International Global Atmospheric Chemistry (IGAC)

ANNUAL PROGRESS REPORT 2012

Section 1

Throughout this report, please note collaboration with other IGBP and ESSP projects, IGBP National Committees, networking organisations (IAI, APN), ICSU bodies, etc., and where the work contributes to IPCC and the new ICSU *Earth System Sustainability Initiative*.

1. Key scientific highlights/findings

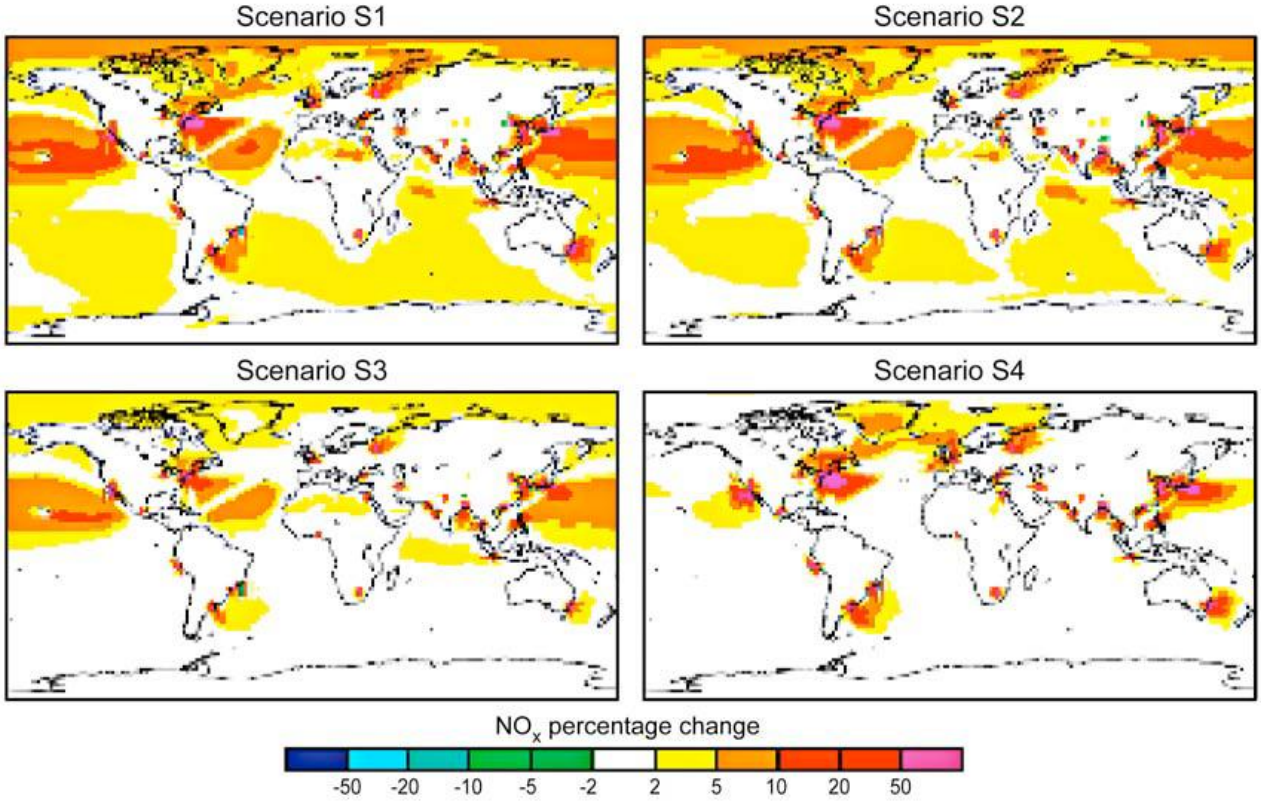
Describe three (or more) recent scientific highlights/findings with text (max. 200 words per highlight), a figure and references. Please focus on results that would not have happened without the project.

Information for: reporting/fundraising & outreach

See following page.

The Impact of Megacities on Air Pollution and Climate

In assessing megacities' emissions, disproportionately large effects were modeled for reactive nitrogen compounds, in particular PAN (peroxy acetyl nitrate). The effects from megacities on global tropospheric NOX concentrations are shown below. Under the low-emission future scenario S2, the influence of megacities is generally reduced, and under the high-emission future scenario S4, although the local influence of megacities is increased, the geographical extent of the influence becomes smaller. In terms of ozone response, the individual model grid cells that contain megacities respond to the megacity emissions differently depending on their latitude. Tropical megacity grid cells generally show increased ozone year-round, while northern extratropical megacities generally show reduced ozone year-round. Eurasian megacities tend to both retain the most pollution in the region immediately surrounding the city, and also to export the most pollution to the boundary layer more than 1000 km away from the city, while tropical cities, especially from Southeast Asia, tend to primarily export the most pollution to the upper troposphere. Vertical transport, is particularly important for determining the differences between the regions.

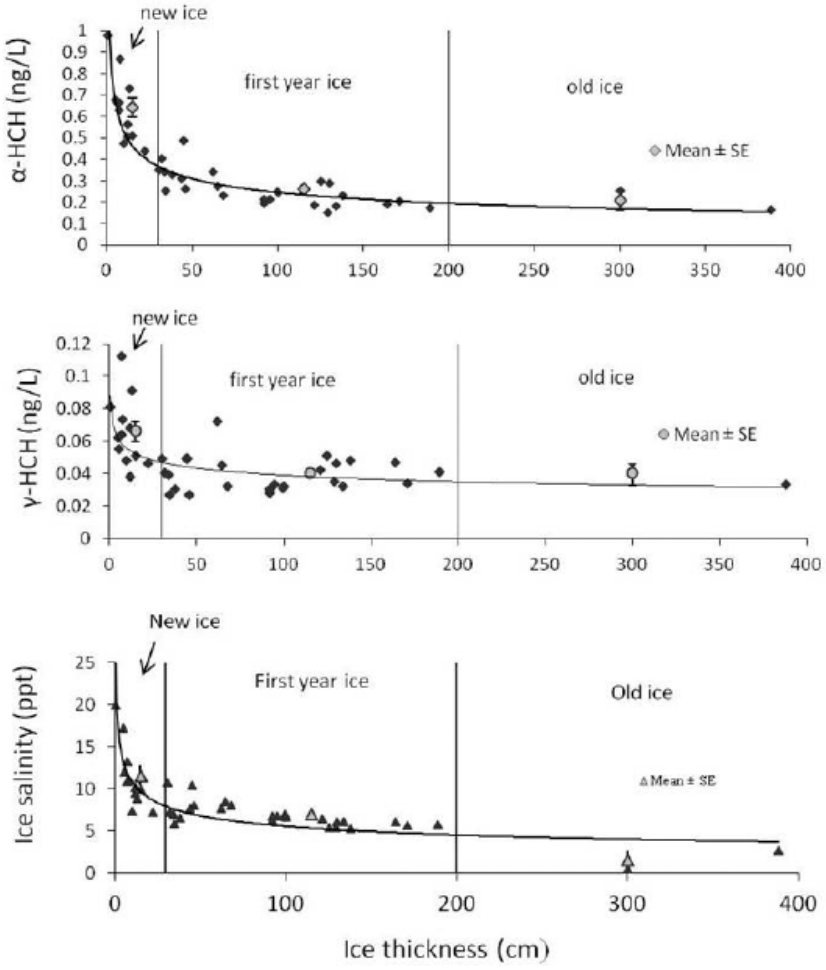


(Above) The percentage change in the global surface NOX mixing ratio due to megacity emissions, computed by the MATCH-MPIC model [*Butler and Lawrence*, 2009]. Four scenarios were considered, based on the missions from the simulations for the IPCC-AR4 intercomparison [*Dentener et al*., 2005]: S1 - year 2000 emissions; S2 - projected 2030 emissions based on current emissions control legislation and national expectations of economic growth; S3 - maximum feasible reduction scenario (all currently available emission control technologies); S4 - pessimistic 'worst case' scenario.

Butler, T. M., Z. S. Stock, M. R. Russo, H. A. C. Denier van der Gon, and M. G. Lawrence (2012). Megacity ozone air quality under four alternative future scenarios. Atmos. Chem. Phys., 12, 4413–4428, doi:10.5194/acp-12-4413-2012.

Air-Ice Chemical Interactions (AICI)

In examining the behavior of α- and γ-HCH in seasonal and first year ice in the CFL campaign, HCH concentrations were found to be higher in younger ice that contained brine (brine salinity >>50). The concentrations of 15 both HCH isomers and their vertical distributions in the ice were highly dependent on the initial entrapment of brine in young ice and the subsequent desalination process. α-HCH and γ-HCH levels decreased exponentially with increasing sea ice thickness following the sea ice desalination curve (see figure). The correlations observed between HCH concentrations, salinity and ice thickness imply that brine rejection is also accompanied 20 by HCH rejection which, in turn, will yield elevated concentrations in the brine-channels within the ice and in the beneath-ice seawater during periods when brine exits the seaice. HCH levels in the brine in the winter were approximately 13 times higher than in bulk ice due to the freezing out effect as new ice forms, reaching 4.0±0.3 ng l−1 for α-HCH, and 0.42±0.01 ng l−1 for γ-HCH. At this time, these concentrations represent 25 the highest HCH concentrations in the Arctic marine environment, exceeding under-ice water concentrations by a factor of _3 in the spring (April - May). In spring, (i.e. from mid-April to mid-May) HCH concentrations in ice brine were found to decrease gradually with time as the brine volume fraction increased (due to melting of the ice crystal matrix) and the brine salinity decreased.



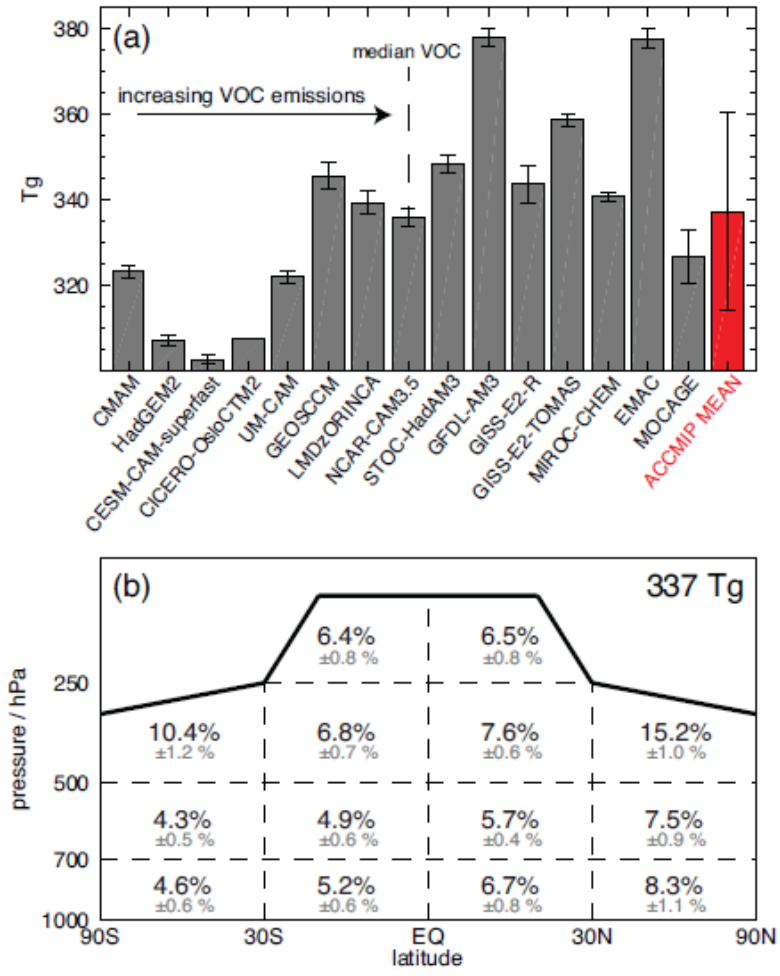
(Above) Dependence of α-HCH (top) and γ-HCH (middle) concentrations and ice salinity (bottom) on sea ice thickness.

Grannas, A. M., C. Bogdal, K. J. Hageman, C. Halsall, T. Harner, H. Hung, R. Kallenborn, P. Kl´an, J. Kl´anov´a, R. W. Macdonald, T. Meyer, and F. Wania (2012). The role of the global cryosphere in the fate of organic contaminants. Atmos. Chem. Phys. Discuss., 12, 16923–17000, doi: 10.5194/acpd-12-16923-2012.

Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP)

Annual mean tropospheric ozone burden was measured and assessed across 15 ACCMIP models. The mean burden is 337±23 Tg. Figure (a) below also indicates the uncertainty in the ozone burden, as represented by the standard deviation of the range of burdens computed for individual years of the time slice. As might be expected from successive years of the same boundary conditions (for most models), the uncertainty 20 is small, and the standard deviations are less than 2% of the burden. There is a significant correlation (r = 0.67) between the modeled ozone burden and the total VOC emissions. There is not a similar correlation between the ozone burden and total NOx emissions.

Figure (b) indicates the distribution of the mean ozone burden throughout the troposphere, using the regions defined by Lawrence et al. (2001) to give a mass-weighted view of the zonal ozone distribution. The hemispheric asymmetry in ozone is apparent from Fig. (b), which shows that 57.5% of the ozone mass is in the NH. The NH extratropics has 60% more ozone than the SH extratropics overall, but the NH tropics has only slightly more ozone (_3 %) than the SH 5 tropics overall. The greatest burdens are found in the extratropical upper troposphere, reflecting the importance of stratosphere-to-troposphere transport of ozone.



(Above) **(a)** Tropospheric ozone burdens for the ACCMIP models from the Hist 2000 simulations. Error bars for the models indicate the variability in the burden between different years of a model's time slice (±1 std. dev.). The error bar on the ensemble mean burden indicates the inter-model spread of the burden (±1 std. dev.). Models are arranged in order of increasing VOC emissions. **(b)** Distribution of the mean ozone burden throughout the troposphere for the mean model, using the "boxes" recommended by Lawrence et al. (2001) for reporting OH concentrations. The solid line indicates the tropopause.

Young, P.J., A. T. Archibald, K. W. Bowman, J.-F. Lamarque, V. Naik, D. S. Stevenson, S. Tilmes, A. Voulgarakis, O. Wild, D. Bergmann, P. Cameron-Smith, I. Cionni, W. J. Collins, S. B. Dalsøren, R. M. Doherty, V. Eyring, G. Faluvegi, L. W. Horowitz, B. Josse, Y. H. Lee, I. A. MacKenzie, T. Nagashima, D. A. Plummer, M. Righi, S. T. Rumbold, R. B. Skeie, D. T. Shindell, S. A. Strode, K. Sudo, S. Szopa, and G. Zeng. Pre-industrial to end 21st century projections of tropospheric ozone from the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP). Atmos. Chem. Phys. Discuss., 12, 21615–21677, doi:10.5194/acpd-12-21615-2012.

2. Activities

List your activities, e.g., research projects, special events (conferences, workshops), model and data intercomparisons, global datasets, etc.
Information for: reporting/fundraising & outreach.

Current Activities

- Atmospheric Chemistry & Climate Model Intercomparison Project (ACCMIP)
  Co-Chairs:
  Drew Shindell, NASA Goddard Institute for Space Studies and Columbia Earth Institute, Columbia University, New York, NY, USA
  Jean-Francois Lamarque, NCAR, Boulder, CO, USA

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 vary widely in space and time.

- Atmospheric Chemistry & Health (AC&H)
  Co-Chairs:
  Candice Lung, Academia Sinica, Research Center for Environmental Change, Taipei, Taiwan
  Christine Wiedinmyer, NCAR, Atmospheric Chemistry Division, Boulder, CO, USA

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 modelling, 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.

- Aerosols, Clouds, Precipitation, & Climate (ACPC)
  Jointly sponsored by iLEAPS and WCRP-GEWEX
  Co-Chairs:
  Graham Feingold, NOAA, ESRL, Boulder, CO USA
  Meinrat O. Andrea, Max Planck Institute for Climate, Germany

  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

  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. 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.

- Air-Ice Chemical Interactions
  Jointly sponsored by SOLAS
  Co-Chairs:
  V. Faye McNeill, Columbia University, USA
  Thorsten Bartels-Rausch, PSI, Switzerland

AICI was first endorsed by the IGAC SSC in 2003 in light of research demonstrating new processes observed in the polar regions at the air-ice interface. The goal of AICI was 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. 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 task Halogens in the Troposphere (HitT). The past eight years of research produced new insights into cirrus ice and NO_Y 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 will be a joint special issue in *Atmospheric Chemistry and Physics* and *Earth System Data* on ``New Perspectives on Air-Ice Chemical Interactions".

- Air Pollution & Climate: A Science-Policy Dialogue
  Co-Chairs: Kathy Law, LATMOS, France
  Paul Monks, University of Leicester, UK

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, led 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. As with many issues, there also exists a divide between the scientific and policy communities that hinders communication and understanding.

- Biomass Burning Initiative
  Jointly sponsored by iLEAPS and WMO
  Co-Chairs:
  Johannes Kaiser, ECMWF, Reading, UK; KCL, London, UK; MPIC, Mainz, Germany
  Melita Keywood, CSIRO, Melbourne, Australia

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.

- Chemistry-Climate Model Initiative (CCMI)
  Jointly sponsored by WCRP-SPARC.
  Co-Chairs:
  Veronika Eyring, DLR, Cologne, Germany
  Jean-Francois Lamarque, NCAR, Atmospheric Chemistry Division, Boulder, CO, USA

  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).

- Deposition of Biogeochemically Important Trace Species (DEBITS)
  Jointly sponsored by WMO
  Chair:
  Kobus Pienaar, North-West University, South Africa

  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.

- 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 cross-roads. 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 InitiAtive (GEIA)
  Jointly sponsored by iLEAPS, AIMES
  Co-Chairs:
  Greg Frost, CU/CIRES and NOAA, USA
  Leonor Tarrason, NILU, Norway

  For the past two decades, GEIA (formerly known 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, the well-respected GEIA emission inventory portal merged with the Emissions of atmospheric Compounds & Compilation of Ancillary Data (ECCAD) portal. GEIA also includes the Community Initiative for Emissions Research and Applications (CIERA), 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.

- Halogens in the Troposphere (HitT)
  Jointly sponsored by SOLAS
  Co-Chairs:
  Roland von Glasow, University of East Anglia, UK
  Ulrich Platt, University of Heidelberg, Germany

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 Impacts of Megacities on Air Pollution and Climate
  Jointly Sponsored by the WMO
  Lead Author:
  Tong Zhu, Peking University, China

  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 will identify knowledge gaps on atmospheric chemistry in megacities. The writing of this report was a major effort of the past three years and it is now nearly complete. WMO has agreed to print and distribute the assessment to be released in 2012. In the future, IGAC plans to provide updates to this assessment every 4 to 5 years.

Working Groups

- IGAC China Working Group
  Chair: Tong Zhu, Peking University China

The sheer magnitude of Chinas 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.

Conferences and Workshops

- ACCMIP 2nd Workshop, 30 January - 1 February 2012, 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.
- Workshop on Health Impacts of Air Quality and Climate in Asia, 8-11 April 2012, 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.
- Developing Asian Megacities towards a Sustainable World, 25-27 April 2012, 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.

- IGAC/SPARC Global Chemistry-Climate Modeling and Evaluation Workshop, 21-24 May 2012, 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.
- IGAC/iLEAPS/WMO Workshop on Biomass Burning, 5-6 July 2012, 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-economic 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.
- Atmospheric Chemistry in the Anthropocene, 17-21 September, 2012, 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.
- A U.S. - Japan Workshop on the Tropical Tropopause Layer, 15-19 October 2012, 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.
- SOLAS/IGAC Workshop on the role of marine gel for the emission for primary organic aerosols from the ocean, 11-13 December 2012, 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 identi_ed priority questions needing to be addressed by the community, some potential controversies on the topic, and a way forward to _ll the knowledge gaps.
- SOLAS/IGAC Halogens in the Troposphere (HitT) Workshop, 17-19 December 2012, 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 modeling; and designed observational strategies to improve understanding of photochemical processes and assess the impact of chlorine chemistry on the marine boundary layer.

3. Contributions to IGBP Integration/synthesis

(List your activities (ongoing or planned) which contribute to the broader integrative aims of IGBP (interdisciplinary initiatives, joint activities with other core projects, contributions to fast track initiatives and to IGBP synthesis activities).
Information for: strategic development.

- Many of IGAC's research priorities are collaborations with the IGBP core projects SOLAS (Surface Ocean Lower Atmosphere Study) and iLEAPS (Integrated Land Ecosystem Atmosphere Process Study), the World Climate Research Program's SPARC (Stratospheric Processes and their Role in Climate) and GEWEX (Global Energy and Water Cycle Experiment) projects, and the World Meteorological Organization (WMO). Collaboration with IGBP's AIMES (Analysis Integration and Modelling of Earth Systems) project allows for scaling of local data to the regional-to-global scale and for investigating atmospheric chemistry/Earth system feedbacks. Through joint workshops and research projects, IGAC, SPARC, AIMES, iLEAPS, and SOLAS have increasingly been working towards an integrated study of Earth System Sustainability Science.

- The IGBP Air Pollution & Climate initiative, led by IGAC, seeks to open a science-policy dialogue on the air pollution and climate challenge. The aim of the Air Pollution and Climate Initiative is to break down the divides between these two disciplines and clarify the synergies and trade-offs of research and mitigation efforts across a spectrum of air pollution and climate change policies. To this end, the 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*. Further, in conjunction with The Keystone Center, IGAC is proposing to hold a third workshop in the winter of 2013 to develop a *Strategic Plan for an Integrated Programme on Air Pollution and Climate Change*.

- Current jointly sponsored activities include:
  - ACPC: Aerosols, Clouds, Precipitation, & Climate (IGAC, iLEAPS, GEWEX)
  - AICI: Air-Ice Chemical Interactions (IGAC, SOLAS)
  - Air Pollution & Climate (IGAC, IGBP)
  - Biomass Burning Initiative (IGAC, iLEAPS, WMO)
  - CCMI: Chemistry-Climate Model Initiative (IGAC, SPARC)
  - DEBITS: Deposition of Biogeochemically Important Trace Species (IGAC, WMO)
  - GEIA: Global Emissions InitiAtive (IGAC, iLEAPS, AIMES)
  - HitT: Halogens in the Troposphere (IGAC, SOLAS)
  - The Impacts of Megacities on Air Pollution and Climate (IGAC, WMO)

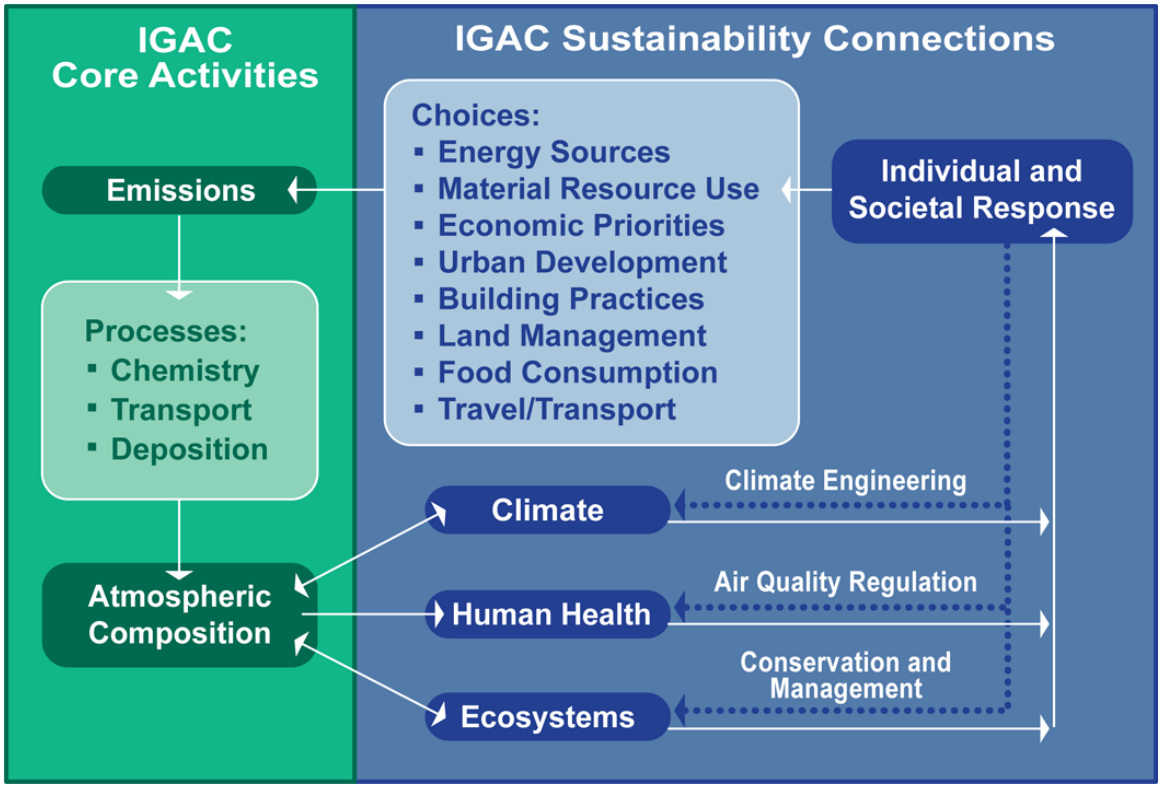
4. Strategic Outlook

List (a) your goals and priorities for the upcoming 2 years, focusing on strategic issues and (b) major activities planned (workshops, conferences, etc.) with dates or approx. timeframe.
Information for: strategic development, reporting/fundraising & networking.

(a) Goals and Priorities

As IGAC enters into its third phase, in response to the Future Earth Initiative, its mission is to coordinate and foster atmospheric chemistry research towards a sustainable world. This is achieved 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. More specifically, IGAC's core activities focusing on emissions, atmospheric processes, and atmospheric composition will integrate more closely with sustainability issues such as climate, human health,

ecosystems, and how individual and societal responses feed back onto the core research-led activities of IGAC. IGAC believes by viewing the environment as a resource and the bases of energy and economic activities, human well-being can be sustained. This strategy has been outlined in the figure below.



(b) Workshops & activities

Below is a list of IGAC workshops for 2013. IGAC is currently accepting proposals for other workshops to be held in the coming year.

- First IGAC Americas Working Group Workshop
  28-30 January 2013
  Bogotá, Colombia
- IGBP/ IGAC Air Pollution & Climate Initiative Workshop: Developing a Strategic Plan for an Integrate Program on Air Pollution and Climate Change
  18-22 March 2013
  Denver, CO

- International Workshop on Changing Chemistry in Changing Climate (C4): Monsoon Focus
  1-3 May 2013
  Pune, India
- SPARC/IGAC Chemistry Climate Modeling Initiative (CCMI) Workshop
  13-17 May 2013
  Boulder, CO, USA
- Extreme Weather and Climate Events in the Southern Caucasus - Black Sea Region Conference
  3-7 June 2013
  Tbilisi, Georgia

- Workshop on Atmospheric Composition and the Asian Summer Monsoon (ACAM)
  9 June-12 June 2013
  Kathmandu, Nepal
- IGAC Open Science Conference
  Atmospheric Chemistry
  22-26 September 2014
  Natal, Brazil

5. Contributions to international assessments

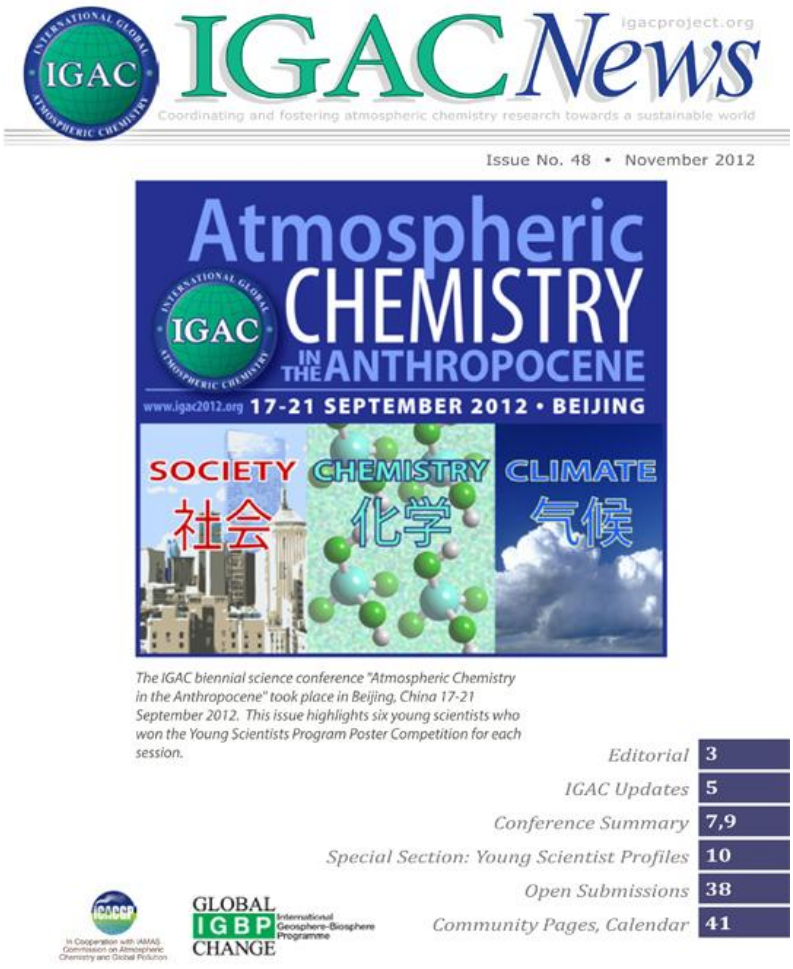
List your links and contributions to international assessments such as IPCC.
Information for: strategic development & reporting/fundraising.

- IGAC SSC or community members who are lead authors for AR5 WGI report:
  - Contributors to the IGAC/SPARC Modelling Activity (AC&C)
    - Arlene Fiore (Chapter 11 Lead Author)
    - Drew Schindell (Chapter 8 Coordinating Lead Author)
    - Veronika Eyring (Chapter 9 Lead Author)
    - Dorothy Koch (Chapter 8 Lead Author)
    - Frank Dentener (Chapter 2 Lead Author)
    - Jean-Francois Lamar (Chapter 8 Lead Author)
    - Piers Forster (Chapter 7 Lead Author)
  - Part of IGBP Air Pollution and Climate Initiative
    - Bill Collins (Chapter 8 Lead Author)
    - Jan Fuglestvedt (Chapter 8 Lead Author)
  - Current or Former IGAC SSC members
    - Maria Cristina Facchini (Chapter 1 Lead Author)
    - Yutaka Kondo (Chapter 7 Lead Author)
    - Phillip Rasch (Chapter 7 Lead Author)
    - Graham Feigngold (Chapter 7 Lead Author)
    - Sandro Fuzzi (Chapter 7 Review Editor)
- The IGAC report on Bounding the Role of Black Carbon in Climate is expected to constitute a direct contribution to AR5. Metrics being reported in the publication were determined based specifically on those used in the IPCC process, and terminology was intentionally used for consistency with IPCC assessments. The 232-page report has been accepted to the Journal of Geophysical Research.
- The IGAC/WMO *Impact of Megacities on Air Pollution and Climate*, published in 2012, itself constitutes a significant international assessment report on the role Megacities play in climate change and air quality.
- IGAC activities contribute to the Future Earth Initiative.
- Given that the IGAC community is composed of over 3,000 scientists, it is difficult to account for all links and contributions to international assessments.

6. Communication and Outreach

List networking activities and products (websites, newsletters, outreach products) for the scientific community and beyond (policymakers, the public). Please give details where end-users have been involved in the concept and production.
Information for: outreach, networking & reporting/fundraising

- IGAC website : http://igacproject.org
- The IGAC Newsletter is mailed to ~1,200 scientists and sent out as an electronic version to ~3,000 scientists. The most recent issue (November 2012 Issue No. 48) featured the 2012 IGAC biennial conference in Beijing, the meeting on Atmospheric Composition and the Asian Monsoon, and a spotlight on six young scientists.



- Updates, reminders, and information about conferences and activities are e-mailed to ~3,000 subscribers via MailChimp.
- IGAC also continuously works with a graphic designer to design logos for all of its activities as well as communicate science more effectively through diagrams, figures and graphs.

7. Publications

List (for the period since your last annual report to IGBP): (a) the top 10 most important publications in the peer-reviewed literature as a result of the project and (b) the total number of peer-reviewed publications attributed to the project and listed in your database

Information for: reporting/fundraising & outreach.

(a) The most important publications in peer-reviewed literature over the past year have been the special issues:

- 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.

Additional publications in 2012 include:

- Atmospheric Chemistry of Iodine (2012) Saiz-Lopez, A., J. M. C. Plane, A. R. Baker, L. J. Carpenter, R. von Glasow, J. C. Gómez Martín, 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. Gómez Martín, T. D. Hay, S.-J. Royer, S. Yvon-Lewis, Y. Liu, L. Hu, C. Prados-Roman, C. Ordóñez, 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.

(b) In total, IGAC has produced 30 special issues in peer-reviewed journals. The total number of peer-reviewed publications is well in the hundreds since IGAC began in 1990.

8. Training and capacity building

List your capacity-building activities eg. Summer schools, Young Scientist Workshops, lecture series, training & education, etc.

Information for: reporting/fundraising & networking.

- IGAC co-sponsors numerous meetings, workshops, symposiums, and conferences to provide travel grants for young and developing country scientists to attend these events.
- An integral part to IGAC's biennial conferences is its Young Scientists Program, which creates a platform for young scientists to present their research and become connected within the larger network of international scientists. This program supported 54 young scientists to participate in the 2012 Beijing conference. Here the Young Scientists Program Committee was formed, which planned activities including an icebreaker with the IGAC

scientific steering committee, 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. IGAC provides travel grants for young scientists to attend conferences based on both need and merit.

- IGAC sponsors National/Regional Working Groups:
  - The China Working Group continues to increase the level of communication and collaboration of research between scientists in the region as well with scientists internationally.
  - The Americas Working Group held its initial planning workshop in January 2012. The aim of this working group is to foster collaboration between scientists in Latin America and connect the Latin America community with the international community.
  - Additional national/regional working groups are currently being explored and planned for implementation. Areas of interest include West Africa, India and Australia/New Zealand.

9. Project administration and management

Describe the structure of the IPO, Node/foci offices and sponsors. Note any resource concerns.
Information for: reporting/fundraising & networking.

- The International Project Office is located at the University of Colorado's Joint Cooperative Institute for Research in Environmental Sciences (CIRES) in Boulder, Colorado. The Boulder IPO is the primary IGAC project office, with one full-time employee, Executive Officer Megan Melamed, and one part-time undergraduate student assistant, Jeff Jennings.
- The IGAC IPO is funded at $280kUSD/year from the period of July 20012-June 2015 by awards from U.S. NSF, NASA, and NOAA.
- IGBP provides ~$35kUSD/year to cover the majority of the costs of the annual IGAC SSC meeting.
- European ACCENT Plus provides €18kEuro/year to provide IGAC travel grants for scientists to attend IGAC related meetings, workshops, symposiums, and conferences.

10. Links with the observations community

List: (a) links/activities with the observation community (e.g., meetings attended, activities, data you are providing), (b) the observation and data products you are using from e.g. ESA, NASA, etc., and (c) additional needs.
Information for: reporting/fundraising, networking and strategic development.

Observations are a key component of IGAC activities, including ACCMIP, ACPC, AICI, DEBITS, GEIA, HitT, and the Megacities Assessment. With over 3,000 scientists across the world, the contributions of the IGAC community to observation networks are too numerous to list here.

11. Other comments

02-02-2012	*Compiled by IGAC Staff*