2007-2008 Annual Report
International Global Atmospheric Chemistry (IGAC) Project Grant

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Overview

The IGAC Project continues to be run out of the NOAA Pacific Marine Environmental Lab facility, with Timothy Bates as P.I. and Sarah Doherty as the IGAC Executive Officer. The project activities are guided and, in many cases, implemented by the IGAC Scientific Steering Committee, which acts on a volunteer basis. Members of the IGAC SSC for 2008 are listed in the Appendix of this report.

Implementation of the project science plan is via four main pathways:

1) Tasks – Research activities with a specific set of scientific goals that are achievable in a 3-4 year timeframe, with requirements around data accessibility, data QA/QC, multi-national inclusion, and capacity-building components. Tasks are proposed to and endorsed by the IGAC SSC and are reviewed annually and on as as-needed basis.
2) Workshops – IGAC will co-sponsor (e.g. by providing organizational and/or financial assistance) focused workshops on specialty topics. In most cases, there is a requirement that these workshops be structured to produce a tangible outcome, such as journal publication(s) or research plan(s).
3) Initiatives – This implementation mechanism is new to IGAC in 2006. Here the SSC identifies areas in atmospheric chemistry that are in need of attention but which are not currently being addressed by the community. The idea is to try to use a "top-down" approach to initiating an activity which, in the end, will require engagement by the research community.
4) Communications/Networking – This covers a myriad of activities, including biennial conferences, a newsletter (mailed to ~3500 researchers around the world), our web page, and miscellaneous networking activities conducted throughout the year.

This past year we collaborated with Chinese colleagues to translate the IGAC Science Plan and Implementation Strategy (originally published in English in 2006) into Chinese. Completed in early 2008, the document can now be downloaded as a .pdf from the IGAC web site (http://www.igac.noaa.gov).

Tasks

Activities within IGAC Tasks continued in 2007 to enrich our understanding of atmospheric chemistry in the Earth system. Following are brief summaries of the activities under IGAC Tasks during 2007:

- AICI Task (Air-Ice Chemical Interactions) & AICI-IPY

The AICI Task was initiated in 2003 and finished its first phase in 2007. Following were the goals of AICI and an indication of success in fulfilling the goal:

- Document range of processes at air-ice interface: *very strong progress*
- Quantify fluxes of trace gases and aerosols under range of conditions: *done for some but not all gases*

- Determine main factors that control fluxes (field and laboratory): *some progress, but much more needed*
- Build simple models to include upper firn and lower troposphere: *in progress, but early days*
- Assess significance of processes at global and regional scale: *first assessments done*
- Develop simple parameterizations for global models: *available in some forms and adoption under discussion in various guises*

In particular four deliverables were promised, all of which were met:

- A web site with documents suitable for public outreach, and with links to key relevant datasets
- Integration of diverse research activities through workshops and other initiatives.
- The creation of a network of field, laboratory, remote sensing and modeling scientists involved in air-ice chemical studies
- A special journal issue summarizing the latest findings, and including synthesis papers combining data from different regions, and from different activities (laboratory, field and modeling). Three of them review the current knowledge in areas of snow photochemistry, halogens and ozone depletion, and mercury, while the other two are tutorials for chemists in snow physics and boundary layer physics:

Anderson, P. S., and W. D. Neff (2007), Boundary layer physics over snow and ice, *Atmos. Chem. Phys. Disc.*, 7, 7625-7677.

Domine, F., M. Albert, T. Huthwelker, J. H.-. W., A. A. Kokhanovsky, M. Lehning, G. Picard, and W. R. Simpson (2007), Snow physics as relevant to snow photochemistry, *Atmos. Chem. Phys.*, 8, 171-208, 2008.

Grannas, A. M., et al. (2007), An overview of snow photochemistry: Evidence, mechanisms and impacts, *Atmos. Chem. Phys.*, 7, 4329-4373.

Simpson, W. R., et al. (2007), Halogens and their role in polar boundary-layer ozone depletion, *Atmos. Chem. Phys.*, 7, 4375-4418.

Steffen, A., et al. (2007), A synthesis of atmospheric mercury depletion event chemistry linking atmosphere, snow and water, *Atmos. Chem. Phys. Disc.*, 10837-10931, 7.

The AICI Task Team in 2006-7 also stepped up to play an important coordinating role for atmospheric chemistry within the International Polar Year (IPY).

At its September, 2007 meeting, the IGAC SSC voted to endorse AICI for a second phase, under "AICI-IPY". AICI-IPY is a recognized IPY project, working closely with OASIS and POLARCAT, also both IPY projects. These projects will bring in many new insights, starting from the knowledge reviewed and synthesized in AICI Phase I. Under AICI-IPY, the Task leads will maintain communication between all those producing new AICI data under AICI-IPY; to further entrain (through communication, workshops and special session) laboratory, remote sensing and modeling teams, to study these problems; and to organize, along with POLARCAT and OASIS, a major post-IPY workshop to again review our knowledge, and to provide a tangible deliverable from AICI-II, that would highlight, and provide a record of, the AICI component of IPY.

- AMMA-AC Task (African Monsoon Multidisciplinary Analysis-Atmospheric Chemistry)

2006 was the peak of the AMMA-AC field activities with the Special Operation Periods during the dry season (January-February) and the wet season (June-July-August-September). Up to five aircrafts were deployed over West Africa with more than 150 people working simultaneously at ground-based sites and airports. 2007 was busy with data analysis and synthesis, much of which took place during a series of workshops:

Feb 2007 – Workshop on impacts of climate fluctuations and trends in West Africa – Bamako, Mali.
April 2007 – AMMA session at EGU (22 posters + 8 oral presentations)
July 2007 - Workshop on modeling activities in Paris (Global models intercomparison exercice 2000 – 2003 – 2006)
Oct 2007 – Participation in the A-Train symposium - Lille, France.
Nov 2007 – Second international AMMA conference - Karlshure, Germany.

AMMA-AC results will be a feature of the Sept 2008 10th IGAC conference in Annecy, France (see below)

Journal special issues were opened by the end of 2007:
Dry season experiment (SOP 0) in JGR (Ed. J. Haywood)
Wet season experiment (SOP1-2) in ACP (Eds. C. Reeves and P. Formenti)

Scientific highlights from AMMA-AC:
- little evidence of SOA formation even through high isoprene
- MCS are efficient for the wet removal of aerosol particles and create favorable conditions for nucleation of new particles
- fresh MCS outflows were sampled (lightning NOx, burst of nucleation)
- aged outflow (aging of air masses in relation with long-range transport)
- several golden days for MCS identified (coordinated flights 5-6-7 August, 11 August, 14-15 August, ...)
- urban survey revealed gaps in the current emissions inventories with missing anthropogenic sources (aircraft measurements + ground-based measurements)
- several occurrences of intrusions of biomass burning plumes from the southern hemisphere (predicted by forecasts, observed by aircrafts, satellites and ozonesoundings)
- evidences of transport of biomass burning emissions in the TTL region
- nocturnal advection of vegetation products (isoprene) observed by the UK-BAe146.
- evidences of NOx emissions by soil
- ozone minimum observed by the MOZAIC aircrafts above the ITCZ (daily flights between Windhoek and Frankfurt AIR NAMIBIA)

Published manuscripts under AMMA-AC:

Lebel, T., Parker, D.J., Bourles, B., Flamant, C., Marticorena, B., Peugeot, C., Gaye, A., Haywood, J., Mougin, E., Polcher, J., Redelsperger, J.-L. and C.D. Thorncroft (2007): The AMMA field campaigns: Multiscale and multidisciplinary observations in the West African region. *BAMS*, in press.

Sauvage B., V. Thouret, J.-P. Cammas, J. Brioude, P. Nedelec, and C. Mari, Meridional ozone gradients in the African upper troposphere, *Geophys. Res. Let.*, 34 (3): Art. No. L03817 FEB 13 2007.

Bock, O., F. Guichard, S. Janicot, J. P. Lafore, M.-N. Bouin, and B. Sultan, Multiscale analysis of precipitable water vapor over Africa from GPS data and ECMWF analyses, *Geophys. Res. Lett.*, 34, L09705, doi:10.1029/2006GL028039, 2007.

C. Flamant, J.-P. Chaboureau, D. J. Parker, C. M. Taylor, J.-P. Cammas,O. Bock, F. Timouk, and J. Pelon, Airborne observations of the impact of a convective system on the planetary boundary layer thermodynamics and aerosol distribution in the inter-tropical discontinuity region of the WAM, *Quart. J. Royal Met. Soc.*, 133(626), 1175-1189, 2007.

- DEBITS Task (Deposition of Biogeochemically Important Trace Species)

DEBITS is a long-standing program of IGAC. In 2003, it entered its second phase, with a new emphasis on:

- determining, at the regional scale and mainly through measurements, the atmospheric removal rates via dry and wet deposition of biogeochemically important trace species;
- working out atmospheric budgets of key elements (S, N, Ca, Cl^-) at the regional scale;
- establishing the chemical and physical factors that regulate these deposition fluxes and to identify parameters to be included into regional and global atmospheric chemistry models.

The role of the DEBITS task is to coordinate measurements and synthesize data from three measurement campaigns: LBA (eastern South America; esp. the Amazon); IDAF (IGAC DEBITS Africa); and DEBITS Asia (CAAP, "Composition and Acidity of Asian Precipitation" and CAD, "Composition of Asian Deposition").

In 2007, measurements continued in these three DEBITS research networks and a new effort was initiated to re-assess our understanding of dry depositional processes and to translate lessons from the DEBITS (and other) field measurements into improved model representation. This idea is borne out of discussions at the DEBITS September 2006 Workshop. This new activity is a joint effort of IGAC, DEBITS, and iLEAPS. A first workshop was held in October, 2007 in Wageningen, Netherlands, on "The

relevance of surface and boundary layer processes for the exchanges of reactive and greenhouse gases". The outcome of this meeting; findings within DEBITS; and needs identified through the IGAC-SPARC Atmospheric Chemistry and Climate initiative will be coordinated in 2008 to determine the direction of this effort.

- Mega-cities: Asia Task

In its first phase, this task aimed to make a comparable set of studies of atmospheric chemistry within mega-cities in the Asian region, with an interest both in air quality and radiative/climate impacts. This was accomplished through parallel measurement in mega-cities in Japan, mainland China, China-Taipei, Korea, and (as of 2007) Thailand.

Progress was made in 2007 on data accessibility, which has been a persistent issue within this task. Data now available for public access include: data from the Japanese study (IMPACT); data from the CAREBEIJING air quality study in Beijing; and data from 2 years of measurements in Hong Kong.

Plans are in place to also archive and release data from measurements in Taiwan (2002-present). Some highlights from studies under this Task in 2007 include:

- Japan, IMPACT study:
  - Methods and accuracies for measurement of aerosols (black carbon, inorganic, organic aerosols, and WSOC) have been established.
  - Understanding of the diurnal and seasonal variations of different types of PM1 aerosols and their precursor gases have been greatly improved and are interpreted in terms of emissions, formation, and meteorological conditions.
  - Understandings of factors controlling the levels of reactive gases have been improved.
  - Efforts to calculate distributions of different types of aerosol and ozone have been made by using regional scale models. This is an important step to systematically understand chemistry and transport of aerosol and ozone in Tokyo and surrounding regions.
  - Size distribution and mixing state of BC and the rate of coating in the plumes from mega-cities have been elucidated
  - Long-term measurements in BC showed dramatic decrease between 2005 and 2007, mostly likely due to regulation of particulate emissions from diesel vehicles.
- China, Pearl River Delta (Hong Kong-Guangzhou-Macau cluster)
  - Data analysis and integration from the July 2006 PRD campaign progressed in 2007. The objectives of the PRD July intensive campaign are to characterize temporal and spatial changes of aerosol, oxidant, and their precursors, to understand chemical composition, size distribution, hygroscopic properties, and optical properties of aerosols, to quantify ozone formation by measurements and modeling, and to explore the relationship between species of aerosols and gaseous phase
- China, CAREBEIJING (Campaigns of Air Quality Research in Beijing)
  - This international campaign was conducted in Beijing and surrounding regions from 10 August – 10 September 2006. The participating organizations and major instruments used were nearly the same as for the PRD 2006 campaign.
  - The objectives of the campaign were understand the sources and causes of air pollution in and around Beijing and to formulate a policy suggestion for the air quality attainment during the 2008 Beijing Olympic games and beyond.
  - As with other Mega-cities: Asia activities, CAREBEIJING included many measurement intercomparisons.
  - Workshops to discuss the results obtained by these campaigns were held in Beijing and Guangzhou in January-February 2007. A meeting to finalize a report on the CAREBEIJING to SEPA was held in Nansha in June 2007 and a second workshop held in October 2007 to discuss publication of the results.
- China, Four-City Study (Hong Kong, Beijing, Shanghai, Lanzhou)
  - This regional-scale study aims to determine the composition of urban plumes from Beijing, Shanghai, and Lanzhou and to compare with the results from subtropical Hong Kong. This is done by deriving emission ratios of measured species and to compare them with and to refine

emission inventories for these urban areas. In addition they are examining the chemical transformation in urban plumes that have aged for 0.5-2 days to learn about the highly uncertain middle-aged chemistry regimes and evaluating the impacts of the urban plumes on regional air quality.

- In 2007, data analysis continued for measurements made in campaigns 2001-2006. Some highlights of this analysis include:
  - A VOC limiting chemistry was identified for producing high ozone (200 ppbv) in southern PRD and in Shanghai, with major contributors being toluene and xylene. NOx appeared to have played an important role in the formation of very high conc. of ozone (300 ppbvb) in downwind rural areas of Beijing;
  - A newly available semi-continuous aerosol ion instrument suffered positive and inferences from high loading of SO2 and aerosols – which are common in many cities in China;
  - New particle formation was observed in relatively polluted air masses in Shanghai and Beijing.
- The investigators are now focusing on the interaction of gas, aerosol and cloud and the impact on regional climate and air quality using mountain-top and aircraft observation platforms.
  - China-Taipei
    - Ongoing efforts include:
      - Investigating aerosol chemical and physical properties at seven ground stations.
      - Evaluating long-range transport of air pollutants and aerosols.
      - Investigating causes of the increasing ozone trends in Taiwan in the last decade.
      - Studying the heat-island effect over Taiwan's Western Plain.
    - The China-Taipei team also participated in the Pearl River Delta and CAREBEIJING campaigns (see above).
  - Korea
    - Within Korea, this largely comprises monitoring visibility and air pollutant levels. Efforts have gone into making these measurements comparable to those in the other Mega-cities: Asia studies.
    - The Korean investigators also participated in the Pearl River Delta and CAREBEIJING campaigns (see above)
  - Thailand
    - This is a new effort within Mega-cities: Asia. EC-OC and CO measurements started in Bangkok in March, 2007, in collaboration with the University of Tokyo, Japan.

The first phase of Mega-cities: Asia concluded in 2007, and a new set of goals have been established for Phase II. This second phase of Mega-cities: Asia was endorsed at this year's IGAC SSC meeting. In Phase II, the Mega-cities: Asia task team will establish measurements of the outflow from the mega-cities in East Asia, in addition to continuation of Phase-I type studies within the urban areas. Results from Mega-cities Phase-I have allowed quantification of source strengths, understanding of the chemical characteristics in source regions, and understanding of the chemical processes taking place within the mega-cities. The focus of Phase II will be to linkage this knowledge on emissions and chemistry in the mega-cities to regional-scale air quality and climate. Specific efforts will be made to study the effects of air pollution on cloud formation and to strengthen modeling efforts in this region. This effort will be enhanced through coordination with the Monsoon Asia Integrated Regional Study (MAIRS), which is being implemented by the ESSP-START project.

Publications from the Mega-cities: Asia Task in 2007 included:

Bae, M.-S., C.-S. Hong, Y. J. Kim, J.-S. Han, K.-J. Moon, Y. Kondo, Y. Komazaki, and Y. Miyazaki, Intercomparison of two different thermal-optical elemental carbons and optical black carbon during ABC-EAREX2005, Atmospheric Environment, 41(13), 2791-2803, 2007.

Chou, C. C.-K., Lee, C.-T., Chen, W.-N., Chang, S.-Y., Chen, T.-K., Lin, C.-Y., Chen, J.-P., Lidar observations of the diurnal variations in the depth of urban mixing layer: A case study on the air quality deterioration in Taipei, Taiwan. Science of the Total Environment, 374, 156-166, 2007.

Ding, A., T. Wang*, V. Thouret, J.-P. Cammas, and P. Nedelec, Tropospheric ozone climatology over Beijing: Analysis of aircraft data from the MOZAIC program, Atmos. Chem. Phys. Discuss., 7, 9795-9828, 2007.

Fukuda, M. Y. Kondo, Y. Miyazaki, Y. Morino, N. Takegawa, Y. Kanaya, H. Tanimoto, R. McKenzie, P. Johnston, D.R. Blake, and T. Murayama, Oxidation and removal of reactive nitrogen in Tokyo, submitted to J. Geophys. Res., 2007.

Kanaya, Y., R. Cao, H. Akimoto, M. Fukuda, Y. Komazaki, Y. Yokouchi, M. Koike, H. Tanimoto, N. Takegawa, and Y. Kondo, Urban photochemistry in central Tokyo: 1. Observed and modeled OH and HO2 radical concentrations during the winter summer of 2004, J. Geophys. Res., 2007, in press.

Kanaya, Y., M. Fukuda, H. Akimoto, N. Takegawa, Y. Komazaki, Y. Yokouchi, M. Koike, and Y. Kondo, Photochemical production rates of oxidant in Tokyo in winter and summer: Implications from direct observations of HO2 radical concentrations, submitted to J. Geophys. Res., 2007.

Kondo, Y., Y. Miyazaki, N. Takegawa, T. Miyakawa, R. J. Weber, J. L. Jimenez, Q. Zhang, and D. R. Worsnop, Oxygenated and water-soluble organic aerosols in Tokyo, J. Geophys. Res., 112, D01203, doi:10.1029/2006JD007056, 2007.

Kuwata, M., Y. Kondo, M. Mochida, N. Takegawa, and K. Kawamurra, Cloud condensation nuclei (CCN) activity of non-volatile particles in Tokyo, J. Geophys. Res., 112, D11207, doi:10.1029/2006JD007758, 2007.

Lin, C.-Y., Z. Wang, W-N. Chen, S-Y. Chang, C.C.K. Chou, N.Sugimoto and Z. Zhao, Long-range transport of Asian dust and air pollutants to Taiwan: Observed evidence and model simulation, Atmos. Chem. Phys. 7, 423-434, 2007.

Lin, C.-Y., Z. Wang, C.C.-K, Chou, C.-C. Chang, and S.C. Liu, A numerical study of an autumn high ozone episode over southwestern Taiwan, Atmospheric Environment, 41, 3684-3701, (doi:10.1016/ j.atmosenv. 2006.12.050), 2007.

Lung, S.-C. C., Mao, I-F., Liu, L-J. S. “Residents’ Particle Exposures in Six Different Communities in Taiwan”, Science of the Total Environment, 377 (1): 81-92, 2007.

Miyakawa, T., N. Takegawa, and Y. Kondo, Removal of sulfur dioxide and formation of sulfate aerosol in Tokyo, J. Geophys. Res., 112, D13209, doi:10.1029/2006JD7896, 2007.

Moteki, N. and Y. Kondo, Effects of mixing state on black carbon measurements by Laser-Induced Incandescence, Aerosol Sci. Technol., 41, 398-417, 2007.

Moteki, N., Y. Kondo, Y. Miyazaki, N. Takegawa, Y. Komazaki, G. Kurata, T. Shirai, D. R. Blake, T. Miyakawa, and M. Koike, Evolution of mixing state of black carbon particles: Aircraft measurements over the western Pacific in March 2004, Geophys. Res., Lett., 34, L11803, doi:10.1029/2006GL028943, 2007.

Park, S. S., Y. J. Kim, and C. H. Kang, Polycyclic aromatic hydrocarbons in bulk PM2.5 and size-segregated aerosol particle samples measured in an urban environment, Environmental Monitoring and Assessment, 128, 231-240, 2007.

Park, S. S., Y. J. Kim, S. Y. Cho, and S. J. Kim, Characterization of PM2.5 Aerosols Dominated by Local Pollution and Asian Dust Observed at an Urban Site in Korea during Aerosol Characterization Experiments (ACE)-Asia Project, J. Air & Waste Manage. Assoc., 57, 434-443, 2007.

Pongkiatkul P. and N. T. Kim Oanh, Assessment of Potential Long-Range Transport of Particulate Air Pollution Using Trajectory Modeling and Monitoring Data, Journal of Atmospheric Research, 85, 3-17, 2007.

Shiraiwa, M., Y. Kondo, N. Moteki, N. Takegawa, Y. Miyazaki, and D.R. Blake, Evolution of mixing state of black carbon in polluted air from Tokyo, Geophys. Res., Lett., 34, L16803, doi:10.1029/2007GL029819, 2007.

Sawa, Y., H. Tanimoto, S. Yonemura, H. Matsueda, A. Wada, S. Taguchi, T. Hayasaka, H. Tsuruta, Y. Tohjima, H. Mukai, N. Kikuchi, S. Katagiri, K. Tsuboi, Widespread pollution events of carbon monoxide observed over the western North Pacific during the EAREX 2005 campaign, J. Geophys. Res., doi:10.1029/2006jd008055, in press, 2007.

Shirai, T., Y. Yokouchi, D.R.Blake, K. Kita, K. Izumi, M. Koike, Y. Komazaki, Y. Miyazaki, M. Fukuda, and Y. Kondo, Seasonal variation of atmospheric C2-C7 NMHCs (non-methanehydrocarbons) in Tokyo, J. Geophys. Res., 2007, in press.

Shiu Chein-Jung, S. C. Liu, Chih-Chung Chang, Jen-Ping Chen, Charles C. K. Chou, Chuan-Yao Lin and Chea-Yuan Young, Photochemical Production of Ozone and Control Strategy for Southern Taiwan, Atmospheric Environment, in press, 2007.

Takegawa, N, T. Miyakawa, K. Kawamura, and Y. Kondo, Contribution of Selected Dicarboxylic and ω-oxocarboxylic acids in ambient aerosol to the m/z 44 signal of an Aerodyne aerosol mass spectrometer, Aerosol Sci. Technol., 41, 418-437, 2007.

Tang, J. H., L. Y. Chan, C. Y. Chan, Y. S. Li, C. C. Chang, S. C. Liu, D. Wu, and Y. D. Li, Characteristics and diurnal variations of NMHCs in urban, suburban, and rural sites of the Pearl River Delta and a remote site in South China. Atmospheric Environment, accepted, 2007.

Tanimoto, H., Y. Sawa, H. Matsueda, A. Wada, S. Yonemura, H. Mukai, T. Wang, S. Poon, A. Wong, G. Lee, K.R. Kim, M.H. Lee N.H. Lin, J.L. Wang, C.F. Ou-Yang, C.F. Wu, Evaluation of standards and methods for continuous measurements of carbon monoxide at ground-based sites in Asia, Papers in Meteorology and Geophysics, in press, 2007.

Tanimoto, H., H. Mukai, Y. Sawa, H. Matsueda, S. Yonemura, T. Wang, S. Poon, A. Wong, G. Lee, J.Y. Jung, K.R. Kim, M.H. Lee, N.H. Lin, J.L. Wang, C.F. Ou-Yang, C.F. Wu, H. Akimoto, P. Pochanart, K. Tsuboi, H. Doi, C. Zellweger, J. Klausen,Direct assessment of international consistency of standards for ground-level ozone:

Strategy and implementation toward metrological traceability network in Asia, J. Environ. Monit., doi:10.1039/b701230f, in press, 2007.
Vo, Thi Quynh Truc and Nguyen, Thi Kim Oanh, Roadside BTEX and other gaseous air pollutants in relation to emission sources. Atmospheric Environment, in press, 2007.
Wu, Waishing and Tao Wang*, On the performance of a semi-continuous PM2.5 sulphate and nitrate instrument under high loadings of particulate and sulphur dioxide, Atmospheric Environment, 41, 5442-5451, 2007.
Zhang, J., T. Wang*, W. L. Chameides, C. Cardelino, J. Kwok , D. R. Blake, A. Ding, K. L. So, Ozone production and hydrocarbon reactivity in Hong Kong, Southern China, Atmospheric Chemistry and Physics, 7, 557-573, 2007.

- POLARCAT Task (Polar Study using Aircraft, Remote Sensing, Surface Measurements and Models, of Climate, Chemistry, Aerosols, and Transport)

A critical number of POLARCAT studies have received funding, mainly in Europe and North America. The main POLARCAT activities will take place in spring and summer 2008, with concurrent campaigns taking place in the North American and European Arctic, the North Atlantic Ocean, and in Siberia.

A new POLARCAT webpage (www.polarcat.no) provides information on the overall POLARCAT coordination and individual POLARCAT activities, and outreach material. It also bundles other information relevant for POLARCAT, such as forecasts for campaigns, links to satellite and other data, etc.

The first POLARCAT campaign, ASTAR 2007, was conducted, with two aircraft based in Longyearbyen, Spitsbergen, from 24 March – 17 April 2007. The scientific focus of the campaign was on aerosols and radiation. Northerly flow prevailed during the entire campaign, such that no polluted conditions could be sampled, but still lots of valuable data were collected. Data analysis is just beginning.

A workshop was held 4-6 June 2007 in Paris. The workshop consisted of scientific presentations to underpin the planning of the upcoming campaigns, as well as detailed discussions on the coordination of the campaigns planned for spring and summer 2008.

A workshop on ”Short-lived pollutants and Arctic Climate” was held from 5-8 November in Kjeller, Norway.

Publications:

Stohl, A., T. Berg, J. F. Burkhart, A. M. Fjaeraa, C. Forster, A. Herber, O. Hov, C. Lunder, W. W. McMillan, S. Oltmans, M. Shiobara, D. Simpson, S. Solberg, K. Stebel, J. Stroem, K. Torseth, R. Treffeisen, K. Virkkunen, K. E. Yttri (2007): Arctic smoke - record high air pollution levels in the European Arctic due to agricultural fires in Eastern Europe. *Atmos. Chem. Phys.* **7**, 511-534.

Law, K. S., and A. Stohl (2007): Arctic air pollution: Origins and impacts. *Science* **315**, 1537-1540, doi: 10.1126/science.1137695.

- HitT Task (Halogens in the Troposphere)

Halogens in the Troposphere (HitT) is a project aimed at studying the sources, transformations and consequences of reactive halogen compounds in the troposphere. The Task was “kicked-off” at a workshop co-sponsored by IGAC April 21, 2007 in Vienna, Austria.

HitT will comprise research in the following areas: focused studies in the polar boundary layer (links with AICI Task & IPY) and the marine boundary layer; upper troposphere/lower stratosphere studies of very short lived species, with focus on bromine and iodine; interactions between halogens and mercury; volcanoes and halogen production; model development (global, process-level and molecular); laboratory studies (frost flowers; gas phase kinetics; heterogenous reactions); and instrument development.

Workshops/Meetings:

IGAC co-sponsored several workshops the past year, mostly around the new Atmospheric Chemistry and Climate Initiative. (Note that the SPARC/GEWEX-GCSS/IGAC Workshop in June, 2006 is feeding into

this initiative). In addition, we supported a workshop for the IGAC AICI Task, where planning for four summary papers was started.

- *Halogens in the Troposhpere (HitT) Workshop*, April 21, 2007, Vienna, Austria (in association with EGU)
- *POLARCAT planning meeting*; in support of IGAC POLARCAT Task, June 4-6, 2007, Paris, France
- *Aerosols, Clouds, Precipitation & Climate (ACPC) Initiative 1st Workshop*, October 8-10, 2007, Boulder, Colorado, USA
- *ACPC Planning meeting*, January 28-30, 2008, Bern, Switzerland
- *POLARCAT Short-lived Species Workshop,* November 5-8, 2007, Oslo, Norway
- *Planning meeting for the IGAC AMMA-AC Task (African Monsoon Multidisciplinary Analysis – Atmospheric Chemistry)*, 26-30 November 2007, Karlsruhe, Germany

Travel costs for liaison activities were also covered, allowing either an IGAC SSC member or the IGAC Executive Officer to attend the steering committee meetings of related projects (e.g. IGBP's iLEAPS, SOLAS, and AIMES Projects and WCRP's SPARC Project), as well as for a member of the Atmospheric Chemistry and Climate Initiative (AC&C; see below) Steering Committee to attend a meeting of the Chemistry Climate Model Validation (CCMVal) workshop, as an AC&C liaison. We continue to consider such liaison travel to be critical to IGAC's goal of advancing atmospheric chemistry research within the context of the Earth system.

Initiatives

Atmospheric Chemistry & Climate

In 2006, IGAC jointly spearheaded a new initiative with WCRP's SPARC (Stratospheric Processes and their Role in Climate) project on "Atmospheric Chemistry and Climate". This initiative seeks to improve the representation of chemistry/climate interactions in models. Four main research activities have been identified, as have two cross-cutting activities:

- *Activity 1: Multi-decadal Hindcast Simulations*

Projections of future climate change are coupled with changes in atmospheric composition whose impacts extend to air quality: e.g., the projected increases in near-surface ozone levels threaten air quality standards for much of the world's population (Prather et al., 2003; Stevenson et al., 2006). The primary objective of this activity is to evaluate the capability of current atmospheric chemistry models to integrate over the variations and trends in circulation and climate, in emissions, and in chemical feedbacks that control atmospheric composition. This will provide the information needed to quantify and reduce uncertainties when the same models are used in climate system models to project conditions in the 21st century. Thus, this activity has direct implications for constraining uncertainties in future IPCC climate assessments. The composition of the atmosphere changes in response to altered forcings (i.e., emissions, land surface change, solar cycle) and climate variations (winds, convection, precipitation, clouds). An ideal test of the models used to project future atmospheric chemistry and climate is provided by the past few decades for which we have observations of trends and variability in atmospheric composition. Through this activity we expect to derive more objective measures of uncertainty in modeling atmospheric chemistry and transport and thus in projecting future composition.

For these model runs, an agreed-up set of experiments are being defined, each with a clear definition of the following: (i) a multi-year series (post-1980) of measurements of one or more atmospheric trace species; (ii) a clear objective grading criteria for evaluating model success; (iii) the multi-year variability of external forcings (e.g., emissions) needed to drive the simulations; (iv) a set of required diagnostics so that the different model simulations can be readily compared and evaluated; and (v) guidelines on the types of chemical models and meteorological fields that can usefully participate.

- *AC& C Activity 2: What controls the distribution of aerosols/gases in the troposphere?*
  Step #1: Investigate what controls the distribution 5km->tropopause.

The atmospheric composition above 5 km plays a crucial role in the coupling between chemistry and climate, as: a) radiatively and chemically active species at this altitude play a major role in the

radiative balance of the atmosphere, due to the low temperatures; b) the long range transport of radiatively active species and their precursors occurs primarily in this region; c) the composition of this region may affect and be affected by processes in the lower stratosphere; and d) the composition in this region may play an important role in determining formation of high-level clouds important to the climate system, such as cirrus. Unfortunately, our understanding of the processes controlling the composition in this region is fraught with uncertainties, as demonstrated in studies under AeroCom (Textor et al., 2006), the TRADEOFF program (Brunner et al., 2003, 2005) and other studies (e.g. Wild, 2007). Due to the complex interactions between the physical, chemical and transport processes that determine composition in the upper troposphere, a systematic approach to unraveling the relative importance of these different processes has so far been missing.

The CCMVal activity has made important contributions to understanding the processes controlling the chemistry and climate response in the lower stratosphere (Eyring et al., 2005). A similar activity for the upper troposphere is highly desirable, but would be complicated by the multitude of processes to be considered:

a) vertical transport by large-scale winds and convection;
b) interaction between vertical transport and long-range horizontal transport;
c) removal of aerosols and gaseous species by wet and dry depositon;
d) in-situ production of ozone precursors (NOx) by lightning and aircraft; and
e) stratospheric-tropospheric exchange.

Under AC&C, we will first address the role of convection and wet deposition, in the belief that these processes may control a large portion of the observed inter-model variability. These processes have not been examined in any systematic way since the intercomparisons summarized by Jacob et al. (1997) and Rasch et al. (1995). This activity will provide important contributions both to future IPCC climate assessments and to WMO ozone assessments by improving model representation of chemically and radiatively important species and thereby leading to understanding of how changes in climate might affect distributions of these species.

- *AC& C Activity 3: Cloud, Aerosol, Chemical Interactions*

This activity is more exploratory than the other three and to date has made little progress in planning. The idea is to address how well we can characterize warm cloud / aerosol interactions in global models, with a specific focus on the interactions with gas chemistry photochemistry. Implementation would be through model runs where a sets of parameters (e.g. cloud droplet number, etc.) and controlled, then the chemistry is allowed to evolve. Specific reaction mechanisms/processes involved in aerosol/cloud interactions would then iteratively be allowed to run interactively in the model in order to investigate impacts of each process on the chemistry in clouds.

We are hopeful that progress on this activity will be forthcoming, albeit on a somewhat delayed schedule.

- *AC&C Activity 4: Future scenarios: Sensitivities & Uncertainties*

The overall motivation for this activity is better representation of aerosols and chemistry in the next round of assessments (i.e. IPCC). The goal is to define future emission scenarios that are consistent with those for the long-lived species used to drive AR5 runs. By running multiple atmospheric composition models with these constrained emissions it will be possible to define "best guess" means and uncertainties for future atmospheric composition of chemically active trace species. These model runs would also be designed to explore sensitivities of the calculated fields to model processes, e.g. the effects of aerosol internal mixing, the impact of OH change on methane, and the response of stratosphere-troposphere exchange to future climate and its effect on tropospheric ozone.

This effort requires a finite set of up-to-date scenarios that span a range of future emissions, including stabilization scenarios. A key goal is to bring together the Integrated Assessment Modeling (IAM) and atmospheric modeling communities. Consistent emissions scenarios for short- and long-lived species will require coordination of atmospheric modelers' requirements and the capabilities of integrated assessment modelers. Thus, runs will focus on a limited set of key species (e.g. NOx, CO, CH4, SO2, BC, OC, NH3 and VOCs) and the emissions scenarios will be developed collaboratively with the IAM community, in part through coordination with the IGBP-AIMES project. For parity, forecasts will be made by large geographic regions, similar to those used for the IPCC SRES scenarios for long-lived greenhouse gases.

Steering Committees for AC&C activities were finalized in 2007, and the SC has been working to establish detailed plans for each of the AC&C activities. The SC has also been coordinating with related projects (e.g. WCRP-SPARC's CCMVal; the AeroCom aerosol model intercomparison project; the ACCENT Model Intercomparison Project; and the Task Force on Hemispheric Transport of Atmsopheric Pollutants, TF-HTAP). A session on AC&C was held at the Fall AGU meeting (December 11-14, 2007; San Francisco). The 2nd Atmospheric Chemistry and Climate Workshop is planned for June 9-13, 2008 in Washington, D.C. It will be held in conjunction with an HTAP meeting planned for the same week and will have overlapping sessions to assure optimum coordination and streamlining of AC&C and HTAP activities.

Laboratory Studies in Atmospheric Chemistry

The IGAC HitT and AICI Tasks both have significant components that need to be addressed through laboratory studies of chemical processes as they occur in the atmosphere. IGAC has not recently been active in the area of laboratory studies, but in the past there were joint IGAC-SPARC efforts in this area. The HitT and AICI task leads have highlighted this need to the IGAC SSC at the same time that the WCRP-SPARC Project Steering Group expressed an interest in revitalizing a joint effort in this area. As many of the areas of interest to these groups overlap (e.g. halogens chemistry & kinetics; chemical processes in ice crystals) a new effort in this area is being planned. The starting point will be a joint AICI-HitT-SPARC workshop in June, 2008 in Cambride, U.K. on laboratory studies in atmospheric chemistry. The workshop will be combination of tutorial lectures – with participation by PhD students actively encouraged and supported – and working group sessions for AICI, HitT, IGAC and SPARC researchers.

Aerosols, Clouds, Precipitation & Climate

IGAC is also involved in an activity initially discussed in 2006 on "Aerosols, Clouds, Precipitation and Climate", specifically addressing the impact of anthropogenic aerosols on precipitation processes. IGBP's iLEAPS (Integrated Land-Ecosystem Atmosphere Process Study) project, IGAC and the WCRP GEWEX (Global Energy and Water Experiment) project are jointly leading this effort. The first ACPC workshop was held in October 2007 in Boulder, Colorado, and plans for the activity were refined at a smaller follow-on meeting of ACPC Steering Committee members in January, 2008 (Bern, Switzerland). These will be built on again in the next meeting, planned for October 2008.

Other IGAC Activities in 2007

The 2007 IGAC SSC meeting was held September 3-6, 2007 in Washington State. All but one SSC member was able to attend. A focus of the meeting was brainstorming for future IGAC activities, and was quite successful in this regard. This meeting was fully organized by the Seattle project office.

IGBP, WCRP and GCOS held a joint invitational workshop October, 2007 in Sydney, Australia, engaging lead authors from IPCC AR4 WG1 and WG2 and other key scientists. The goal of the workshop was to seek recommendations on how these three international programs could address key gaps and uncertainties in research and observations that currently hinder our ability to detect, describe, understand, forecast, mitigate and adapt to human-induced climate change. Sarah Doherty (IGAC Executive Officer) was invited to participate in the meeting and is the lead author on a publication of the meeting outcome, shortly to be submitted to the Bulletin of the American Meteorological Society. This supporting role of IGAC has been positively acknowledged by the leadership of IGBP, WCRP and GCOS.

IGAC 2008 Conference Planning

The 10th IGAC Open Science Conference will be held September 7-12, 2008 at the Imperial Palace in Annecy, France. The theme of the conference is "Bridging the Scales in Atmospheric Chemistry: from local to global". A particular focus will be on the interactions between the earth system compartments across these scales. The planned session themes are:

1. Chemistry-climate: regional impact on the global scale
2. Biogenic and anthropogenic impacts of urban centres on the regional and global scale

3. Impact of clouds/chemistry on regional and global scales
4. Observing Atmospheric Composition from the Global to the local
5. From the nanoscale to the macroscale: Process studies.

A feature of the 10th IGAC conference is coordination with the 2008 WCRP-SPARC General Symposium, which is taking place the week immediately preceding the IGAC Conference in Bologna, Italy. The last two days of the SPARC conference and the first two days of the IGAC conference are being jointly sponsored by the two organizations and will focus on the areas of atmospheric chemistry and climate and the tropical tropopause layer. Special registration fees have been established for both conferences, allowing attendees of one to attend the joint sessions of the other conference for a reduced fee. We hope thereby to build on the efforts of the past few years to increase coordination and collaboration between these two organizations.

As with past IGAC conferences, we have planned a special Young Scientists Program and are in the process of raising funds specifically to support the participation (travel, registration, etc.)
The conference web page (http://www.igacfrance2008.fr/) is now open for registration and abstract submission.

The IGAC Seattle project office has taken an active role in planning the conference program, the young scientists' program, and other aspects of the meeting organization.

Newsletter

Three newsletters were produced in 2007 and were mailed to ~32,000 scientists. All IGAC newsletters are available to download on our web page. We received very positive feedback in particular on this special issue on satellite retrievals of tropospheric chemistry, which many considered to be an excellent survey and reference tool/

- Issue No. 35 [March, 2007] Special Issue on Satellite Retrievals of Tropospheric Chemistry
- Issue No. 36 [July, 2007] Articles from CACGP/IGAC/WMO Cape Town Symposium poster award winners; Atmospheric Chemistry & Climate Initiative (AC&C); Network for the Detection of Atmospheric Composition Change (NDACC)
- Issue No. 37 [November, 2007] Special Issue on routine measurements from mobile platforms (CARIBIC, MOZAIC, CONTRAIL, TROICA, cargo ships)

IGAC Scientific Steering Committee Membership, 2007

Name	Country	Expertise
John Burrows*	Germany	Remote sensing, air quality, photochemistry
Jen-Ping Chen	China-Taipei	Aerosol physics & aerosol-cloud interactions
Nikolai Elansky	Russia	Field measurements, trace species, toxins
Laura Gallardo-Klenner	Chile	Inverse modeling, air quality, UT/LS, aerosol-cloud interactions
David Griffith	Australia	Gas phase species, remote sensing, FTIR spectroscopy, isotopic fractionation
Achuthan Jayaraman*	India	Aerosols, modeling, field measurements, air quality

Maria Kanakidou	Greece	Gas-particle interactions, modeling, atmos. oxidizing capacity
Yutaka Kondo	Japan	Air quality, trace gases, ozone, field measurements, remote sensing
Kathy Law (co-chair)	U.K.	Photochemistry, UTLS, integration of field measurements/modeling
Celine Mari	France	Mesoscale modeling, atmospheric chemistry and dynamics interactions
Randall Martin*	Canada	Remote sensing, air quality, photochemistry
David Parrish*	USA	Photochemistry, trace gases, field measurements
Stuart Piketh	South Africa	Biosphere-atmosphere interactions, aerosol-cloud interactions
Graciela Raga	Mexico	Air quality, modeling, aerosol-cloud interactions
Philip Rasch	USA	Modeling aerosols, aerosol-cloud interactions, UTLS
Eric Wolff*	U.K.	Photochemistry, air-ice chemical interactions, paleo
Tong Zhu	China-Beijing	Air quality, kinetics, biosphere-atmosphere exchanges

***** *These members rotating off as of January 1, 2008*