric chemistry and health communities have developed research programs that, for the most part, do not explicitly acknowledge or relate to one another, and, as a result, even basic knowledge is not always widely shared. This initiative brings together these two communities to explore the various and multi-dimensional interactions between atmospheric chemistry and human health, with IGAC leading the atmospheric chemistry research needs. There were two workshops on AC&H in the past year: Atmospheric Chemistry & Health: Future Direction October 2011 in Boston, MA; and the Workshop on Health Impacts of Air Quality and Climate in Asia April 2012 in Guangzhou, China (see Workshops below).

- **Aerosols, Clouds, Precipitation, & Climate (ACPC)**

Jointly sponsored by IGBP-iLEAPS and WCRP-GEWEX



ACPC was established in 2007 to obtain a quantitative understanding of the interactions between aerosol, clouds, and precipitation and their role in the climate system. ACPC is a coordinated effort encompassing six strategic elements: 1) a focus on regimes where there are strong indications of aerosol-cloud-precipitation interactions;

2) an emphasis on statistical characterizations of aerosol-cloud-precipitation interactions;

3) the development of approaches that leverage past and ongoing activities;

4) thorough integration of modeling and observational activities;

5) a hierarchical approach to both modeling and data collection/analysis; and

6) continued development of measurement techniques (The ACPC Science)

In addition, a new component of ACPC is the SAT-ACPC effort, which seeks to address specifically how satellite-based measurements can be used to improve the understanding of the role of aerosols in precipitations processes. ACPC is currently working to expand the GoAmazon2014 research field campaign sponsored by the U.S. Department of Energy (<http://campaign.arm.gov/goamazon2014>).

The Amazon Basin has strong coupling between terrestrial ecosystems and the hydrologic cycle.

GoAmazon will provide the needed observations to study how aerosols and surface fluxes influence cloud cycles under clean and polluted conditions. View the ACPC Science Implementation Plan here: [http://www.igacproject.org/sites/all/themes/bluemasters/images/2009\\_ACPC\\_SciencePlan\\_FINAL.pdf](http://www.igacproject.org/sites/all/themes/bluemasters/images/2009_ACPC_SciencePlan_FINAL.pdf).

- **Air-Ice Chemical Interactions (AICI)**

Jointly sponsored by SOLAS



The IGAC SSC first endorsed AICI in 2003 in light of research demonstrating new processes observed in the polar regions at the air-ice interface. The goal of AICI is to assess the significance of these processes at local, regional, and global scales by bringing together the laboratory, field, and modeling communities. The first phase of AICI was very successful providing important information on the full range of processes and trace gases that are exchanged at the air/ice and snow/ice interface and how they related to atmospheric chemistry and climate. The first phase resulted in various publications, including a Special Issue in Atmospheric Chemistry and Physics ([http://www.atmos-chem-phys.net/special\\_issue80.html](http://www.atmos-chem-phys.net/special_issue80.html)). In June 2011, AICI held a workshop at Columbia University, USA that brought together new insights from AICI studies over the last eight years, including work carried out at part of Ocean-Atmosphere-Sea Ice-Snowpack (OASIS), International Polar Year (IPY), and another IGAC Activity Halogens in the Troposphere (HitT). The past eight years of research produced new insights into cirrus ice and NO<sub>y</sub> chemistry of the upper troposphere, air-snowpack exchange, and the role of halogen activation in the polar boundary layer. Much discussion during the workshop dealt with novel laboratory results that provide a molecular level understanding of the chemistry in snow and with the challenge to connect those to field observations by appropriate models. The challenge to develop detailed snow-chemistry models that better describe and predict air-snow interactions is considerable given that the chemistry proceeds via multiple steps, the snow is highly heterogeneous, and the number of important trace gases and radicals is numerous. The outcome of the Columbia University workshop is a joint special issue in Atmospheric Chemistry and Physics and Earth System Data on "New Perspectives on Air-Ice Chemical Interactions" ([http://www.atmos-chem-phys.net/special\\_issue275.html](http://www.atmos-chem-phys.net/special_issue275.html)).

- **Air Pollution & Climate: A Science-Policy Dialogue**

An IGBP Synthesis Topic



As part of its second phase synthesis activities, the IGBP has identified several key areas which cut across research in its own core projects and which also reach out beyond IGBP with the aim of exploring future cross disciplinary research needs. The IGBP Air Pollution & Climate initiative, lead by IGAC, seeks to open a science-policy dialogue on the air pollution and climate change challenge. There is still a separation between air pollution and climate change in both the policy and scientific communities. This separation is reflected in the temporal and geographic scales of interest: air pollution efforts focus on the near-term and the local and regional scales, whereas climate change efforts focus on the long-term and global scale. As with many issues, there also exists a divide between the scientific and policy communities that hinders communication and understanding. The aim of the Air Pollution and Climate Initiative is to break down these divides and clarify the synergies and trade-offs of research and mitigation efforts across a spectrum of air pollution and climate change policies. Two workshops, Tackling the Air Pollution and Climate Change Challenge June 2011 in Arona, Italy, and Air Pollution and Climate: A Science-Policy Dialogue in Asia in November 2011 led to the release of a statement entitled *Time to Act: The Opportunity to Simultaneously Mitigate Air Pollution and Climate Change at the Planet Under Pressure* conference March 2012 (see Publications). The next step of the initiative is to develop a Strategic Plan for an Integrated Program on Air Pollution and Climate that engages the international earth system science, social science, and policy communities to be released in 2013.

- **African Monsoon Multidisciplinary Analysis - Atmospheric Chemistry (AMMA-AC)**  
[Concluded 2012]



AMMA was an international project launched in 2002 to improve knowledge and understanding of the West African Monsoon, its variability, and its impact on West African nations. Phase one of AMMA came to a completion at the beginning of 2010 and findings were published in a Special Issue of Atmospheric Chemistry and Physics. AMMA-AC during Phase 1 focused on the development of measurement networks of trace gases and aerosols throughout West Africa.

- **Biomass Burning Initiative**

Jointly sponsored by WMO and IGBP-ILEAPS

Biomass burning changes the land surface drastically and leads to the release of large amounts of trace gases and aerosol particles that play important roles in atmospheric chemistry and climate. In addition, there is large uncertainty on how climate change and global change will impact the frequency, intensity, duration, and location of biomass burning in the short- and long-term making their emissions a large source of uncertainty of future atmospheric composition. Therefore biomass burning and its emissions need to be observed and modeled accurately for understanding the composition of the atmosphere and how it changes at different temporal and spatial scales. Significant gaps remain in our understanding of the contribution of deforestation and savanna, forest, agricultural waste, and peat fires to emissions. Coordinated international activities organized by IGAC, iLEAPS, and WMO (e.g. interdisciplinary laboratory measurements and field campaigns that integrate ground-based and airborne observations as well as detailed analysis of satellite data and numerical modeling results) will help better quantify the present and future impact of biomass burning emissions on the composition and chemistry of the Earth's atmosphere. The first workshop to define this new activity was held at the WMO in Geneva, Switzerland 5-6 July 2012.

- **Bounding the Role of Black Carbon in Climate**

This focused effort is to produce an assessment report that summarizes the most current knowledge on black carbon (BC) and its role in climate as well as provide a best estimate and uncertainty range for the radiative forcing by BC. This effort results from a request for such an assessment by national and international groups trying to formulate policies to mitigate short-term climate warming. It is expected to constitute a direct input to the next Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), and has been structured to accommodate the IPCC framework. The report was accepted to *Journal of Geophysical Research - Atmospheres* December 2012 ([http://www.igacproject.org/sites/all/themes/bluemasters/images/BoundingBC\\_2PageSummary.pdf](http://www.igacproject.org/sites/all/themes/bluemasters/images/BoundingBC_2PageSummary.pdf)).

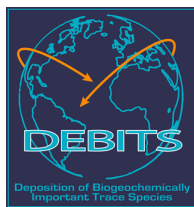
- **Chemistry-Climate Model Initiative (CCMI)**

Jointly sponsored by WCRP-SPARC

CCMI is coordinating model evaluation and associated modeling activities between the domains of chemistry and climate dynamics. To best reflect current understanding, CCMI seeks to frame scientific inquiry in this arena through an integrated stratosphere-troposphere approach. These efforts are meant to culminate in increasingly accurate global atmospheric models and a well-informed IPCC Fifth Assessment Report (IPCC AR5). The first workshop for this activity was held in Davos, Switzerland 21-25 May 2012 (see Workshops below).



- **Deposition of Biogeochemically Important Trace Species (DEBITS)**



Wet and dry deposition of chemical species to the earth's surface plays an essential role in controlling the concentration of gases and aerosols in the troposphere. The chemical composition of atmospheric deposition provides important information on many interacting physical and chemical mechanisms in the atmosphere such as emission sources, atmospheric dynamics and transport, atmospheric removal processes, and nutrient cycling in ecosystems. Long-term research on deposition thus provides critical information on natural and anthropogenic influences on the atmosphere and provides information on the temporal and spatial evolution of atmospheric chemistry. Phase I of DEBITS, which was initiated in 1990 under the first phase of IGAC, focused on the development of an international measurement network of stations to monitor the wet and dry deposition of biogeochemically important trace species. As a result of Phase I, DEBITS stations are of the highest data quality and assurance, following the WMO/GAW data quality objectives. In Phase II, the DEBITS science community has adopted a twofold approach to maintain the present operational structure of DEBITS and to support a new integrated approach to deposition flux measurements and impact studies. Despite the efforts of the DEBITS Task and other research, wet and especially dry deposition remains a large unknown in the chemical budget of the atmosphere. The IGAC SSC believes there is still a strong need for international collaboration and integration of research on atmospheric deposition, especially in implementing and maintaining long-term monitoring networks and understanding the chemical/physical properties of deposition. For more information, please see the DEBITS website at <http://Debits.sedoo.fr>.

- **Fundamentals of Atmospheric Chemistry**

Fundamental atmospheric chemistry research provides essential data used in all practical (laboratory, field measurements, remote sensing) and theoretical (climate modeling, pollution modeling, cloud microphysics) aspects of scientific endeavor. These studies encompass a diverse range of areas including gas-phase kinetics, heterogeneous chemistry, chamber studies, photochemistry, spectroscopic and thermodynamic chemical data, and meteorology that together, with the attendant measurement techniques, deliver the data and the constant evolution required to work in the atmospherically relevant physical and chemical regimes. The evolution of atmospheric chemistry research has resulted in more emphasis on field research and modeling than on fundamental research typically done in the laboratory. Therefore, laboratory studies for atmospheric chemistry stand at a crossroads. In many respects they are decreasing due to shifts in funding towards large field campaigns. Many of the pioneers and innovators of the last great paradigm shift have begun to retire and there is a risk of a shrinking community, yet the need remains the same if not more in light of challenges such as climate change, climate manipulation, and pollution-related health impacts. In response, IGAC is exploring the need for an initiative on Fundamentals of Atmospheric Chemistry that would stress the importance of continued fundamental research in atmospheric chemistry but that would explore innovative ways fundamental research could be sustained and possibly move from the laboratory bench to, for example, a component of field research.



- **Global Emissions IntiActive (GEIA)**  
Jointly sponsored by IGBP-iLEAPS, IGBP-AIMES



For the past two decades, GEIA (formerly know as the Global Emission Inventory Activity) has provided access to various global and regional emission inventories in a consistent framework, organized workshops that bring together inventory developers and users, prepared state-of-the-science emission summaries and provided these data to international scientific projects. The joint IGAC/iLEAPS/AIMES GEIA initiative seeks to build on the success of the past two decades by expanding the breadth of GEIAs activities in order to be a forum for exchange of expertise and information that unite the scientific, regulatory, and operational emission communities (see figure below). Under the new GEIA umbrella (<http://www.geiacenter.org/>), the well-respected GEIA emission inventory portal merged with the Emissions of atmospheric Compounds & Compilation of Ancillary Data (ECCAD, <http://eccad.sedoo.fr/>) portal. GEIA also includes the Community Initiative for Emissions Research and Applications (CIERA, <http://ciera-air.org/>), which works to facilitate the consistent, timely, and transparent development of emissions inventories at all scales, including evaluations and analyses of emission datasets, and the inter-operational exchange and communication of emissions information. Significant advances planned for the new GEIA are the introduction of new observations from space and from a variety of Earth-based platforms, and the incorporation of other emission efforts such as operational emissions that can be used for air quality forecasting.

- **Halogen in the Troposphere (HitT)**  
Jointly sponsored by IGBP-SOLAS



The primary objective of the SOLAS/IGAC task HitT is to determine and quantify the importance of reactive halogen compounds (RHCs) in tropospheric chemistry and climate forcing. Key themes are the influence of RHC on the oxidative capacity of the atmosphere, the ozone budget, as well as in aerosol nucleation and growth. The goal of HitT is to facilitate international collaboration between laboratory, field, and model activities regarding tropospheric halogen chemistry especially in the following domains: polar regions, salt lakes, marine boundary layer (both remote and coastal), volcanoes, free troposphere, and urban areas. Since HitT was first endorsed as an IGAC Activity in 2007, halogens in the troposphere has become a very active research field publishing special issues in Atmospheric Chemistry and Physics on "Radical Chemistry over sunlit snow: interactions between HOX and halogen chemistry at Summit, Greenland" and "The TransBrom Sonne ship campaign in the West Pacific." HitT also works closely with the AICI IGAC Activity as well as the international multidisciplinary OASIS program. Advancements in atmospheric chemistry research on halogens in the troposphere is leading to several upcoming field campaigns such as the 2012 Tropical Ocean troposphere Exchange of Reactive Halogen Species and Oxygenated VOC (TORERO) field campaign funded by NSF and NCAR, the Surface Ocean Processes in the ANthropocene (SPORAN II) funded by the German Federal Ministry for Education and Research, and HALOPROC II funded by the German Research Foundation (DFG). The most recent workshop under HitT addressed climate impact of seasalt-derived CI atoms, held in Kiel, Germany 17-19 December 2012 (see Workshops below).

- **ITCT [Concluded 2011]**  
Over the years, IGAC has endorsed a series of research campaigns on intercontinental transport and chemical transformation. These tasks have included three campaigns on aerosol characterization

experiments (ACE-1, ACE-2, and ACE-Asia), ITCT-Lagrangian-2k4 experiment that was part of ICARTT, and most recently, the Polar Study using Aircraft, Remote Sensing, Surface Measurements and Models, of Climate Chemistry, Aerosols, and Transport (POLARCAT).

- **Megacities-Asia [Concluded 2012]**

The Megacities-Asia Task Team facilitated better coordination between groups making measurements of aerosols and oxidants in and around large cities in Asia. Their activities included maintaining a centralized web page; holding periodic workshops to increase communication between research groups; organizing instrument intercomparisons; and facilitating collaborative publications. The large-scaled, coordinated measurements of aerosols and oxidants in megacities in Asia provided the necessary observations to make the link between source emissions and regional-scale air quality and climate impacts. The results of Megacity Asia are summarized in the Asia chapter of IGAC/WMO report on The Impacts of Megacities on Air Pollution and Climate, available at [http://www.wmo.int/pages/prog/arep/gaw/documents/GAW\\_205\\_DRAFT\\_13\\_SEPT.pdf](http://www.wmo.int/pages/prog/arep/gaw/documents/GAW_205_DRAFT_13_SEPT.pdf).

- **WMO - IGAC Impacts of Megacities on Air Pollution and Climate**

Jointly sponsored by the World Meteorological Organization

As of 2008, for the first time, the majority of the world's population is living in urban areas, many in megacities (with populations over 10 million). Megacities are not only the center of growing economies, but are also large sources of air pollutants and climate-forcing agents. Under this initiative an assessment has been written that for the first time summarizes the current knowledge around atmospheric chemistry in megacities in Africa, Asia, South America, North America, and Europe. The assessment also summarizes past and current research projects on this topic such as MEGAPOLI, CityZen, ICARTT, CalNex, MILAGRO, CareBeijing, PRIDE-PRD, and IMPACT. Finally the report identifies knowledge gaps on atmospheric chemistry in megacities. IGAC plans to provide updates to this assessment every 4 to 5 years. The book was printed and distributed in 2012. The assessment is available at [http://http://www.wmo.int/pages/prog/arep/gaw/documents/GAW\\_205\\_DRAFT\\_13\\_SEPT.pdf](http://http://www.wmo.int/pages/prog/arep/gaw/documents/GAW_205_DRAFT_13_SEPT.pdf).

## National/Regional Working Groups

There are many regions of the world where there are many great scientists but often their research is conducted very independently and their results often do not reach the international community. However, as atmospheric chemistry research questions and their connections to societal issues become more global, there is a strong desire to engage these scientists in order to incorporate their research and local knowledge of these regions of the world. Therefore, the goal of IGAC National/Regional Working groups is two fold; one is to create a strong cohesive community of atmospheric scientists in a specific nation/region that together would have a sum greater than its parts, and the second is to connect the regional/national working groups to the larger IGAC community in order to foster international collaboration.

- **China Working Group**



The sheer magnitude of China's landmass coupled with its growing and economically advancing population makes it critical to understand its role in air quality and climate on both regional and global scales. Chinese atmospheric chemists have been conducting frontier research for forty years in areas such as urban and regional air pollution and the climate effects and health impacts of air pollution. IGAC intends to more fully integrate Chinese research experience by establishing its first national working group in China. The goals of the IGAC China Working Group are to:

- Encourage participation of Chinese atmospheric scientists to engage their leadership in international atmospheric chemistry research programs;
  - Strengthen ties with IGAC to facilitate the implementation of IGAC related research projects and tasks in China;
  - Provide advice or consultation on major research plans in atmospheric chemistry in China to promote funding support;
  - Promote academic exchange on atmospheric research in China and internationally, especially with IGBP China Working Groups; and
  - Provide a platform in China to facilitate the academic growth and development of young researchers in atmospheric chemistry.
- **Americas Working Group** (Future Working Group)  
The first workshop to develop an IGAC Americas Working Group will be held fall 2014. The workshop will bring together scientists from across the Americas, with a focus on Latin America but including scientists from the US and Canada. The workshop will focus on the following areas:
    - Improving the collaboration and communication between scientists in Latin America
    - Connecting the Latin America community to the international community
    - Training and fostering the next generation of scientists
    - Influence/promote a more proper distribution of funds for research
    - Enhance visibility and credibility of scientists in Latin America

The outcome of the workshop will be to develop a formal proposal for an IGAC Americas Working Group identifying its leadership, composition, structure, and goals.

## Workshops

IGAC has co-sponsored the following workshops between 2009 and 2012.

- **4-6 June, 2009, IGAC/POLARCAT Special workshop with policymakers on Short-lived Pollutants and Arctic Climate, Durham, New Hampshire, USA**  
This workshop focused on relaying the recent scientific findings of POLARCAT to policymakers and identifying techniques to effectively translate this scientific knowledge into public policy.
- **13-15 April 2010, Megacities and Coastal Zones IGBP Fast Track Initiative (FTI) workshop**  
This FTI is a joint activity of SOLAS, IGAC and LOICZ which specifically looked at how atmospheric chemistry in coastal urban areas affects and is affected by interactions with the coastal marine environment. A report from the workshop is in preparation and will constitute a contribution to the wider Megacities and Coastal Zone IGBP Synthesis.
- **19-21 May 2010, AMMA-Africa meeting, Abidjan, Cote d'Ivoire**  
With the intensive field phase of AMMA completed, focus has shifted to maintenance of measurements (e.g. ground stations) established under AMMA, establishing leadership and coordination within Africa to continue AMMA-related research, and planning next steps.
- **26-28 May 2010, Bounding the Role of Black Carbon in Climate report Lead Authors meeting, Boulder, Colorado**  
The third meeting of the Bounding BC lead authors was held, with focus on the synthesis sections of the document.

- **15 July 2010, Megacities Assessment Lead Authors meeting, Halifax, Canada**  
 Chapter leads of this IGAC/WMO Assessment report met to determine final steps needed to complete the report. Action items were decided on and circulated.
- **29 September 2010, meeting of the lead organizers of the ACPC initiative, Bern, Switzerland**  
 With the ACPC Science Plan now published, this workshop focused on planning the first ACPC field experiment, which will take place in Brazil.
- **4-6 October 2010, first organizational meeting of SAT-ACPC**  
 A new component of ACPC to address specifically how satellite-based measurements can be best used to improve our understanding of the role of aerosols in precipitation processes.
- **13-15 April 2011 ACC-MIP Workshop, Toulouse, France**  
 Discussed the first model results of ACC-MIP run and planned the next steps for the ACC-MIP analysis.
- **6-7 June 2011, Air-Ice Chemical Interactions (AICI) 3rd Workshop, Columbia University, NY USA**  
 The meeting provided a forum to bring together new insights from AICI studies, including work carried out as part of the Ocean-Air-Sea Ice-Snow project (OASIS), Halogens in the Troposphere (HitT, another IGAC activity), and the International Polar Year (IPY). The outcomes of the workshop will be featured in a joint special issue between *Atmospheric Chemistry and Physics* and *Earth System Science Data* entitled "New Perspectives on Air-Ice Chemical Interactions (AICI)."
- **9-10 June 2011, Tackling the Air Pollution & Climate Challenge, Arona, Italy**  
 As part of the International Geosphere-Biosphere Programme's (IGBP)/IGAC Air Pollution & Climate Initiative, a two-day workshop was held in Arona, Italy on 9-10 June 2011 to discuss the development of an effective science-policy dialogue to address the Air Pollution and Climate Change Challenge. The workshop had 22 participants across the science-policy spectrum representing 13 different countries.
- **6-7 October 2011, The First International Workshop on the Long-Range Transport and Impacts of African Dust on the Americas, San Juan, Puerto Rico**  
 Interest is growing in the long-range transport of mineral dust and its impact on climate, human health, and ecosystems. The largest dust sources are located in the northern hemisphere and, of these, the most intense and persistently active are those located in North Africa, which emits about half of the global total. Every year, large amounts of African dust are transported by the trade winds over vast areas of the North Atlantic to the Americas. This workshop provided a scientific forum for specialists on topics related to the long-range transport and impacts of mineral dust in the atmosphere, but with emphasis on African dust and its transport and impacts on the Americas.
- **12-13 October 2011, AC&H: Current Knowledge & Future Directions, Boston, MA USA**  
 As part of the IGAC Atmospheric Chemistry & Health Initiative, representatives of the U.S. Environmental Protection Agency, the World Health Organization, and the European Commission reviewed ways in which atmospheric science and research on air pollution-related health effects currently inform policy making. They discussed the potential contributions of an integrated research program to address air pollution and issues related to climate change, including the health effects of diverse short-lived greenhouse pollutants such as black carbon, sulfate particles, and ozone. Workshop participants plan to issue a report with copies of the presentations and prepare a summary of the major conclusions and recommendations for publication in a peer-reviewed journal.
- **7-10 November 2011, Air Pollution & Climate: A Science-Policy Dialogue in Asia, Taipei, Taiwan**  
 As part of the IGBP/IGAC Air Pollution & Climate Initiative, a three-day workshop on Air Pollution and Climate: Creating a Science-Policy Dialogue in Asia was held at Academia Sinica. The workshop had 25 participants across the science-policy spectrum representing 15 different countries. The workshop focused on framing the IGBP/IGAC statement *Time to Act: The Opportunity to*

*Simultaneously Mitigate Air Pollution and Climate Change.* The Statement was released during the Planet Under Pressure Conference 26-29 March 2012 in London as part of the session on Tackling the Air Pollution and Climate Change Challenge: A Science-Policy Dialogue (see Publications).

- **30 January - 1 February 2012, ACCMIP 2nd Workshop, Pasadena, CA USA**  
The workshop further defined the experimental setup of the ACCMIP projects currently underway, along with the delivery schedule and format, while focusing primarily on discussion of specific topics for analyses that would be performed on the ACCMIP dataset.
- **8-11 April 2012, Workshop on Health Impacts of Air Quality and Climate in Asia, Guangzhou, China**  
Seventy-two participants from Asia, Europe, and the United States were brought together to build collaborations, exchange knowledge, and plan an interdisciplinary framework for addressing science questions related to four themes: climate, air quality, health, and social vulnerability in Asia. The workshop enabled the interactions of experts from many diverse disciplines, including those from the atmospheric, health, and social sciences.
- **25-27 April 2012, Developing Asian Megacities towards a Sustainable World, Zhangjiajie, China**  
To understand the mechanism of human impact on the geophysical/chemical processes and their feedbacks on the Earth System is the most important topic for global change research. In recent years, Monsoon Asia Integrated Regional Study (MAIRS) has been promoting research on the impacts of aerosol emission and land cover change in megacities on the local/regional climate in the monsoon Asian region. The output of this workshop will be published as a "Strategic Plan of Asian Megacity Study," it is mainly focused on 5 themes: Development of Asian Megacities; Climate and urbanization; Assessment of resilience and vulnerability of Asian megacities; Vulnerability and resilience of Asian cities; Regional collaboration and future studies.
- **21-24 May 2012, IGAC/SPARC Global Chemistry-Climate Modeling and Evaluation Workshop, Davos, Switzerland**  
Approximately 130 scientists from 16 different countries over four continents attended the workshop. Through a combination of invited talks, contributed talks, poster sessions and working group discussions, participants identified science questions relevant to chemistry-climate model evaluation, the specific physical or chemical processes associated with each question, the relevant observations, and the associated model diagnostics. The workshop participants recommended the creation of a joint IGAC - SPARC Chemistry-Climate Model Initiative (CCMI) to coordinate future IGAC and SPARC chemistry-climate model evaluation and associated modeling activities.
- **5-6 July 2012, IGAC/iLEAPS/WMO Workshop on Biomass Burning, Geneva, Switzerland**  
This workshop at the WMO Headquarters gathered 20 participants from 11 countries, each representing different topics linked with the impact of fires on the Earth system, to discuss the formation of an international and interdisciplinary activity on biomass burning. The workshops presentations and discussions emphasized the fact that fires are an integral part of the Earth Systems, and that their atmospheric and radiation impacts, as well as socio-economical and ecological impacts need to be analyzed in an integrated way. In order to make progress in this field, the discussions identified emerging directions for fire research and offered first insights for the focus of the future activity on fires.
- **15-19 October 2012, A U.S. - Japan Workshop on the Tropical Tropopause Layer, Honolulu, HI, USA**  
Here 50 participants gathered at the East-West Center of the University of Hawaii to discuss the Tropical Tropopause Layer (TTL). Nearly 20 of the participants were graduate students and young scientists. The workshop summarized the current state of understanding of the TTL with tutorial presentations, summarized and formulated key questions surrounding the TTL, and discussed and coordinated observations planned over the next few years in the tropical Pacific region.

- **11-13 December 2012, SOLAS/IGAC Workshop on the role of marine gel for the emission of primary organic aerosols from the ocean, Kiel, Germany**

This workshop convened 15 participants to form a deeper understanding of the biogenic sources of primary organic aerosol from the ocean, their chemical composition and of their physical properties. The attendees identified priority questions needing to be addressed by the community, some potential controversies on the topic, and a way forward to fill the knowledge gaps.

- **17-19 December 2012, SOLAS/IGAC Halogens in the Troposphere (HitT) Workshop, Kiel, Germany**

For this workshop, 25 attendees assessed current knowledge surrounding the relevance and also atmospheric reaction cycles of natural chlorine in the troposphere. Participants identified areas where a deficit in understanding existed; discussed the potential for new advances in atmospheric detection, laboratory studies, and modelling; and designed observational strategies to improve understanding of photochemical processes and assess the impact of chlorine chemistry on the marine boundary layer.

## Open Science Conferences

IGAC's biennial Open Science Conferences are the primary mechanism for dissemination of scientific information across our community. The conference is held jointly with iCACGP quadrennially. A special effort is made to engage young and developing country scientists. Since 2004 we have had a Young Scientists Program as an integral part of the conference. The following Open Science Conferences were held between 2009 and 2012.

- **11-16 July 2010, Atmospheric Chemistry: Challenging the Future, Halifax, Canada**

The 11th IGAC Science Conference, held in Halifax with a theme of "Challenging the Future," gathered 370 participants and included 65 oral presentations, as well as over 400 posters. An important feature was the large number and high quality of young scientists' contributions, highlighted by a poster competition resulting in six young scientist winners. The conference was organized around five sub-themes:

1. Climate chemistry interactions
2. Observing atmospheric composition
3. Chemistry at the interfaces
4. Trace gas and aerosol source strengths
5. Pollutant transformation and loss.

While the conference spanned a huge range of topics in atmospheric chemistry, there was specific attention to formation processes of organic aerosol, measurements (techniques) and modeling frameworks. A number of presentations discussed the increasing importance of satellite observations and their synergistic use in models. Elegant techniques for source apportionment of aerosol/gas, using isotopes and other markers received much attention. Modeling and measurements of HO<sub>x</sub> radicals, and the potential role of recycling reaction pathways was a fourth major theme. All invited and keynote speakers were encouraged to reflect on the future challenges for atmospheric chemistry. Numerous examples were given where we still have to improve our observational and modeling capacities, to provide evidence-based, credible and useful results for policy making.

- **17-21 September, 2012, Atmospheric Chemistry in the Anthropocene, Beijing, China**

The 12th IGAC Science Conference was held at the China National Convention Center in Beijing, with a theme of "Atmospheric Chemistry in the Anthropocene" to address the critical interactions between the atmosphere and human activities in an era when humans have fundamentally altered the composition and chemistry of our atmosphere. Greater than 500 scientists and students from more than 40 countries, including over 100 scientists, were in attendance. 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

The conference included keynotes, 12 invited and 60 submitted oral presentations, and poster sessions during which conference participants discussed 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. The Young Scientists Program Committee was formed, which planned activities including an icebreaker 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. The young scientist poster competition was held throughout the conference, with six best poster awards presented.

## Communications/Networking

- **IGAC Newsletter**

IGAC continues to produce a scientific newsletter on a four-month basis that is distributed internationally to ~3000 scientists. While many peer-reviewed publications result from IGAC Activities, the primary product resulting directly from this grant is the IGAC Newsletter. The printing and mailing of the newsletter is taken care of by Academia Sinica in Taipei, but Megan L. Melamed (funded under this grant) is fully responsible for planning newsletter issues, recruiting article authors, and editing of the newsletter. A graphic designer at the University of Washington, Dept. of Atmospheric Sciences, is paid under this grant to do article layout. All past issues of the newsletter (now numbering 46 in total) are downloadable from the IGAC web page.

- **IGAC Website**

<http://igacproject.org/>

This past year a primary focus of the IGAC International Project Office was to redesign the IGAC webpage. The web site highlights IGAC's current activities, conferences, workshops, and IGAC related events. In order to enhance networking, we have two new special features: a listing of job openings related to atmospheric chemistry and an events calendar. It is our goal to create an interface that is more accessible for the international IGAC community.

- **IGAC Mailing List**

IGAC this past year launched a new email based mailing list that gives individuals control over how much they want to hear from IGAC. Community members can choose to receive a hard or digital copy of our newsletter or can decide to keep in closer touch with the IGAC community by signing up to be notified of upcoming IGAC related conferences, workshops, and other grand gatherings.

## Journal Articles

### 2009

- Atmospheric composition change global and regional air quality (2009) Monks, PS, C Granier, S Fuzzi, A Stohl, ML Williams, H Akimoto, M Amann, A Baklanov, U Baltensperger, I Bey, N Blake, RS Blake, K, Carslaw, OR Cooper, F Dentener, D Fowler, E Fragkou, GJ Frost, S Generoso, P Ginoux, V Grewe, A Guenther, HC Hansson, S Henne, J Hjorth, A Hofzumahaus, H Huntrieser, ISA Isaksen, ME Jenkin, J Kaiser, M Kanakidou, Z Klimont, M Kulmala, P Laj, MG Lawrence, J Lee, C Liousse, M Maione, G McFiggans, A Metzger, A Mieville, N Moussiopoulos, JJ Orlando, CD O'Dowd, PI Palmer, DD Parrish, A Petzold, U Platt, U Pschl, ASH Prvt, CE Reeves, S Reimann, Y Rudich, K Sellegri, R Steinbrecher, D Simpson, H ten Brink, J Theloke, GR van der Werf, R Vautard, V Vestreng, Ch Vlachokostas, R von Glasow, *Atmos. Env.*, 43 (33),5268-5350.
- Clean air for megacities (2009) Parrish, DD, T Zhu, *Science*, 326, 674-675.
- Comparison of air pollutant emissions among mega-cities (2009) Parrish, DD, WC Kuster, M Shao, Y Yokouchi, Y Kondo, PD Goldan, JA deGouw, M Koike, T Shirai, *Atmos. Env.*, 43 (40), 6435-6441.



- POLARCAT (Polar Study using Aircraft, REmoste Sensing, Surface Measurements and Models, of Climate, Chemistry, Aerosols, and Transport) Special Issue (2009) Eds. A. Stohl, K. Law, J.W. Bottenheim, P. Monks, and P. Quinn. *Atmos Chem Phys*.

## 2010

- Radical Chemistry over sunlit snow: interactions between HOx and halogen chemistry at Summit, Greenland Special Issue (2010) Eds. J. Dibb, J. Kaiser, J. Stutz, R. von Glasow, and J. Abbatt, *Atmos. Chem. Phys.*

## 2011

- The TRansBrom Sonne ship campaign in the West Pacific Special Issue (2011) Eds. K. Krueger, B. Quack, D. Wallace, W.T. Sturges, and K. Kreher. *Atmos. Phys. Chem. Discuss.*

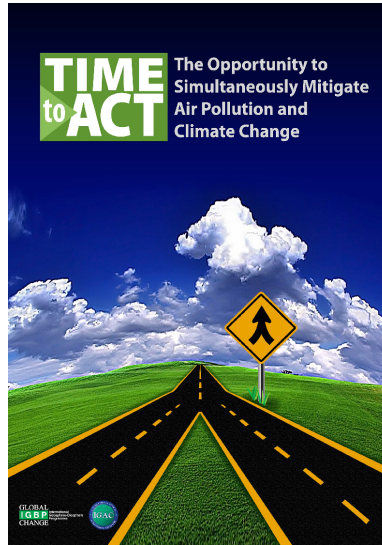
## 2012

- The Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP) Special Issue (2012) Eds. M. Dameris, D. Spracklen, and H. Tost. *Atmos. Chem. Phys. Discuss.*
- New perspectives on Air-Ice Chemical Interactions (AICI) Special Issue (2012) Eds. V. F. McNeill, E. Wolff, T. Bartels-Rausch, and H. Pfeiffenberger. *Atmos. Chem. Phys. Discuss.*
- Atmospheric Chemistry of Iodine (2012) Saiz-Lopez, A., J. M. C. Plane, A. R. Baker, L. J. Carpenter, R. von Glasow, J. C. Gmez Martn, G. McFiggans, R. W. Saunders. *Chem. Rev.*, 112 (3), pp. 1773-1804. doi: 10.1021/cr200029u.
- Latitudinal distribution of reactive iodine in the Eastern Pacific and its link to open ocean sources (2012) Mahajan, A.S., J. C. Gmez Martn, T. D. Hay, S.-J. Royer, S. Yvon-Lewis, Y. Liu, L. Hu, C. Prados-Roman, C. Ordez, J. M. C. Plane, and A. Saiz-Lopez. *Atmos. Chem. Phys. Discuss.*, 12, pp. 15541-15564. doi: 10.5194/acpd-12-15541-2012.
- Multiphase Halogen Chemistry in the Tropical Atlantic Ocean (2012) Sommariva, R. and R. von Glasow. *Environ. Sci. Technol.*, 46 (19), pp. 10429-10437. doi: 10.1021/es300209f.
- Significant concentrations of nitryl chloride observed in rural continental Europe associated with the influence of sea salt chloride and anthropogenic emissions (2012) Philips, G.J., M.J. Tang, J. Thieser, B. Brickwedde, G. Schuster, B. Bohn, J. Lelieveld, and J.N. Crowley. *Geophys. Res. Lett.*, 39, L10811, doi:10.1029/2012GL051912.
- Uncertainties in gas-phase atmospheric iodine chemistry (2012) Sommariva, R., W.J. Bloss, R. von Glasow. *Atmos. Environ.*, 57, pp. 219-232. doi: 10.1016/j.atmosenv.2012.04.032.

## Book Publications

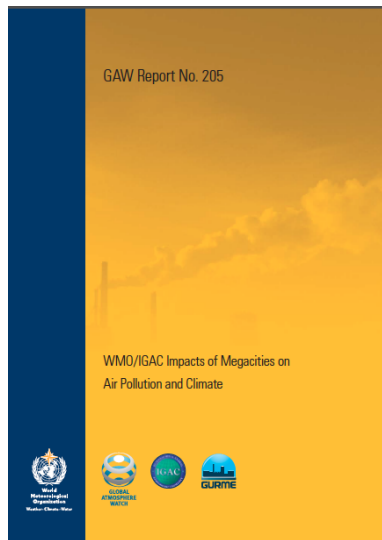
- **Time to Act: The Opportunity to Simultaneously Mitigate Air Pollution and Climate Change**

The Air Pollution & Climate initiative released a statement on the air pollution and climate change opportunity as part of the Planet Under Pressure Conference 26-29 March 2012 in London, U.K. during a session on Tackling the Air Pollution and Climate Change Challenge.



- **WMO - IGAC Impacts of Megacities on Air Pollution and Climate**

This impact assessment, a joint effort between the World Meteorological Organization (WMO) and IGAC, details the unique challenges that urban areas pose to air quality and climate now and in the coming decades. Emphasis is on an assessment of the state of information regarding air pollution in megacities across five continents, including an integrated analysis for North America. An overview of current international collaborative research, key issues and a broad outlook are also discussed.



## 4 Contributions

The role of the IGAC Project is twofold. Its first responsibility is to coordinate and foster atmospheric chemistry research at an international level. Although IGAC does not conduct research, it does provide an “added value” to atmospheric chemistry research. Examples of this are facilitation of international collaboration for research field campaigns, which means that scientists funded at the national level gain access to resources, knowledge, and coordination thus getting more “bang for their buck” from their research grants, e.g. AICI. IGAC also has organized international efforts to address research needs in specific regions of the world, e.g. AMMA-AC, or on specific topics in atmospheric chemistry, e.g. the IGAC/iLEAPS/GEWEX ACPC initiative. In addition, IGAC coordinates the synthesis, assessment, and summary of research that would otherwise not occur, e.g. the *Bounding the Role of Black Carbon* as part of the IGAC/SPARC AC&C initiative. IGAC, through the Atmospheric Chemistry & Climate (AC&C) initiative is contributing to the IPCC assessment process by providing key bounds on the role of aerosols in radiative forcing and for the first time providing model estimates of radiative forcing by short-lived species across a suite of models following a unified framework. IGAC also has a strong focus on engaging the next generation of young atmospheric scientists by providing travel grants to IGAC co-sponsored workshops, meetings, and conferences as well as highlighting their work in the IGAC newsletter. Therefore, from early in their careers, these young scientists join an international network of atmospheric scientists that will further facilitate atmospheric chemistry research at an international level.

IGAC’s second responsibility is to act as a liaison between the atmospheric chemistry community and the broader Earth System Research community. As part of the IGBP, IGAC contributes to understanding the current state of knowledge of the Earth System and identifying the most pressing issues in the Earth System. IGAC facilitates integrative research and synthesis efforts that leverage atmospheric chemistry research to address larger Earth System questions, e.g. Global Emissions Initiative (GEIA). In addition, IGAC publishes books such as the IGAC/WMO *Impacts of Megacities on Air Pollution and Climate* that can reach a wider audience than individual papers published in atmospheric chemistry journals. IGAC also works to reach across the aisle into different disciplines in order to bridge the divide between scientific experts, i.e. the IGAC Atmospheric Chemistry & Health (AC&H) initiative. Finally, IGAC is also engaging stakeholders in order to address the most pressing issues of our time with activities such as the IGBP Air Pollution & Climate: A Science-Policy Dialogue initiative. Through its activities, IGAC provides an invaluable service to the international atmospheric chemistry community, the wider Earth System Research community, and to stakeholders both by advancing atmospheric chemistry research and contributing to understanding of the Earth System.