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IGAC News

Coordinating and fostering atmospheric chemistry research towards a sustainable world

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ENVISAT satellite was launch in March 2002 and provided Earth observations for nearly a decade when on 8 April 2012, the European Space Agency (ESA) lost communication with ENVISAT. A month after trying to reestablish communication, on 9 May 2012 ESA declared the ended the ENVISAT mission.

Image courtesy of European Space Agency

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The End of the ENVISAT Mission

John P. Burrows
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President of IAMAS-ICACGP

After 10 years in space, the contact to the European environmental satellite ENVISAT was lost on the 8th April 2012 and has not be re-established as yet. On the 9th May 2012, ESA declared the official end of the ENVISAT Mission. This is sad news for the Institute of Environmental Physics (IUP) of the University of Bremen, which has been the scientific lead in one of the ENVISAT instruments, the SCIAMACHY (SCanning Imaging Absorption spectrometer for Atmospheric CHartographY), which is a Greek word meaning hunting the sky, a battle with shadows or doing an impossible task. As director of the institute, founder and "Principal Investigator" of the SCIAMACHY project, I have the following comments with respect to the end of ENVISAT.

The news about the end of the ENVISAT mission is a large disappointment. Within its 10 years of operation the SCIAMACHY instrument on ENVISAT produced a unique and trail blazing data set. SCIAMACHY was up to its last downlink of data from ENVISAT in excellent working condition and was expected to work for several more years.

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The SCIAMACHY concept was developed in the 1980's. SCIAMACHY spun off the smaller and cheaper SCIA-mini, which was descoped to become GOME (Global Ozone Monitoring Experiment) on the platform ERS-2, launched in 1995 and decommissioned by ESA in 2011, and the GOME-2 on the EUMETSAT/ESA Metop, the first of which started delivering data in 2007. There are plans for a follow on to GOME-2, called EU/EUMETSAT/ESA GMES (Global Monitorinring of Environment and Security, part of the European component of GEOSS) Sentinel 5 as part of the Metop second generation. The SCIAMACHY team developed and proposed the GeoSCIA and GeTROPE concepts, a version of which is being realised as GMES Sentinel 4, planned as the first geostationary remote sounding instrument for tropospheric pollution. There are now three generations of scientists working on GOME and SCIAMACHY data and improving the instrumentation. The excellences of the work of the scientists, engineers and administrators, who designed, built and ran the system comprising ENVISAT and ERS-2, needs to be pointed out and congratulated.

The loss of the data products from GOME, and now SCIAMACHY and the other ENVISAT instruments, however, leaves a large gap in the global observation of key atmospheric constituents and parameters; in particular for the greenhouse gases carbon dioxide and methane and the determination of the vertical profiles of key atmospheric trace gases, aerosols, clouds and meteorological parameters by so-called limb and occultation observations. Unfortunately and in spite of the European nations ratifying international treaties such as the UNECE LTAP , UNFCCC and the Montreal and the Kyoto protocols, these measurements are not foreseen or planned within the EU/EUMETSAT/ESA follow-on program GMES within the next decade.

Already in the 1990s, the ESA earth observations user consultation process identified that the most important user requirement is "the continuity and improvement of key observations in the space segment". In spite of GMES having an ambitious atmospheric monitoring service, its focus is currently placed on the support of operational "upstream and downstream services". GMES is potentially a very important instrument and step forward, but it has not secured the continuity of space based global measurements, aimed at delivering atmospheric data products and provided by ENVISAT.

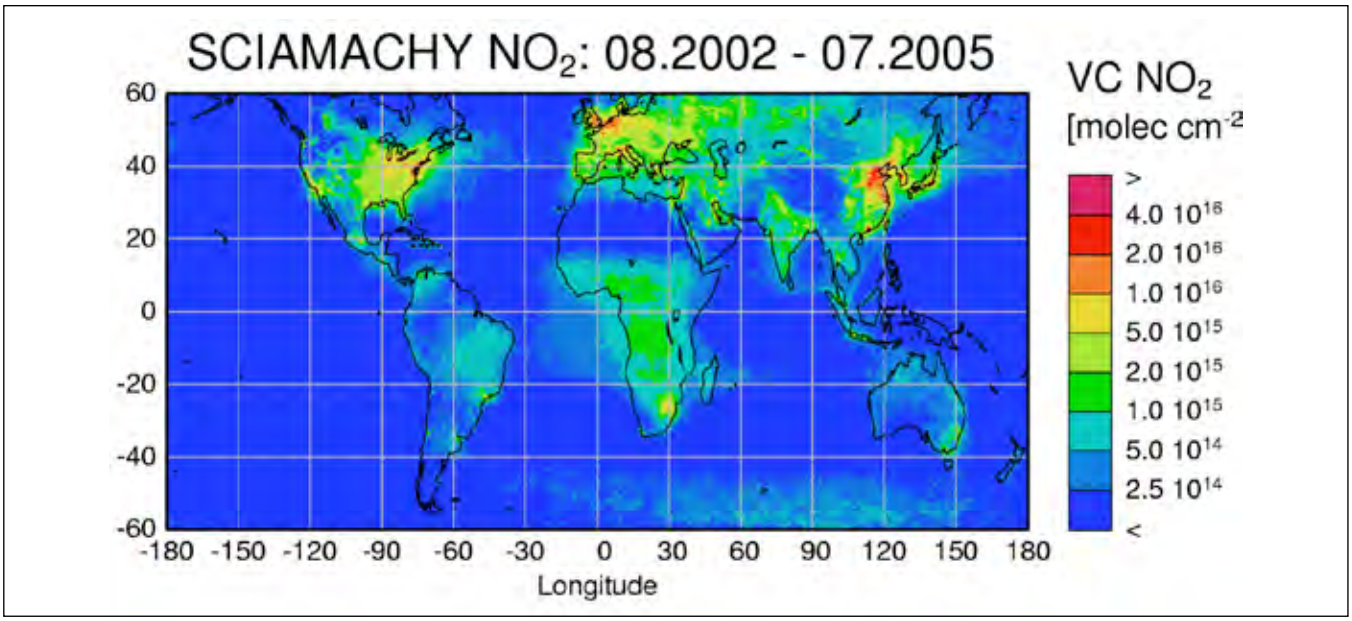
It took approximately 10,000 years from the Neolithic revolution for the earth's human population to reach one billion

around 1800. Since the industrial revolution, this population and its standard of living has been growing approximately exponentially by utilizing the cheap energy provided by fossil fuel combustion. For example there are now approximately 2 billion more people on the earth, since SCIAMACHY was proposed in 1988.

Our understanding of the earth system and its biogeochemistry has increased dramatically since the discoveries at the beginning of the 20th century of the tropopause and stratosphere by the Teisserenc de Bort and Richard Assmann and the estimates of Arrhenius showing the impact of increasing the greenhouse gas. These were serendipitous and are examples of many surprising discoveries revealed by observational systems e.g. winter and summer smog, global increases of their greenhouse constituents tropospheric ozone, carbon dioxide, methane and nitrous oxide, changes in aerosol type and amount and acid deposition, the global depletion of stratospheric ozone and the appearance of an "ozone hole", unexpected clouds of bromine oxide at high latitudes, etc. An adequate observational system for atmospheric composition is required to separate the impact of natural phenomena from anthropogenic activity and provide early warning of the environmental and climate change. Global observations from space are a unique part of this system, needed for atmospheric, environmental and climate research during this phase of the anthropocene and provide an objective evidence base for national and international policymakers in their efforts to achieve sustainable development. In the last two decades, the scientific community has identified the needs described in the plans of GCOS http://gosic.org/ios/GCOS-main-page.htm, CEOS IGOS http://www.un.org/earthwatch/about/docs/igoshome.htm GEOSS http://www.earthobservations.org/geoss.shtml and http://www.nap.edu/catalog/11820.html,i.e. the issue of the provision of an adequate space segment is not new.

As pointed out at the WMO World Climate research Project Open Science Conference as recently as October 2011 "We cannot manage what we can't measure."

As pointed out at the WMO World Climate research Project Open Science Conference as recently as October 2011 "We cannot manage what we can't measure." Part of the SCIAMACHY nadir measurements (about 40%) will be continued by the spin-off instrument GOME-2. However after the sudden and unexpected end of ENVISAT, atmospheric and climate research urgently needs the initiation of replacement missions to minimize the gap in the precise determination of the total amount of carbon dioxide and the vertical distribution of key atmospheric substances and parameters at adequate "fit for purpose" spatial resolution and temporal sampling. These data are also needed to provide the evidence base for environmental policymaking as the anthropocene evolves. This is a call to the EU, European Governments and their international partners to direct their space agencies in collaboration with the scientific community to deliver the atmospheric and earth observation system needed.



Example of tropospheric NO_2 vertical column in molecules cm^{-2} from the SCIAMACHY Instrument

IGAC International Project Office Relocates

The IGAC International Project Office (IPO) has relocated to the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado in Boulder, CO USA. Whether you are studying or working at one of the many laboratories/universities in Colorado or visiting Boulder from afar, please send us a note and set up a time to come say hello (info@igacproject.org).

iCACGP and IGAC Announce the Location of the 2014 Conference

The International Commission on Atmospheric Chemistry and Global Pollution (iCACGP) and IGAC are please to announce that the 2014 joint 13th Quadrennial iCACGP Symposium and 13th IGAC Science Conference will be held in Natal, Brazil.

iCACGP and IGAC are delighted to be holding their joint conference for the first time in South America. This region of the world is of key importance in the earth system, has a growing community of atmospheric scientists and is the host of many integrated and inter- and transdisciplinary international research activities in atmospheric sciences over the past decades.

Please stay posted for further information on the exact dates and conference theme (http://www.igac-icacgp2014.org/).

We hope to see you all in 2014 in Natal, Brazil!

Launch of the New IGAC Mailing List

IGAC has new options for staying in touch with the community. We have recently launched a new email based mailing list that gives you control over just how much you hear from us. You can choose to receive a hard or digital copy of our newsletter, which is published three times per year. Or you 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!

If you are currently receiving IGAC notifications for workshop, conferences, etc., then make sure to click *update subscription* preferences in the lower portion of these mailings to choose your level of communication with the IGAC community.

If you have not been receiving email notifications from IGAC, then you are not signed up for our new email service and we only have a physical mailing address for you. In which case, you need to join the new email list by going to http://eepurl.com/eu3U6.

If you have any questions about our new mailing service, or IGAC in general, please contact us at info@igacproject.org.

Launch of the New IGAC Website

Our newly designed IGAC website launched at the end of February! We are excited to present a completely remodeled website that highlights our current activities, conferences, workshops, and IGAC related events. It is our goal to create an interface that is more accessible for our international community. Come check us out at igacproject.org

Submit Articles to the Next IGAC Newsletter

The next upcoming IGAC newsletter is now open for article submissions! Workshop Summaries, Science Features, Activity News, and Editorials are all acceptable and desired. Science Features are to be submitted at a recommended length of approximately 1500 words with 1-2 images. All other submissions must be approximately 600 words and have a maximum of 1 image. Images must be high resolution in the format of a .jpeg file. The deadline for submissions for the November Issue of the IGAC Newsletter is 1 October 2012. Any questions concerning content or formatting may be sent to info@igacproject.org.

IGAC Events Proposal Submissions

If you are interested in receiving support for workshops related to IGAC's Activities and Vision, look no further. IGAC provides financial support and non-financial endorsements of meetings, workshops, symposiums, and conferences. Sponsored events are required to publish an event summary in the IGAC Newsletter and IGAC may request a Science Feature or Young Scientist Spotlight article related to the workshop topic. Please visit igacproject.org and go to IGAC Events to learn more about how to submit a proposal for an IGAC sponsored event. Any questions regarding proposals or to submit a proposal please write to info@igacproject.org. The deadline for proposal submissions will be twice a year with the next deadline being **1 October 2012**.

Atmospheric Chemistry and Health: current knowledge and future directions • Boston MA, USA •12-13 October 2012

Frank Dentener[1], Tong Zhu[2], Aaron Cohen[3], Burt Brunekreef[4]

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Despite their many common scientific issues and concerns, investigators studying atmospheric sciences and those assessing the health impact of air pollution generally pursue isolated research programs and rarely collaborate. As a result, even basic knowledge is not always widely shared. In October 2011, leading experts representing both areas met at the Health Effects Institute in Boston, USA, for a two-day workshop designed to explore the various and multidimensional interactions between atmospheric chemistry and health effects. Participants identified the main areas in which integrated research is needed and discussed the benefits for environmental and health policy that would accrue from dealing with air pollution and atmospheric chemistry in a more unified way. They summarized recent findings on the role of atmospheric chemistry in epidemiology and toxicology and the health effects of individual and multiple components of the air pollution mixture; they also discussed the current status of and recent advances in atmospheric measurements and modeling most relevant to health effects research. One of the overarching conclusions of the workshop was that particulate matter mass concentrations and ambient ozone levels have been exceedingly useful indicators for the complex mix of components in ambient air pollution and have provided the basis for epidemiologic research and risk assessment to support national and international air quality standards and guidelines. The experts further agreed that current science cannot identify definitively which specific components in these complex mixtures explain the adverse health effects that are so consistently observed. They were, however, optimistic that future research, and specifically closer inter-disciplinary collaboration of atmospheric scientists and health effects researchers, on measurements, emissions, modeling and statistical analysis of health outcomes, may provide the basis for more targeted emission controls of specific sources and components responsible for the health effects.

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.

The workshop was co-sponsored by the United Nations World Meteorological Organization (WMO), the European Commission's ACCENT program (European Network of Excellence on Atmospheric Composition Change), the international Commission on Atmospheric Chemistry and Global Pollution (iCACGP), the International Global Atmospheric Chemistry project (IGAC) and the Health Effects Institute. For further information on the workshop, contact Frank Dentener (frank.dentener@jrc.ec.europa.eu), Tong Zhu, Aaron Cohen, and Bert Brunekreef.

Connecting global air pollution with health outcomes

J. Jason West
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Ozone and fine particulate matter ($PM_{2.5}$) influence human health, ecosystems, and the global climate. Of these varied effects, the acute and chronic effects of these pollutants on human health have been most influential in motivating policy responses to reduce emissions of $PM_{2.5}$ and of the precursors of ozone and $PM_{2.5}$.

Since about 2005, there has been a growing interest in using global atmospheric models to support analyses of human health impacts. Prior to that time, regional atmospheric models had been used to drive health impact analyses in support of assessments of the costs and benefits of emission control policies, such as in urban areas or on the scales of the US and Europe (e.g., *Hubbell et al.*, 2005). Increasingly, global atmospheric models are used to understand air pollution impacts on continental to global scales. The desire to assess health impacts for global scale problems then drove health applications for themes such as: background pollution, long-range pollutant transport, the effects of widespread emissions changes, and the interactions of climate change with air pollution.

Health benefits of reducing methane emissions

Methane is unique as a volatile organic compound (VOC) and ozone precursor because of its long lifetime (though for climate change, methane is a short-lived greenhouse gas!), for which methane truly affects the global background of ozone [*Fiore et al.*, 2002, 2008; *Dentener et al.*, 2006]. We saw this as a unique opportunity to control ground-level ozone all around the world, and conducted a cost-benefit analysis by evaluating the cost of methane emissions control against the benefits of actions to reduce methane for reduced ozone and improved human health. We used a global chemical transport model (MOZART-2) to simulate the global change in ozone from an immediate 20% reduction in global anthropogenic methane emissions, finding that ozone would decrease globally by about 1 ppb. This would be sufficient to prevent about 30,000 premature deaths in 2030. We then found, depending on the value placed on each avoided death and other uncertainties, that this health benefit can be enough to fully justify the 20% methane decrease [*West et al.*, 2006; 2012].

Health effects of long-range air pollutant transport

We have also quantified the human health impacts associated with the long-range transport of ozone and

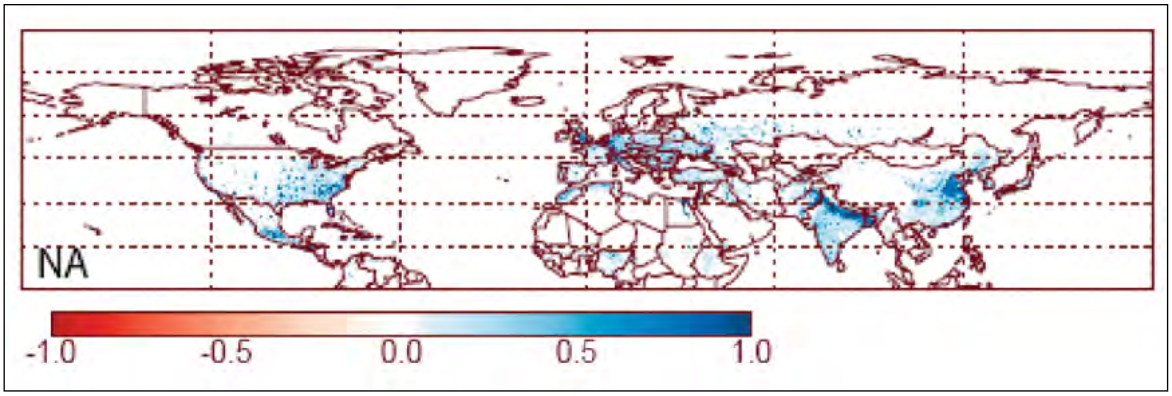

Figure 1. Annual avoided cardiopulmonary mortalities per 1000 km2 from a 20% emission reduction in NMVOC, NO_X, and CO emissions from North America, using the multi-model mean ozone change of fourteen global models. Avoided deaths within North America are about 900 per year, but this is less than the roughly 3600 per year in the Northern Hemisphere [*Anenberg et al.*, 2009].

its precursors. We used the approach of simulating the effects of ozone precursors (individually or together) from continental source regions on ozone within that continent and globally; in one study, we used the Hemispheric Transport of Air Pollutants (HTAP) source-receptor simulations performed by multiple models [*Anenberg et al.*, 2009]. Through these studies, we estimated the ozone resulting from emissions within a single source region, and its effects on premature mortality within that source region, as well as globally. We estimated that emissions of ozone precursors within North America, Europe, and the Former Soviet Union may cause more deaths outside of those source regions than within [*Duncan et al.*, 2008; *Anenberg et al.*, 2009; *West et al.*, 2009]. This was surprising to us, but the basic logic is simple. Even if the effect of ozone precursors on downwind regions is on the order of 10% of that within the source region, there may be 10 times the population exposed to that pollution outside of the source region. For example, in Figure 1, a reduction of ozone precursors from North America would be expected to cause health benefits in downwind regions, including densely-populated regions of Asia. This would suggest that limiting health benefits to within the source nation or region, as is commonly done in cost-benefit analyses, might significantly underestimate the true global health benefits of reducing ozone.

We similarly estimated the premature mortalities for the long-range transport of $PM_{2.5}$. As $PM_{2.5}$ and its precursors have a shorter lifetime than ozone, we might expect a smaller inter-continental influence of $PM_{2.5}$. However, the relationship between $PM_{2.5}$ and mortality is stronger than that for ozone. We estimate that the health effects of inter-continental transport of $PM_{2.5}$ are comparable to those for ozone, but with potentially much greater within-region effects [*TFHTAP*, 2010].

Global burden of disease

Concurrent with this research, the health effects community has engaged in estimating the Global Burden of Disease (GBD) due to exposure to outdoor air pollution. The GBD study convened by the World Health Organization attempts to quantify the global health effects attributable to all major causes ranging from AIDS and malaria to environmental factors such as indoor air pollution, outdoor air pollution, and climate change. The GBD study concluded in 2004 addressed outdoor air pollution in the form of urban $PM_{2.5}$, and based estimates of $PM_{2.5}$ concentration only on measured values from urban monitors. Because many world regions lack monitors (very few were present in Asia, Africa, and Latin America), the authors used an econometric approach in which urban $PM_{2.5}$ was modeled as a function of demographic factors (population, economic income, etc.) for the cities where observations were present, and then applied those relationships globally [*Cohen et al.*, 2004].

Since that 2004 study, there has been a proliferation of new observational data, and an increased recognition of the value of atmospheric models to inform exposure estimates where monitors are lacking. We used MOZART-2 to drive our own estimate of GBD. While MOZART-2 may have significant errors, our approach had advantages: we modeled ozone as well as $PM_{2.5}$, and included rural populations as well as urban. We also used a simulation of pre-industrial air pollution to estimate the GBD more rigorously for the anthropogenic contribution to air pollution, which we estimated as the difference between the present-day and pre-industrial. The results for mortalities came out higher than was estimated earlier. We estimated that roughly 3.5 million cardiopulmonary and 220,000 lung

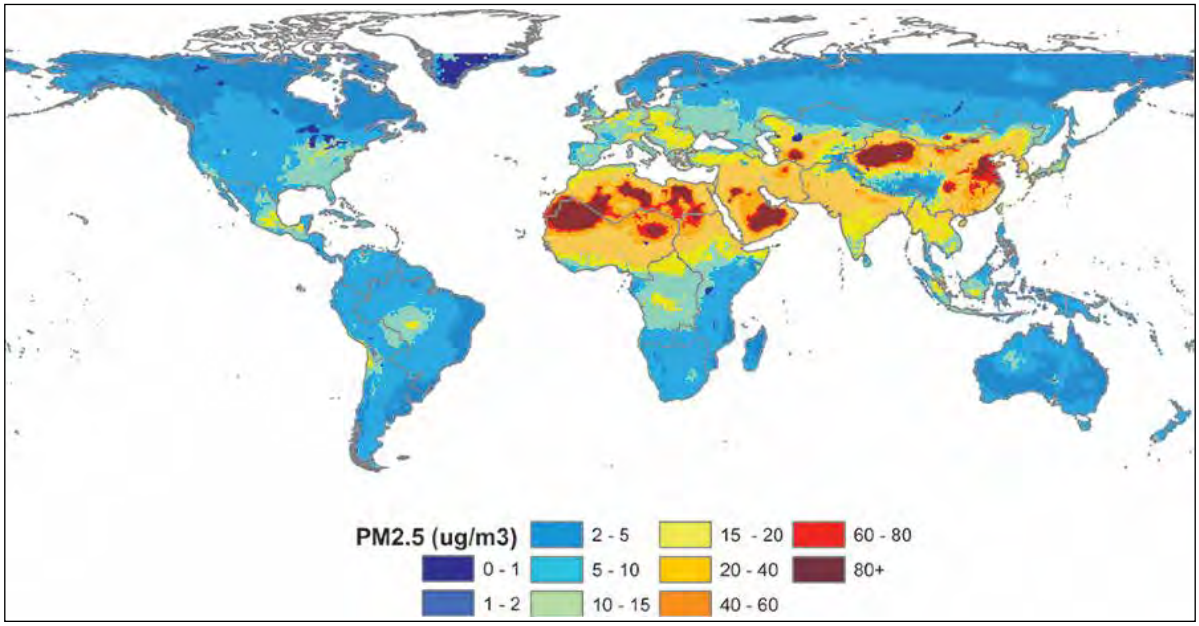

Figure 2. Annual average $PM_{2.5}$ surface concentration for 2005, estimated using a combination of data from satellites, surface observations, and a global atmospheric model [*Brauer et al.*, 2012].

cancer mortalities per year are associated annually with anthropogenic $PM_{2.5}$, and 0.7 million per year with anthropogenic ozone. The deaths attributable to $PM_{2.5}$ are about 6% of all deaths that occur globally [*Anenberg et al.*, 2010].

The GBD team is now working to produce new estimates of global mortalities from outdoor air pollution (http://www.globalburden.org), and has made some very interesting strides forward in better representing exposure. Satellite observations have been used to give estimates of multi-year average $PM_{2.5}$ concentrations at fine resolution (roughly 10 km) [*van Donkelaar et al.*, 2010]. These satellite observations were then combined with surface observations and the TM5 global model to give a best estimate dataset for global surface concentrations at fine resolution, for the period 1990-2005 (Figure 2) [*Brauer et al.*, 2012]. This new dataset will provide much more meaningful concentration fields for the new GBD study, to be released this year.

Other studies using global atmospheric models for health

Several other studies have used global atmospheric models to quantify human mortality. These include our studies of future air pollution mortality [*West et al.*, 2007] and of the health benefits of reducing black carbon emissions from world regions [*Anenberg et al.*, 2011]. Others have focused on the effects of emissions from ships [*Corbett et al.*, 2007] and aircraft [*Barrett et al.*, 2010], and have considered the health effects of future climate change and air pollutant emissions [*Selin et al.*, 2009]. These methods were likewise used to evaluate the human health benefits of policy actions to reduce emissions of black carbon, methane, and ozone precursors; the human health benefits of these actions were shown to be substantial, providing important motivation to reduce these short-lived climate forcers [*Shindell et al.*, 2012].

Important uncertainties and future directions

The methods used when applying global models to human health impacts have several important uncertainties, of which two merit discussion here. First, the coarse resolution of most global models (roughly 100 to 400 km) is incapable of resolving the fine gradients of population and pollutant concentrations found near urban areas. We recently analyzed the importance of grid resolution for estimates of mortality in the US, finding that the resolutions typical for global models would underestimate $PM_{2.5}$ mortality, perhaps requiring current estimates to be increased by ~60%, and that the error due to resolution is greater for primary $PM_{2.5}$ species than for secondary species [*Blayney*, 2012]. Meanwhile the coarse models have been shown to cause biases in ozone estimates [*Wild and Prather*, 2006].

There are several ways to address these issues. For present-day exposures, the use of satellite observations for representing fine-scale concentrations has been a remarkable step forward. But for simulating changes in emissions or

future scenarios, models are necessary. Current global models can now be run at finer resolution (~0.5°), giving much better representation of concentrations. Others have used nested models with fine grid resolution over one or more populated regions (e.g. *Jacobson*, 2008). Future work should aim to develop sub-grid scale parameterizations, based on the satellite data and finer resolution regional models, to statistically relate the coarse grid concentrations with a distribution of exposures for the people living within that coarse grid.

A second important uncertainty is in the use of epidemiological concentration-response relationships mainly from studies in the US to estimate global health effects. Many more epidemiological studies of ozone and $PM_{2.5}$ have been conducted in the US and Europe than elsewhere in the world, but studies elsewhere are broadly consistent. While we expect that human lungs in the US are basically the same as lungs in China, there are many other differences that have bearing on health outcomes, including diet, access to medical care, prevalence of infectious diseases, and cultural practices. This is typically dealt with in international studies by estimating cause-specific mortalities; since air pollution is expected to affect cardiovascular disease most directly, and since a smaller fraction of people die of cardiovascular disease in Africa than in the US, limiting the analysis to cardiovascular disease can account for this difference in the causes of death. Nonetheless, these uncertainties will only be resolved through more extensive analysis of health effects outside of the US and Europe. Similarly, as the major epidemiological studies in the US focus on adult populations (e.g. *Pope et al.,* 2002), health impact assessments commonly limit themselves to adults. By neglecting children and young adults, these assessments likely underestimate the true health impacts.

Finally, while I have focused here on the use of models for assessment of health impacts, there are also tremendous opportunities to use models to provide estimates of exposure that can drive air pollution epidemiological studies. For this type of application, regional models with scales that match the exposed population of interest would be most appropriate. By continuing dialogue between the atmospheric science and health effects communities, we can better recognize these types of opportunities to work together.

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Atmospheric Isocyanic Acid (HNCO): A Possible Cause of Pollution-related Health Effects

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Introduction

The connection between air pollution and adverse health effects has been well demonstrated as a general concern. However, in most cases the detailed biochemical mechanism by which individual pollutants exert their influence remains unclear. This article explains how a specific connection, between biomass burning-generated isocyanic acid (HNCO) and chronic inflammatory diseases was found, and what needs to be done to further explore it [*Roberts et al.*, 2011].

HNCO sources to the atmosphere

Biomass burning (BB) is a major atmospheric source of gaseous and particulate pollutants on regional to global scales, and small scales, e.g. within the homes of people who use biomass for cooking and heating. BB is a direct source of climate forcing agents such as CO_2 and black carbon particles and precursors for O_3 and secondary organic aerosol (SOA) in the form of volatile organic compounds (VOCs) that can, for example, condense on atmospheric particles directly or through chemical reactions. Consequently, there has been an increasing interest in understanding these emissions, in part through intensive measurements in controlled laboratory settings. It was during one

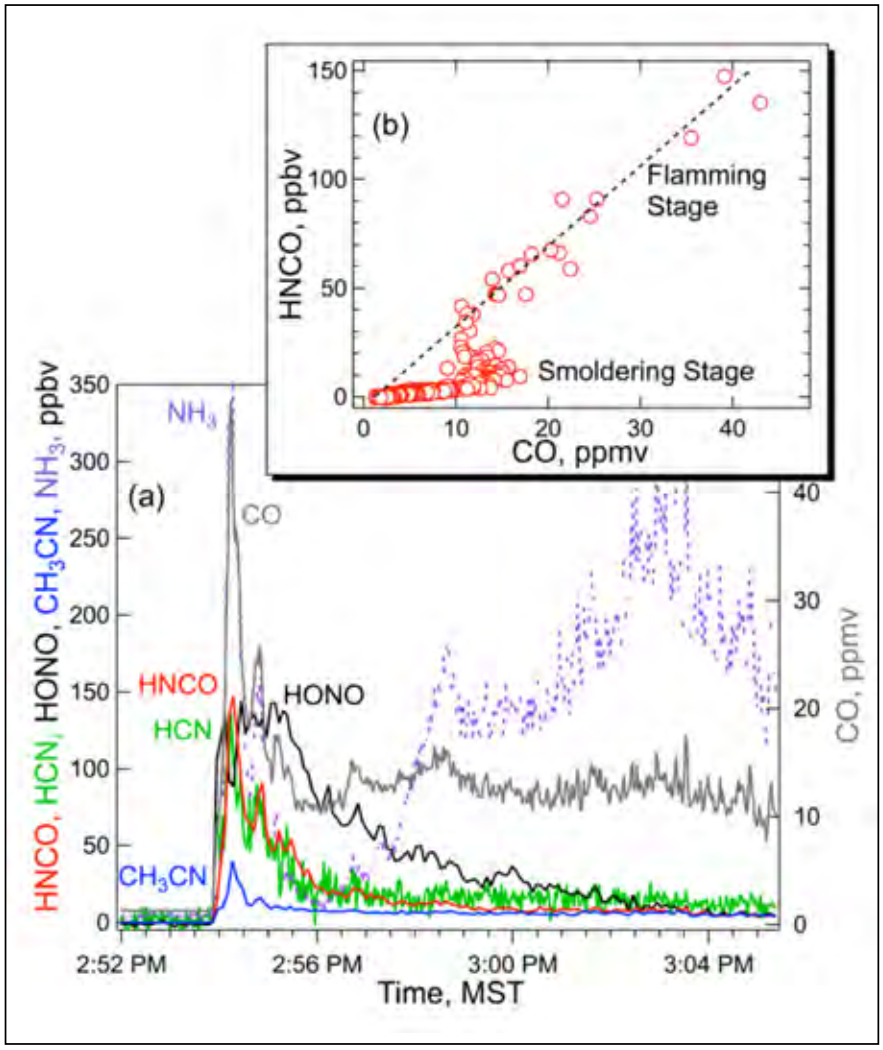

Figure 1. Results of a test burn of a sample of Mesquite. Panel (a) shows emission profiles for carbon monoxide and key nitrogen containing species, including HNCO, and panel (b) the correlation of HNCO with CO for the entire burn.

such study that we deployed a new instrument, the Acid-CIMS (chemical ionization mass spectrometer), which uses acetate ions to measure acidic species in the gas phase [*Roberts et al.*, 2010; *Veres et al.*, 2008]. It was immediately clear that there were unexpected compounds in the smoke and among the most prominent was HNCO. HNCO is not readily measured by the previously widely used techniques in atmospheric chemistry such as infrared spectroscopy and gas chromatography. The acid-CIMS data from our BB study show that HNCO is well correlated with flaming stage carbon monoxide (CO) and hydrogen cyanide (HCN) for a given fuel (Figure 1). In addition, the range of relative emissions, HNCO/HCN, was 0.33 – 1.

A survey of the literature and some simple lab experiments revealed that HNCO is a common product of the pyrolysis or low temperature combustion of nitrogen-containing materials, including some coals [Nelson et al., 1996], cigarettes (especially those that have added urea), and refuse. The atmospheric photooxidation of reduced nitrogen species (amines, amides) also produces HNCO as a by-product [*Barnes et al.*, 2010]. Perhaps one of the more intriguing sources of HNCO is urea selective catalytic reduction (SCR) technology that is being implemented to control NO_X from diesel engines. Very little is known about that currently, beyond some measurements on a test-bed system [*Heeb et al., 2011*].

Atmospheric Chemistry of HNCO

The removal of HNCO from the atmosphere via reaction with OH radicals or photolysis, is quite slow (many months to many years), thus the lifetime is determined primarily by heterogeneous uptake and other reactions. The removal by uptake is governed by solubility and hydrolysis, both of which are pH dependent, with opposite tendencies, i.e. solubility goes up with increasing pH and hydrolysis rates go down. This behavior prompted us to consider whether there were other liquid phase processes that might be faster than hydrolysis. In fact, isocyanates, including HNCO, react with many common organic species through a process know as carbamylation, shown below for an alcohol:

$$HNCO + ROH \Rightarrow ROC(O)NH_2 \quad \text{(eq. 1)}$$

In principle, any group with an active hydrogen, e.g. -NH_2, -SH, can undergo carbamylation. To the extent that these reactions are faster than hydrolysis, they will increase removal of HNCO by heterogeneous uptake, and will result in novel reduced nitrogen compounds on particles and surfaces.

Biochemistry and Health Implications of HNCO

In the process of researching the carbamylation chemistry noted above, we discovered a fairly rich literature connecting protein carbamylation to specific biochemistry that is thought to trigger adverse health effects, including heart disease, rheumatoid arthritis, and cataracts. The working hypothesis for those studies has been that enzymatic processes lead to high blood cyanate (NCO-) levels, which in turn cause protein carbamylation and associated inflammation. Our realization was that HNCO provided a direct environmental source of cyanate, because of the high solubility of HNCO at physiologic pH (pH =7.4).

One detailed study found that 100 µM concentrations of NCO- induced protein carbamylation in vitro [*Wang et al.*, 2007]. Our solubility data show that this concentration of NCO- corresponds to an atmospheric mixing ratio of 1 ppbv. We have therefore, adopted 1 ppbv HNCO as a preliminary threshold for concern about exposure/effects, but more studies are needed to further characterize this. We do note that several jurisdictions have placed quite low limits on work-place concentrations of isocyanates.

Ambient Measurements and Global modeling of HNCO

Since the initial lab work on BB emissions we have made several sets of HNCO measurements in ambient air. Mixing ratios were quite modest in Pasadena during the CalNex 2010 experiment, at 10-100 pptv, but up to several hundred pptv in Boulder, CO during the Four-mile Canyon fire (September 2010). More recently, unpublished data from a wintertime study at the Boulder Atmospheric Observatory (BAO) has shown that plumes from small agricultural fires can result in HNCO mixing ratios over 1.2 ppbv, even 10 km away from the source. "Background" HNCO concentrations in the BAO study were in the range 40-100 pptv on average.

The prediction of HNCO concentrations through atmospheric modeling has been useful in determining where and when HNCO concentrations are likely to be elevated and in examining the processes that are responsible for HNCO removal. Our recently published study [*Young et al.*, 2012] modeled HNCO in the troposphere by adding HNCO emissions estimates to the MOZART-4 global model. This was done by scaling the HNCO emissions to those of HCN, the major source of which is BB, using the low range of HNCO/HCN results from our BB measurements (0.3). With this ratio, we estimated an HNCO source from emissions of 1490 Gg/yr (Gg = giga-grams as HNCO). For HNCO loss, the model included parameterizations for dry deposition (slow over land; fast over water) and heterogeneous uptake in cloud water. The latter process was

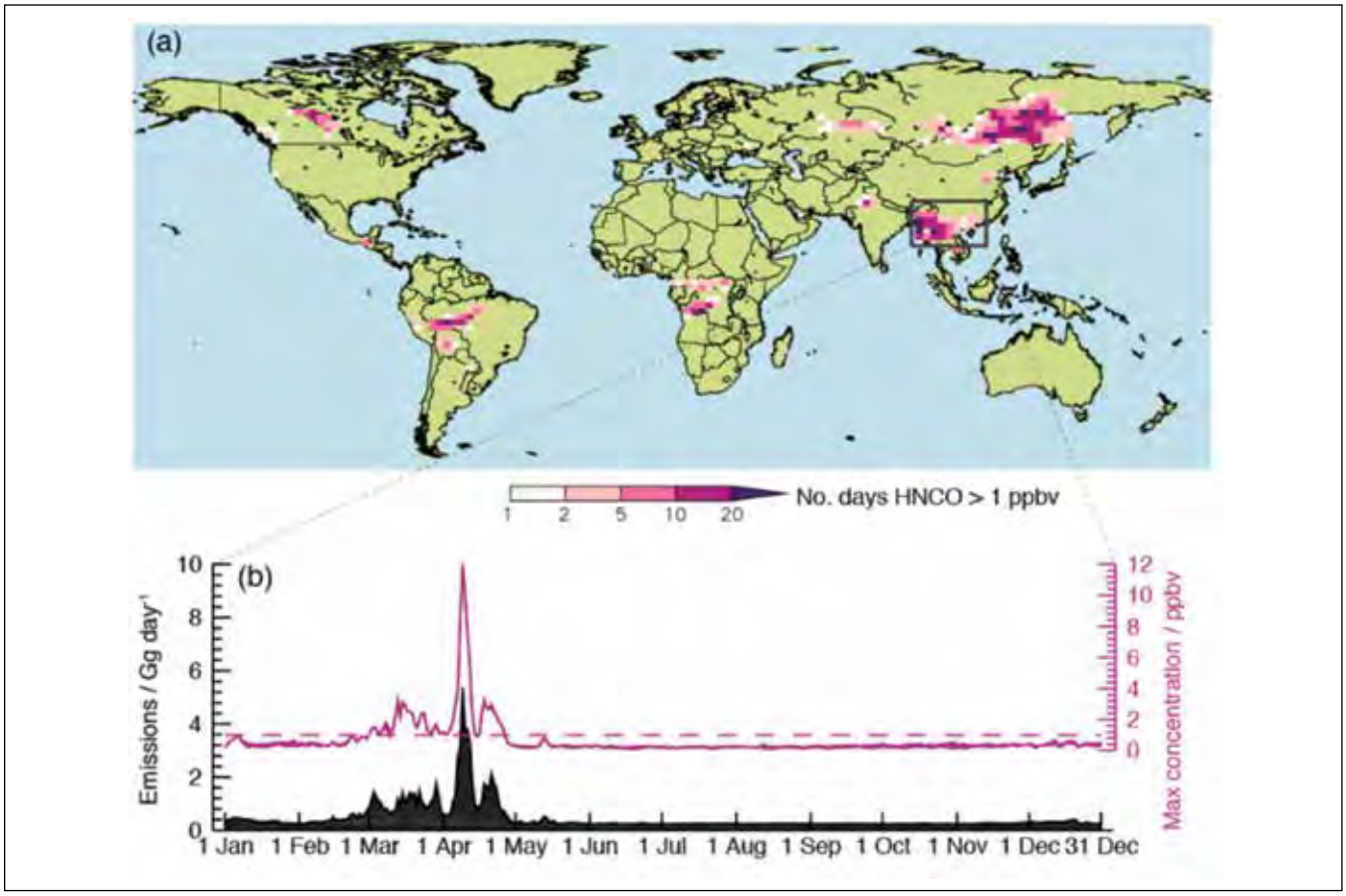

Figure 2. (a) A map of the number of high HNCO (>1 ppbv) days calculated by the MOZART-4 model, and (b) timelines of emissions and daily maximum HNCO concentration for any grid cell within Southeast Asia region, as indicated by the box in (a).

dependent on pH, as discussed above, although there was no consideration of the aqueous phase reactions, i.e. it was assumed that cloud water uptake was irreversible. Gas-phase loss by reaction with OH was also included, although this was only found to contribute significantly to the loss in the upper troposphere. Using the model-calculated pH, the lifetime of HNCO was of the order of 1 month, reduced to less than a week if the heterogeneous loss was globally fixed at a pH of 7.

The top panel of Figure 2 shows the number of days the surface concentration of HNCO exceeds 1 ppbv in a given model grid cell, using conditions appropriate for 2008 (meteorology and estimated fire emissions). The main regions that stand out are those impacted by large BB emissions, such as Siberia, northern Canada and several tropical locations. This is made clear in the lower panel of Figure 2, which highlights the model results for part of Southeast Asia, showing the daily mean time series of HNCO emissions (left hand axis), and the regional maximum surface HNCO concentration (right hand axis). Clearly days with very large fire emissions drive the HNCO concentrations above 1 ppbv. Interestingly, this is still the case when the heterogeneous loss is fixed at pH = 7, suggesting that understanding HNCO emissions is a priority.

Conclusions and Future needs

It is clear from ambient measurements, emissions studies, and global modeling that the BB source of HNCO alone can lead to atmospheric concentrations above our proposed threshold for serious biochemical impacts (although there remain important unknowns in trying to connect ambient concentrations of HNCO with specific health effects). Clearly, we need to refine our understanding of atmospheric HNCO in a number of ways; (1) Measurements of ambient HNCO and HNCO/CO in homes using a range of common bio-

fuels; The latter data could be used with existing data on CO exposure in homes using biofuels to assess the health impacts of HNCO; (2) Targeted consideration of BB types that occur in populated areas and are traditionally underrepresented in global fire inventories such as crop residue fires and garbage burning; (3) Exploration of a threshold emission level above which removal processes are overwhelmed; (4) We need more ambient measurements to confirm emissions inventories and models; (5) Detailed study of the HNCO exposure-effects relationships for human populations; (6) Further research on biochemical mechanisms.

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Health Impacts of Air Quality and Climate Change Workshop • Guangzhou, China • 9-11 April 2012

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An international workshop on "Heath Impacts of Air Quality and Climate Change in Asia" was held at Sun Yat-sen University in Guangzhou, China, 9-11 April 2012. Air quality has been of increasing concern in Asia due to very rapid economic growth and urbanization. Due to the impacts of regional air pollution on human health, and the awareness that climate change may exacerbate the health impacts, the preservation of clean air in Asia will be the focus of world attention. There is the need and opportunity for new interdisciplinary approaches to assess the climate-air pollution-health-vulnerability interactions and using this understanding to help design strategies for more sustainable development pathways.

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 sci-

ences. Working groups addressed specific cross-disciplinary issues and identified concrete topics, such as designing field, vulnerability, and modeling experiments that could form the basis for a new international project on "Air Pollution and Human Health in Asia". The results of the workshop include the identification of key scientific questions, the development of a conceptual framework to address the questions, and an integrated assessment of the various issues related to Asia. These results will be summarized in a white paper led by the workshop organizers.

A major theme of the workshop discussions dealt with the question: "What are the drivers of emissions and social vulnerabilities in Asia, and how do these contribute to the barriers and benefits of mitigation scenarios?" Significant challenges to address this question were identified. Distinguishing the specific influences of climate, atmospheric chemistry, health, economy, and social structure is difficult and mixed analytical approaches are necessary to fully understand the problem. Further, the fields discussed span many spatial scales, from the individual to local, community, city, region and global scales. Connecting data, models, and observations across these scales was identified as a key need for this emerging interdisciplinary community. Data quality and availability remains an issue.

"What are the drivers of emissions and social vulnerabilities in Asia, and how do these contribute to the barriers and benefits of mitigation scenarios?"

A conceptual framework that connects the air quality and climate, the health impacts, and the social aspects of a given region within Asia was prepared. To test this framework, a pilot study is planned to compare three cities (Guangzhou, Xi'An and Taipei) within the Asian region. The pilot study will take advantage of current datasets and model outputs for each city, to compare and contrast atmospheric chemistry, meteorology, emissions, social structures, economics, and health outcomes.

The agenda of the workshop, along with copies of the presentations, is posted at: www.sysueeswxm.org/workshop/. The structure of the workshop consisted of a few overview talks, poster sessions, with much of the time allotted to discussion, in both breakout and plenary sessions. The third day of the workshop included a tour of the Guangdong Atmospheric Monitoring Supersite of China in Heshan, southwest of Guangzhou. The workshop, organized by Louisa Emmons (NCAR) and Xuemei Wang (Sun Yat-Sen University), is one of the network-building components of an NSF Earth System Modeling Project on Chemistry and Climate in Asia (PIs: M. Barth, NCAR and G. Carmichael, Univ. Iowa). The workshop was endorsed by IGAC and its Atmospheric Chemistry & Health Initiative (AC&H), and was sponsored by K.C. Wong Education Foundation of Hong Kong, Sun Yat-Sen University, National Science Foundation of China, National Center for Atmospheric Research (sponsored by the US National Science Foundation).

Workshop on Developing Asian Megacities toward a Sustainable World • Zhangjiajie, Hunan Province, China • 25-26 April 2012

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Monsoon Asia is home for more than half the world population. The economies of the region are growing very rapidly, and much of the growth is due to urbanization and associated industrialization. Based on the World Urbanization Prospects of the United Nations (2009 Revision) in 2010, 10 of the 21 world megacities and 15 of the 30 world's largest cities are in Asia. At the same time, Asia is both a typical monsoon region and an important part of the global climate system. In rapidly developing Asian cities, environmental problems are occurring in changes of water quantity and quality, air quality, land cover and ecosystem services. With its active and intensive economic and social activities, megacities play an important role in the sustainability of the Earth System. While developing megacities can learn many lessons from developed megacities, all the megacities are facing their own challenges.

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. In 25-27 April 2012, MAIRS and IGAC jointly hosted an international workshop on "Developing Asian Megacities toward a Sustainable World" in Zhangjiajie, Hunan Province of China, collaborating with the Institute of Atmospheric Physics/Chinese Academy of Sciences, Peking University and GLP (Global Land Project) Beijing Node office. The objectives of this workshop were:

- Understanding the current situation and challenges of Asian megacities
- Identifying the fundamental and cross cutting issues about megacities in Asia
- Discussing about the urban governance and future urban planning
- Discussing the future opportunities that have policy relevance

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. This book will contribute to the understanding of the current status of the study of megacities in the Asian region from the aspect of "urbanization and monsoon climate", the audiences of this book will be global change scientists, research organizations, funding agencies and policy makers.

SOLAS-IGAC France joint meeting: Chemistry, Transport and Biogeochemistry Feedbacks: Frontiers in Chemistry, Physics and Biology • Paris, France • 29-30 June 2011

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On 29-30 June 2011, a SOLAS-IGAC joint meeting was held in Paris, France at University Diderot Paris VII under the auspices of INSU (website is: http://www.lisa.u-pec.fr/SOLAS/2011/). Why a joint SOLAS-IGAC meeting? IGAC is dedicated to studying the chemical composition of the atmosphere and its impact on climate and air quality. The research conducted in SOLAS extends from the physical transport in the oceanic and atmospheric boundary layers of matter and energy in ocean, water and air, atmospheric chemistry and photochemistry at the interface of these two systems. The SOLAS program covers the study of biogeochemical cycles in the ocean-atmosphere interface, which includes: emissions and processes of chemical transformation and deposition of gases and aerosols species, characterization of exchange between both oceanic and atmospheric boundary layer reservoirs, study of the flux of CO2 and other gases and their radiative link with climate. These themes feed directly on the issues of atmospheric chemistry in terms of stress sources and sinks of reactive species of short or long life. Improving parameterizations of emission and deposition of halogenated species, sulphur and nitrogen, and aerosols (DMS, marine aerosols, etc.) is a key challenge for both communities to gain more insight in the coupled climate pollution in the Earth system.

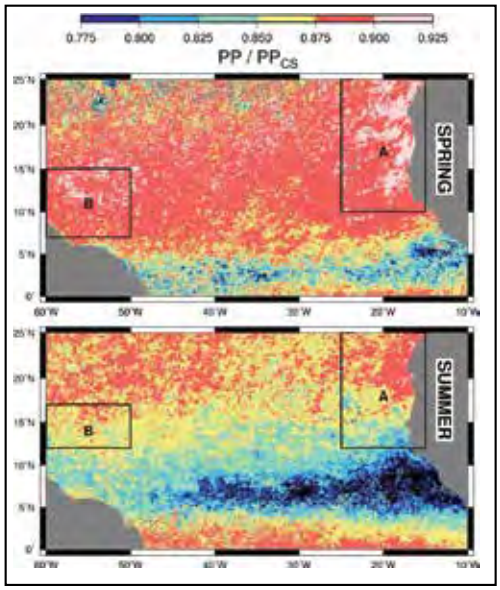

Figure 1. Ten-year average of the ratio PP/PPcs between PP as derived from satellite observations and PP calculated for a clear sky condition (Dust Optical Depth (550 nm) = 0.05). The results are shown for spring and summer season [*Chami et al.*, In Press].

The attendance of the meeting was between 30 and 50 people during the 7 sessions. The first morning was dedicated to informal updates of the SOLAS program and of IGAC Activities and a guest lecture given by Alex Baker from the School of Environmental Sciences University of East Anglia in UK entitled "Climatological estimates of atmospheric nutrient deposition to the Atlantic Ocean - problems and potential". On the afternoon of the first day, the Mid-Term Strategy Topic on "Atmospheric control of nutrient cycling and production in the surface ocean" was covered by a few oral presentations on results from mesocosms studies in the Mediterranean Sea and from dust deposition investigations in the Southern ocean. A new mineralogical database for atmospheric dust was also presented. Then the Mid-Term Strategy topic on "Air -Sea flux in the EBUS and OMZs systems" was tackled by presenting the ongoing Support to Science Element Project from ESA Oceanflux Upwelling Theme. Ongoing SOLAS activities at the French Navy service in Brest were presented for the first time in our community. The following morning was devoted to presentations on aerosols and the presence of biosurfactants on aerosols as an indication of the link between biogenic activity and cloud formation. Then a few presentations related to the Mediterranean French project MERMEX and CHARMEX were presented. In that frame, a presentation was focused on the impact of dust aerosols on the photosynthetically available radiation (PAR) at the sea surface and on the associated oceanic primary production (PP) over the subtropical Atlantic Ocean based on a ten-year time series of satellite observations (Figure 1). Finally anthropogenic carbons changes in the subpolar North Atlantic were presented based on the δ13C analysis. Abstracts, extended abstracts and some full text presentations are available on the SOLAS-France web pages.

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IGBP/IGAC Release Statement on Air Pollution and Climate Change

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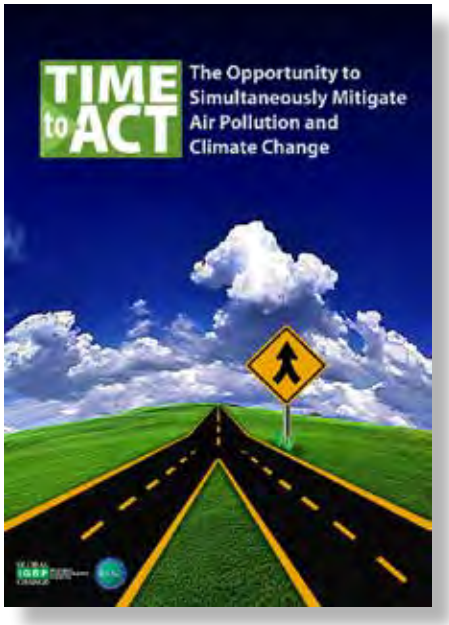
Air pollution is projected to be the world's top environmental cause of premature mortality worldwide by 2050, ahead of dirty water and lack of sanitation. Current climate change mitigation actions will not be enough to prevent the global average temperature from exceeding the internationally agreed goal of 2˚C above pre-industrial levels by 2050. A statement released at the Planet Under Pressure Conference in March 2012 by the International Geosphere-Biosphere Programme (IGBP) and the International Global Atmospheric Chemistry (IGAC) project shows these two issues are inexorably linked and calls for an integrated approach to addressing air pollution and climate change in order to slow the rate of climate change and protect human health, food/water security and ecosystems.

The statement, Time to Act: The Opportunity to Simultaneously Mitigate Air Pollution and Climate Change, builds upon current efforts to address short-lived climate forcers (SLCF) such as the United Nation Environmental Program (UNEP) Integrated Assessment of Black Carbon and Tropospheric Ozone and The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants. However, the statement goes beyond addressing just SLCFs and examines all the linkages between air pollution and climate change, including how reductions of some air pollutants that lead to cooling, such as sulfur



dioxide, will uncover warming from carbon dioxide already emitted and how climate change may render air pollution control management strategies less effective.

Addressing air pollution and climate change together provides a unique opportunity to simultaneously achieve both air quality and climate policy goals in the near-term. Therefore, the IGBP/IGAC statement calls for action to develop a holistic framework to integrate air pollution and climate change solutions into economic development and broader decision processes in various local, national, regional, and global contexts. The integrated framework should be informed by scientific research that cuts across traditional disciplines to develop mitigation strategies adapted to the physical, economical, political and social contexts within a given nation or region. The scientific and economic basis for a coordinated approach to mitigating air pollution and climate change is well established. The time to act is now.

The statement was launched at the IGBP/IGAC Air Pollution & Climate Initiative session entitled "Tackling the Air Pollution and Climate Change Challenge." The session opened with the launch of the IGBP/IGAC Statement. This was followed by panel presentations highlighting key issues related to tackling the air pollution and climate change challenge from science and policy perspectives. A moderator led question and answer session involving the audience and panel concluded the session. The panel included Martin Williams (King College London), Drew Shindell (NASA-GISS), Jan Fuglesvedt (CICERO), Cathy Liousse (Laboratoire d'Aérologie), Tim Wallington (Ford Motor Company), Zia Wahud (Bangladesh University of Engineering and Technology) and Ralf Koppmann (University of Wuppertal). The Air Pollution & Climate Initiative co-chairs, Kathy Law (LATMOS-CNRS) and Paul S. Monks (University of Leicester) chaired the session and Terry Keating (US EPA) moderated the session.

For more information on the IGBP/IGAC Air Pollution & Climate Initiative, visit http://www.igacproject.org/AirPolClim.

IGAC / SPARC Workshop on Global Chemistry-Climate Modeling and Evaluation • Davos, Switzerland • 21-24 May 2012

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Increasingly, the chemistry and dynamics of the stratosphere and troposphere are being studied and modeled as a single entity in global models. As evidence, in support of the upcoming Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5), several groups have performed simulations in the Coupled Model Intercomparison Project Phase 5 (CMIP5) using global models with interactive chemistry spanning the surface through the stratosphere and above. In addition, tropospheric and stratospheric global chemistry-climate models are continuously being challenged by new observations and process analyses. Some recent intercomparison exercises have for example highlighted shortcomings in our understanding and/or modeling of long-term ozone trends and methane lifetime. Furthermore, there is growing interest in the impact of stratospheric ozone changes on tropospheric chemistry via both ozone fluxes (e.g. from the projected strengthening of the Brewer-Dobson circulation) and actinic fluxes. This highlights that there is a need to better coordinate activities focusing on the two domains and to assess scientific questions in the context of the more comprehensive stratosphere-troposphere resolving models with chemistry. To address the issues, the IGBP (International Geosphere Biosphere Programme) and iCACGP's (international Commission on Atmospehric Chemistry and Global Pollution) International Global Atmospheric Chemistry (IGAC) and WCRP's (World Climate Research Programme) Stratospheric Processes And their Role on Climate (SPARC) projects convened a joint workshop to discuss emerging themes in chemistry-climate modeling of the stratosphere and the troposphere and associated process-oriented model evaluation.

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, workshop participants identified science questions relevant to chemistry-climate model evaluation, the specific physical or chemical processes associated with each question, the relevant observations (in-situ, ground-based, aircraft and satellite communities were represented) and the associated model diagnostics. While it is clear that in several cases, scientists lack a full understanding of the main processes, the various working groups specifically identified research topics that met all criteria. In addition, the workshop participants agreed on a new set of community wide simulations to support upcoming ozone and climate assessments and to make progress in process-understanding.

The workshop participants recommended the creation of a joint IGAC / SPARC Chemistry-Climate Model Initiative (CCMI) to coordinate future (and to some extent existing) IGAC and SPARC chemistry-climate model evaluation and associated modeling activities. A white paper summarizing the goals of the CCMI, including a more detailed summary of the workshop, will be published in the IGAC and SPARC newsletters in early 2013.

Paul Young

IGAC Young Scientist Travel Grant Awardee
IGAC/SPARC Global Chemistry-Climate Modeling and Evaluation Workshop
21-24 May 2012
Davos, Switzerland

Where are you from?

I'm from the UK, born in Portsmouth – HQ for the Royal Navy, birthplace of Charles Dickens, and where Boris Johnson, Mayor of London, referred to as "too full of drugs, obesity, underachievement and Labour MPs".

Where did you receive your undergraduate and graduate degrees and in what subjects?

I did my undergraduate degree at the University of Bristol in Chemistry with Environmental Sciences, and worked with Dudley Shallcross on modeling dimethyl sulfide chemistry for my final year project. My PhD was at the University of Cambridge, working with John Pyle, who Dudley had told me was the "Daddy of modeling" in the UK.

Where and what is your current position?

For the next few weeks, I'm a research scientist at the Cooperative Institute for Research in the Environmental Sciences (CIRES) at the University of Colorado-Boulder, although I'm physically based in the NOAA Earth System Research Laboratory, Chemical Sciences Division.

What is your current area of research?

I research the chemical composition of the atmosphere: how it affects air quality and how it interacts with climate. I do this by running global models and using the model output of others, but I even like real world data too.

Was there an event, influential individual or childhood dream that lead you to become a scientist? If not, what led you to pursue a career in science?

I'm always a bit envious of people who knew what they wanted to do since they were young. I really had no idea and flipped between wanting to be a doctor, patent lawyer, actuary, and in business. In the end, I applied to do chemistry as I figured it kept my post-university options pretty open. In the second year of the degree I added the "with environmental science" option, which meant that I would do some biology and geology courses with the chemistry, keeping things a bit broader. At about this time, I started reading James Lovelock and getting into what we now call Earth System Science. I figured this was an excellent field to allow me to work across different traditional subjects. After that, a mixture of good contacts and luck led me to a PhD studying biosphere-atmospheric chemistry interactions, followed by a post-doc with the freedom to work on climate science more broadly. What's kept me here is the privilege of being paid to do something that you find interesting…and that I like being my own boss.

You recently accepted a position at Lancaster University, congratulations! Now that you will be a mentor to young scientists, what is the one thing you hope your students will learn from you about pursuing a career in science?

Thanks! Obviously, I hope that my students and young scientists will learn and execute best practice for their research. Other than that, I would encourage them to make plenty of friends in the field and beyond, and think up their own ideas for collaborations. I think that this is an excellent way to find out what some of the key questions are, as well as helping to point to unknown areas where your

research could be relevant.

What was the highlight of the IGAC/SPARC Chemistry-Climate Modeling and Evaluation Workshop for you?

Without wanting to sound like a contestant on some TV dating program, I do like meeting new people, especially those whose field I may have originally thought was tangential to my own. Some of my best friends are dynamicists!

Your research involves using global chemistry-climate models. What do you think will be the largest advancement in these models in the next 10-15 years?

People sometimes think of using the increasing computer power for modeling in 3 ways: more complexity, higher resolution, greater number of ensembles. Currently, as we build Earth system models (ESMs), we're doing a lot with increasing complexity, and this is obviously great as we get to investigate lots of fun interactions, like climate-chemistry, chemistry-biosphere and troposphere-stratosphere. Adding some kind of interactive "human element", say emissions controls when modeled pollution episodes get too severe, is definitely on the hit list in the next decade I'd say. This would then entrain behavioral scientists, economists, and their ilk, into the ESM community, which would be a Good Thing.

Increasing model resolution is also an unstoppable force, providing opportunities to resolve chemistry/climate processes currently at the sub-grid scale (e.g. megacity emissions, fire plumes). Using greater numbers of ensemble members has not been exploited much in this community, and this will likely change as we try to better explore a fuller range of model uncertainty. Better understanding of multi-model ensembles (Why do model A and model B differ for tropospheric ozone production?) will hopefully be a major outcome of the forthcoming IGAC/SPARC modeling initiatives.

What do you most often find yourself doing for fun when your not busy pushing the limits of the knowledge of mankind?

If policing the behavior of my children (three under 5) counts as fun, then I am often found removing lipstick stains from furniture, chasing toddlers out of the chicken coop, and removing Lego bricks embedded in my foot. However, I do love my family and try to spend as much time as I can with them. Sometimes they let me play the guitar and take them on bike rides, and the kids are a great excuse to go and see some more choice American pursuits, like monster trucks, the demolition derby, and the rodeo. It's not all yoghurt knitting in Boulder County!

15th GEIA Conference • Toulouse, France

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The 15th Conference of the Global Emissions InitiAtive (GEIA), Emissions to Address Science and Policy Needs, took place on 11-13 June 2012 at the Conference Hôtel d'Assezat in Toulouse, France. The conference had more than 80 participants from 25 countries. The organizing committee consisted of Cathy Liousse, Paulette Middleton, Claire Granier, Leonor Tarrasón, and Greg Frost. The Conference was sponsored by IGAC, iLEAPS, CNRS, CNES, and the ACCENT-Plus and MACC-2 EU projects.

The GEIA Conference demonstrated that the world's scientific emissions community has matured from accounting for emissions to carrying out science to understand emissions. The GEIA community has also evolved, from providing input to atmospheric science to providing emissions estimates to understand air pollution and climate change and support the development of environmental policies.

The Conference's scientific presentations highlighted current and emerging emissions research. More than 90 oral and poster presentations were organized into 5 themes:

- Evaluation and improvement of energy sector emissions
- Evaluation and improvement of traffic sector emissions
- Evaluation and improvement of fire and natural emissions
- Creating community-driven interoperable emissions databases
- Impacts and implications of improved emissions estimates

The Conference's full program and presentations are available at www.geiacenter.org.

The Conference included a Town Hall discussion of current capabilities and future priorities for emission information and communication. Small groups of Conference participants met in half-hour blocks to discuss three topics:

1. Emission Information for the Assessment of Air Quality & Climate
2. Emission Information for Control Measures and Planning
3. Improving Community Connections for Emissions

These open discussions were guided by three questions:

4. What are the main limitations in present emission information or communication methods?
5. What are the main innovation methods that can be used to overcome such limitations?
6. What are emerging priorities for improving emissions research or communication/interoperability?

The Conference's presentations and discussions identified emerging directions for emissions research and offered some recommendations for future GEIA activities:

1. Science:

- There is a strong need for emissions measurements and monitoring in emerging countries in Africa, Asia, and Latin America. Links between science and society in these regions are critical to understanding emission differences with the developed world.
- The global and regional emissions community is integrating existing emissions data sets and information, expanding its use of downscaling techniques, increasing the flexibility of inventories, and providing better inventory consistency checks.
- At the same time, the focus on emissions process understanding is evolving and new emission model developments involve improved descriptions of land use, planetary bound-

Figure 1. 15th GEIA Conference venue - Conference Hôtel d'Assezat, Toulouse, France

ary layer processes, convection processes, and a more accurate description of sub-grid processes.

- Innovative methodologies are currently used to improve emissions understanding. These include integrated methods that combine multiple models with observations and make use of data assimilation and inverse modeling techniques; multispecies analysis; dynamic emission factors; new ground-based and remote-sensing optical observations; and observations based on eddy covariance flux methods.
- Scientific approaches are quantifying emissions trends and changes over a variety of spatial and temporal scales.

2. Advice:

- GEIA can facilitate linkages between the scientific and regulatory emission communities.
- Priority issues that deserve increased regulatory attention include: speciated measurements of organic compounds from anthropogenic and biogenic sources; quantification of fugitive emissions from the energy sector.
- GEIA can assist regulatory agencies with scientific guidance on emissions, preferably in coordination with other international scientific efforts.

3. Communication:

- GEIA can help increase the interoperability of emission information databases, to enable objective evaluations of inventories.
- GEIA can join with other community efforts to push for common data access.
- GEIA can identify additional community tools for emission data validation and evaluation.
- GEIA can help the community develop air quality metadata descriptions to facilitate information exchange between models, observations and emissions.

A roadmap of GEIA priorities over the next 5 years will be described in an upcoming New Directions column in Atmospheric Environment.

The 16th GEIA Conference is planned for mid-2014 in Boulder, Colorado, USA.

Figure 2. 15th GEIA Conference participants

IGAC/iLEAPS/WMO Workshop on Biomass Burning • Geneva, Switzerland • 5-6 July 2012

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A workshop was held by the International Global Atmospheric Chemistry Project (IGAC), the Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS) and the World Meteorological Organization (WMO), with the aim of discussing the formation of an international and interdisciplinary activity on biomass burning. This initiative would coordinate and facilitate research on all aspects of biomass burning, in order to better quantify the impact of biomass burning on atmospheric chemistry and climate. The workshop took place on 5-6 July 2012 at the WMO Headquarters in Geneva, Switzerland. The workshop gathered 20 participants from 11 countries, representing different topics linked with the impact of fires on the Earth system.

During their past conferences and steering committees meetings, IGAC and iLEAPS recognized that a lot of progress has been made on the study of fires during the past years, which have emphasized the importance of biomass burning on atmospheric chemistry and climate. These discussions have shown that an international and interdisciplinary collaboration would greatly improve the understanding and quantification of the many different aspects of biomass burning.

The workshop opened with a brief summary of past and current activities related to fires within IGAC, iLEAPS and WMO. This was followed by reviews of activities in various regions, including South America, Europe, Australia and Russia. From these presentations, topics for break-out sessions were identified.

Small groups of workshop participants met in two forty-five minutes blocks to discuss the topics related to (1) Emission models, emission factors and plume models, forecasting of fires, (2) the use of satellite and surface observations for characterizing fires, (3) the evaluation of fire products, and of their uncertainties, (4) the main limitations in present emission information or communication methods, (5) Historical and future fires, (6) Fires and Land use and (7) Fires and air quality and Health.

The workshop's presentations and discussions emphasized the fact that fires are an integral part of the Earth System and all its components: atmospheric and radiation impacts, as well as socio-economical and ecological impacts that needs 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.

Air Quality Model Evaluation International Initiative (AQMEII) • Utrecht, The Netherlands • 8 May 2012

Stefano Galmarini1, Christian Hogrefe[2], and S. Trivikrama Rao[2]
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The 4th workshop of the Air Quality Model Evaluation International Initiative (AQMEII) was held on May 8 in Utrecht, The Netherlands, in conjunction with the NATO/SPS International Technical Meeting on Air Pollution Modeling and Its Application. AQMEII was launched in 2009 as a long-term forum to monitor and improve the state-of-the-science in regional-scale air-quality models and model evaluation methodologies [Rao et al., 2011]. AQMEII functions through the organization of periodic conference calls, workshops, and coordination of joint modeling activities to facilitate model evaluation and model inter-comparisons. In its first phase, AQMEII organized annual model simulations for 2006 over both Europe and North America using specified input datasets and used the outputs from these simulations to conduct a number of model evaluation analyses. A total of 22 modeling groups from 13 countries participated in the Phase 1 activity.

The May 8th workshop, which was attended by roughly 30 scientists from Europe and North America, opened with several presentations summarizing the AQMEII Phase 1 results and providing an overview of ongoing AQMEII Phase 1 analyses. Fifteen papers resulting from the Phase 1 activity were published in the AQMEII special issue of Atmospheric Environment in June 2012. Workshop participants were also reminded that there is an open invitation to the scientific community to utilize the large 4-D database of observations and model outputs generated during AQMEII Phase 1 for developing innovative model evaluation techniques and for improving the science in regional-scale air quality models [*Galmarini and Rao*, 2011].

The workshop then turned towards presentations and discussions of Phase 2 of AQMEII which is targeted towards European and North American modeling groups that use on-line or coupled meteorology-air quality models and that wish to evaluate and inter-compare their model results based on a common modeling platform [see Alapaty et al., 2012]. The goal of this activity is to assess how well the current generation of coupled regional-scale air quality models can simulate the observed spatio-temporal variability in the optical and radiative characteristics of atmospheric aerosols and associated feedbacks among aerosols, radiation, clouds, and precipitation. Following these presentations and discussions, the workshop participants agreed upon the following timeline for the AQMEII Phase 2 activity:

- Summer/Fall 2012: Emissions and chemical boundary conditions will be provided to participating modeling groups.
- Fall/Winter 2012/2013: Participating groups perform air quality model simulations.
- Winter/Spring 2012/2013: Participating groups begin data delivery to the Joint Research Centre ENSEMBLE system.
- Spring/Summer 2013: Collective data analysis of model results at the Joint Research Centre and by modeling groups.
- August 25, 2013: 5th AQMEII workshop in conjunction with the 33rd NATO/SPS International Technical Meeting on Air Pollution Modeling and Its Application in Miami to review Phase 2 results and identify potential publications in the peer-reviewed literature.

Further information on this activity can be found on the AQMEII website at http://aqmeii.jrc.ec.europa.eu/.

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

September

GEO AQ CoP Workshop
Metadata for Atmospheric Composition and Air Quality
5-7 September 2012 · Dublin, Ireland
http://wiki.esipfed.org/index.php/Air_Quality_Metadata_Workshop_Dublin_2012

IGAC SSC Meeting
15-16 September 2012 · Beijing, China

IGAC Open Science Conference
Atmospheric Chemistry in the Anthropocene
17-21 September 2012 · Beijing, China
www.igac2012.org

Third International Conference on Earth System Modelling
17-21 September 2012 · Hamburg, Germany
http://www.meetings.copernicus.org/3icesm/

October 2012

A U.S.-Japan Workshop on the Tropical Tropopause Layer: State of Current Science and Future Observational Needs
15-19 October 2012 · Honolulu, Hawaii USA
http://physics.valpo.edu/ttlworkshop/

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November

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

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

December

AGU Fall Meeting
3-7 December 2012 · San Francisco, CA USA
Fallmeeting.agu.org/2012/

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

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

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

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3. Atmospheric Chemistry and Climate
Greenhouse gases, stratospheric ozone, aerosols, clouds, precipitation, their interactions and feedback effects in the climate system, potential interactions of air pollution control and climate, and prospective on Earth's future.
4. Atmospheric Chemistry and Health
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5. Atmospheric Chemistry and Surface-Atmosphere Exchange
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6. Atmospheric Chemistry Fundamentals
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