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IGACnews

facilitating atmospheric chemistry research towards a sustainable world

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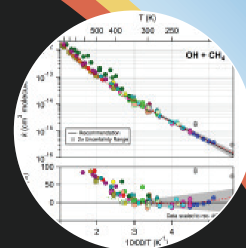
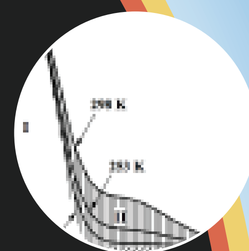
june/july 2016

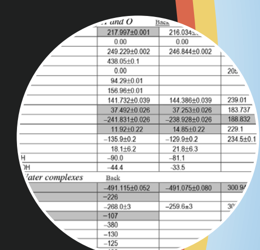
Gas-Phase Kinetics



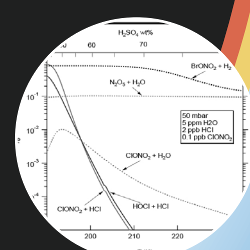
Photochemistry



Thermochemical Properties



Heterogeneous and Multiphase Processes



NASA Data Evaluation

Chemical Kinetics and Photochemical Data for Use in Atmospheric Studies: Evaluation Number 18

see page 16

» INSIDE

SPARTAN An Emerging Global Particulate Matter Network

» EARLY CAREER PROFILE

Audrey Gaudel on what motivated her to become a scientist

contents

departments

igac event summaries

igac activity updates

early career scientist profile

science feature

open submissions

On the Cover

The NASA chemical data evaluation for atmospheric studies was recently updated.

Data images: JPL Publication 15-10, Oct. 2015.

Editor: Megan L. Melamed
Newsletter Design: Allison Gray

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

editor's note

A Tree Is Only As Strong As Its Roots

Former IGAC Co-Chair Paul Monks refers often to the statement "A tree is only as strong as its roots." This metaphor applies to IGAC in two ways: (1) IGAC's commitment to fundamental scientific research and (2) IGAC's commitment to fostering community.

In an era where the focus seems to be on applied research, research for solutions, interdisciplinary research, transdisciplinary research, etc., the importance of fundamental research can appear to be lost. However, the value of the aforementioned types of research is only as strong as its roots, or the fundamental science, that supports them. This is why in 2013 IGAC made a special effort to focus on **Fundamentals of Atmospheric Chemistry**. IGAC wanted to highlight the importance of strengthening the roots of atmospheric chemistry research so that the tree trunk of applied research and the branches of inter- and transdisciplinary research are supported by a strong root system. In light of this, IGAC is pleased to reprint the introduction to the newly released evaluation on *Chemical Kinetics and Photochemical Data for Use in Atmospheric Studies* (see pg. 16). The work done by the scientists to provide an updated evaluation significantly contributes to atmospheric chemistry research. Without these important fundamental data sets, the roots of the atmospheric chemistry research tree would be weakened. IGAC continues to focus and strengthen the roots of fundamental atmospheric chemistry research, e.g., IGAC just released a call for proposals for workshops on fundamental atmospheric chemistry research (see call for proposal **here**).

I speak often and admiringly about the IGAC community because you are the strong roots that makes IGAC a great organization. The IGAC community is comprised of thousands of people from around the world who want to be involved in advancing research on topics related to atmospheric chemistry through international collaborations. The breadth of involvement of each IGAC community member varies. Whether you are someone like Owen Cooper leading an IGAC activity and writing multiple workshop summaries for IGACnews (see pg.5 and pg. 11), or an Early Career Scientist like Audrey Gaudel contributing to an IGAC activity (see pg. 15), or Candice Lung who continues to be an ambassador for IGAC and its science after her term on the scientific steering committee has ended (see pg. 20), or just read IGACnews to be informed about what IGAC is up to, YOU help to form the strong roots of the IGAC community. Without these roots, IGAC would not be the great organization it is. I am truly grateful to the IGAC community. I am looking forward to the upcoming 14th biennial IGAC Science Conferences in Breckenridge, CO, USA 26-30 September 2016 (**igac2016.org**) as it is my opportunity to thank many community members in person for taking the time to make IGAC a successful organization.

I hope to see you in September in Breckenridge, CO, USA!

Happy reading!

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

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

2016 IGAC Science Conference – Register TODAY!!!

IGAC Breckenridge 2016

26-30 September 2016

The 2016 IGAC Science Conference is a high profile event that will attract approximately 600 top international scientists, industry leaders, policy makers and early career scientists from around the world. The scientific program includes six exciting sessions on atmospheric chemistry and urbanization, agriculture and ecosystems, energy, fundamental studies, climate change, and observing composition and variability. Please visit **igac2016.org** for more information.

Location of the 2018 Joint 14th Quadrennial iCACGP Symposium/ 15th IGAC Science Conference

14th iCACGP 15th IGAC TAKAMATSU KAGAWA JAPAN 2018

The bid winner for the joint 14th Quadrennial iCACGP Symposium/15th IGAC Science Conference 2018 is the Local Organizing Committee (LOC), Chaired by Hiroshi Tanimoto, from Takamatsu, Kagawa, Japan! We look forward to seeing you all in 2018 in Japan! Read the official announcement **here**.

Recent IGAC Publications

PACES air Pollution in the Arctic: Climate Environment and Societies

Arctic Air Pollution: Challenges and Opportunities for the Next Decade. (2016). Arnold S, Law K, Brock C, Thomas J, Starkweather S, et al. *Elementa Science for the Anthropocene*, doi: 10.12952/journal.elementa.000104.

Mexico City Hosts a Course on Remote Sensing for Latin Americans. (2016) Grutter, M., J. C. Antuña-Marrero, and C. Rudamas. *Eos, 97, doi:10.1029/2016EO051059*.

AMERICAS WORKING GROUP

Fostering a Collaborative Atmospheric Chemistry Research Community in the Latin America and Caribbean Region. (2016) Marcos Andrade-Flores, Nestor Rojas, Megan L. Melamed, Olga L. Mayol-Bracero, Michel Grutter, Laura Dawidowski, Juan Carlos Antuña-Marrero, Carlos Rudamas, Laura Gallardo, Ruben Mamani-Paco, Maria de Fatima Andrade, and Nicolas Huneeus. *Bull. Amer. Math. Soc.*

What We Breathe Impacts Our Health: Improving Understanding of the Link between Air Pollution and Health. (2016). J. Jason West, Aaron Cohen, Frank Dentener, et al. Environ. Sci. Technol., 50, 10, doi: 10.1021/acs.est.5b03827.

Atmospheric Chemistry and Health · AC&H ·

Submit articles to the next IGAC News

IGAC is now accepting article submissions for the next IGACnews. Workshop Summaries, Science Features, Activity News, and Editorials are all acceptable and desired. Science Features should have an approximate length of 1500 words with 1-2 images. All other submissions should be approximately 500 words and have 1-2 images. Please provide high-resolution image files. The deadline for submissions for the Oct/Nov issue of the IGACnews is 14 October 2016. Send all submissions to **info@igacproject.org**.

25-27 JANUARY 2016
BEIJING, CHINA

IGAC Sponsored

AUTHOR
Owen Cooper, CIRES, University of Colorado and NOAA/ESRL/CSD, Boulder, CO, USA

HOST INSTITUTIONS AND FUNDING

FUNDING

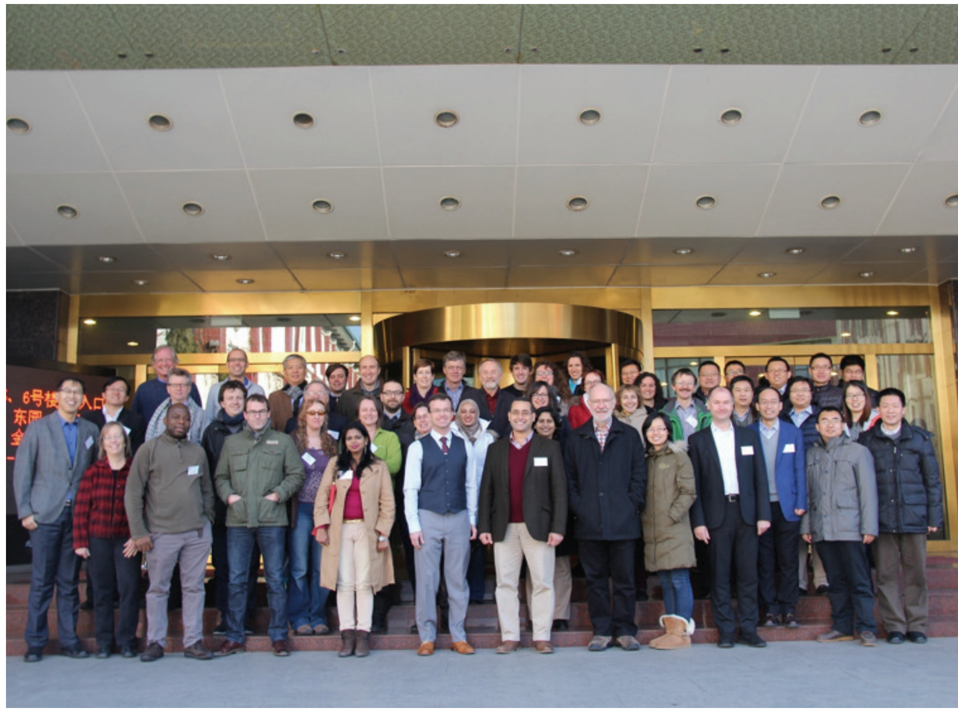
PARTICIPANTS
Australia, Canada, China, France, Germany, India, South Africa, Switzerland, United Kingdom, United States

BACKGROUND

TOAR tropospheric ozone assessment report

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

Third TOAR Workshop



Workshop Participants

T*ropospheric Ozone Assessment Report (TOAR): Global metrics for climate change, human health and crop/ecosystem research*, is one of IGAC's newest Activities, with a mission to provide the research community with an up-to-date scientific assessment of tropospheric ozone's global distribution and trends from the surface to the tropopause. In fulfilling this mission, TOAR has two primary goals: 1) Produce the first tropospheric ozone assessment report based on the peer-reviewed literature and new analyses. 2) Generate easily accessible, documented ozone exposure and dose metrics at hundreds of measurement sites around the world (urban and non-urban), freely accessible for research on the global-scale impact of ozone on climate, human health and crop/ecosystem productivity.

OAR Workshop 1.03 (third workshop of the first TOAR initiative) was held at the Xijiao Hotel in Beijing, China, January 25-27, 2016. The workshop was funded by the Research Center for Eco-Environmental Sciences (RCEES) at the Chinese Academy of Sciences, Nanjing University, NOAA ESRL's Chemical Sciences Division, IGAC and the World Meteorological Organization. The workshop was coordinated by Zhaozhong Feng (RCEES) and Aijun Ding, Nanjing University, and Owen Cooper and Christine Ennis of the University of Colorado/NOAA ESRL, Boulder, and was attended by 45 scientists from 10 countries in East Asia, North America, Europe, South Asia, Africa and Australia.

Xijiao Hotel – Workshop Location

The workshop had five primary goals:

1. Review the first draft of the seven chapters comprising the assessment report.
2. Produce revised outlines of each chapter for the second-draft review scheduled for September 2016.
3. Update the TOAR community on the status of the TOAR database and identify new and missing datasets, to be uploaded to the database by April 30, 2016.
4. Initiate the detailed planning of the TOAR surface ozone data analysis to inform Chapters 4, 5, and 6.
5. Provide an opportunity to the TOAR community to learn about ozone-related research in China through a short symposium of leading Chinese scientists.

The workshop delivered on all of its goals and the workshop summary, along with the detailed assessment report outline, can be downloaded from **igacproject.org/TOAR**. Excellent progress was made on the design and scope of the TOAR database, designed by Martin Schultz and hosted by Forschungszentrum Jülich, Germany. The database is the largest collection of ozone metrics ever achieved, with data from over 8000 sites worldwide.

The workshop also hosted a short symposium on the second morning, which featured presentations by ten leading Chinese scientists who shared their latest findings on tropospheric ozone research within China. The talks presented new ozone data sets from urban and rural sites across the country, many of which are now long enough for assessing the existence of surface ozone trends. The talks also addressed ozone photochemical formation within China and demonstrated that the ozone distributions across the country are changing with shifting emissions, as is ozone production efficiency. Since the workshop many of these unique datasets have been uploaded to the TOAR database.

SEE
Audrey Gaudel
Early Career Scientist Profile
on p. 15

The next steps for TOAR are to finalize the database during the summer of 2016 and produce ozone metrics at thousands of surface monitoring sites around the world. These metrics will be analyzed for the report and will reveal the regions of the world where ozone pollution reaches levels that harm human health and crop/ecosystem productivity. The 8 chapters of the report are scheduled for submission to a peer-reviewed journal by December, 2016.

14 MARCH 2016
FAIRBANKS, ALASKA, USA

IGAC Sponsored

Arctic Air Pollution and Societies Workshop

Ice-carved polar bear at display in front of the workshop building

AUTHORS

Julia Schmale, Paul Scherrer Institute, Switzerland

Sandy Starkweather, NOAA, USA

Kathy Law, Latmos CNRS, France

Steve Arnold, University of Leeds, UK

HOST INSTITUTIONS

UNIVERSITY OF ALASKA FAIRBANKS

2016 ARCTIC SCIENCE SUMMIT WEEK

FUNDING

IASC

PARTICIPANTS

USA, UK, France, Switzerland, Denmark, Iceland, Russia, Germany, Italy, Greenland, Finland, Portugal, China, Canada, Sweden

BACKGROUND

PACES air Pollution in the Arctic: Climate Environment and Societies

IGAC provided financial support to a workshop under the jointly sponsored IGAC/IASC PACES activity, which aims to build strong interdisciplinary and international collaborations to coordinate research efforts on Arctic air pollution. This particular workshop was aimed at highlighting the social science perspectives related to Arctic air pollution and exploring ways that the social and natural sciences could collaborate on mutual interests.

At Arctic Science Summit Week (ASSW) 2016 in Fairbanks, Alaska, the IASC and IGAC co-sponsored initiative "air Pollution in the Arctic: Climate, Environment and Societies" brought together researchers active in the physical/chemical science of air pollution with those active in relevant social science and humanities topics. The primary purpose of the workshop was to facilitate a structured dialogue between these diverse scientific perspectives in order to map joint research interests that could lead to working group of interdisciplinary research under PACES. About 30 people with a large variety of scientific backgrounds attended the workshop.

To start discussion, presentations from a variety of scientific disciplines were given to provide a common knowledge ground for further discussion. Contributions came from various research fields and covered a range of topics including: specificities of Arctic air pollution, modeling and monitoring approaches (atmospheric sciences); concerns of North Slope communities in Alaska and responses (Cultural anthropology); a methodological perspective on working with communities (Economic ecology/anthropology); the specific interdisciplinary research needs of an emerging national air pollution "service" in Russia; environmental law in the Arctic (law); options for societal engagement within community based monitoring; health and well-being (Medicine).

Both presentations and the open discussion revealed the diversity of contexts through which air pollution can be studied and suggested ways in which linking these contexts is essential to broadening understanding and developing science that is of greater service to society. Air pollution is inextricably linked to local activities, which are changing with Arctic development and community response to these developments. Examples of emissions from natural resource extraction facilities were discussed, as well as those from infrastructure building and other large-scale activities (e.g. airport development). It was noted that locally produced air pollution, in combination with stagnant weather conditions and inversion layers can lead to significant localized build-up of concern to communities. By contrast long-range transported air pollution is a current focus of the climate science community, which might have less visible impacts on Arctic residents. In the discussions is became clear that the nature and extent of local emission sources is not well characterized yet and that this can be one topic to be explored within PACES.

Many talks highlighted the contested nature of topics like air pollution in communities and the need for information that is viewed as credible and legitimate. In considering how various actors in the Arctic observe, monitor and inform each other about air pollution, the issue of trust emerged as an important consideration and subject of study in particular for cultural anthropologists. One example concerned air quality monitoring equipment, which is deployed by Arctic industry. This data, though made available to residents, is rarely accepted by the local population due to a lack of trust between residents and industry. By engaging local communities in monitoring (e.g. by deploying small and inexpensive devices), trust in the data can be earned as residents would collect data themselves. Experience with such activities already exists and best practices with regards to appropriate community involvement can be adopted.

In addition to the need for credible and legitimate information, institutional and legal capacity for response to Arctic air pollution was also explored. An overview of legal and regulatory mechanisms that have been successful with other emissions (e.g. CFC's) revealed that the legal frameworks and institutions take time to develop and the organization of scientific information should informed by these capacities. These issues were identified as areas in which PACES could become active.

In considering how various actors in the Arctic observe, monitor and inform each other about air pollution, the issue of trust emerged as an important consideration and subject of study in particular for cultural anthropologists.

Furthermore, the close linkage of air pollution to human well-being was discussed. For example, air pollutants are absorbed by lichens that are eaten by animals which in turn serve as food for local communities. Air pollutants hence enter the food web quickly. To further explore the nexi between emissions, ecosystems and human well-being an interdisciplinary approach combining social and natural sciences will be needed. Local communities hold much of the relevant knowledge that atmospheric scientists would not be able to access otherwise. One of the bottom lines in this respect was that a contribution to clean air within the larger sustainable development context in the Arctic can only be achieved when developing more holistic, i.e. systemic, knowledge of causes and effects. This logically requires interdisciplinary research approaches that include community knowledge as well. IGAC

IGAC ON SOCIAL MEDIA

IGAC is on LinkedIn, Twitter and Facebook in an effort to further advance international scientific cooperation and serve as a resource to the public, especially you. Please join us to stay apprised of the most current news on conferences, workshops and publications. Let us hear from you on how to improve the international conversation, **@IGACProject**.

6-8 APRIL, 2016
LONDON, UK

IGAC Endorsed

AUTHOR

Roy M. Harrison,
University of Birmingham, UK

HOST INSTITUTION AND FUNDING

ROYAL SOCIETY OF CHEMISTRY

PARTICIPANTS

Australia, Austria, Azerbaijan, Belgium, Botswana, Brazil, China, Finland, France, Germany, Greece, Hungary, India, Ireland, Italy, Netherlands, Nigeria, Singapore, Spain, Sweden, Switzerland, United Kingdom, United States.

BACKGROUND

IGAC endorsed the Chemistry in the Urban Atmosphere – Faraday Discussion to support its efforts to facilitate research on air quality and human health. The urban atmosphere plays a key role in understanding the connection between air pollutants and human exposure to them.

Chemistry in the Urban Atmosphere – Faraday Discussion

The audience during a discussion session

There are many sound reasons to study the chemical reactions, composition and dynamics of the urban atmosphere, yet it is a neglected topic in comparison to regional and global atmosphere studies. The most important drivers include:

(a) Most of the world's population lives in cities, and it is within those cities that people receive the majority of their air pollutant exposure.

(b) The chemical and dynamical complexity of the urban atmosphere far exceeds that of regional and global atmospheres. Urban areas contain major pollution sources which create strong concentration gradients. Urban air circulations are much affected by the buildings and terrain, and hence air movements are less easily predicted than in more uniform environments.

These considerations motivate studies of the urban atmosphere, with the ultimate aims of predicting composition in three dimensions and with high spatial and temporal resolution, facilitating prediction of human exposure.

This was the 275th Faraday Discussion Meeting under the auspices of the Royal Society of Chemistry, the ninth such meeting to focus

Burlington House, Piccadilly, London. Home to the Royal Academy of Arts and the Royal Society of Chemistry.

on atmospheric chemistry and/or air pollution, but the first with a specific focus upon the urban atmosphere. Faraday Discussion Meetings have a unique format, with papers circulated in advance, allowing only 5 minutes for presentation, and an extended discussion of groups of papers with close to 30 minutes allocated per paper. The programme, other than the opening and closing addresses was divided into four themes:

1. Chemical Complexity of the Urban Atmosphere and its Consequences;
2. Timescales of Mixing and of Chemistry;
3. Urban Case Studies; and
4. Numerical Modelling Strategies for the Urban Atmosphere.

The meeting was fully booked, with almost 200 participants, limited by the size of the room. In addition to 27 oral presentations, there were 71 posters in a programme over three days which included two well-attended poster sessions with wine, and a conference dinner, held at the Royal Society. At the dinner, the Introductory Speaker, Professor Urs Baltensperger of the Paul Scherrer Institute, Switzerland was presented with the Spiers Memorial Award, given annually in recognition of an individual's outstanding contribution to the field of a Faraday Discussion. Other invited speakers who contributed to this lively meeting were Neil Donahue (USA), Alastair Lewis (UK), William Brune (USA), Spyros Pandis (USA/Greece), Sasha Madronich (USA), Alison Tomlin, (UK) and Jose-Luis Jimenez (USA), who gave the closing remarks lecture.

The level of interest in this meeting, the quality of the papers and the vigour of the discussion left the participants with an overwhelming impression of the importance, dynamism and distinctive character of the field of urban atmospheric chemistry. There was also a huge amount of policy-relevant science, with contributions from the floor from members of major government agencies. The papers and a record of the discussion will be published by the Royal Society of Chemistry as a volume in its well-cited Faraday Discussion publications series.

25-28 APRIL 2016
FORSCHUNGSZENTRUM JÜLICH, GERMANY

IGAC Sponsored

AUTHORS

Owen Cooper, CIRES, University of Colorado and NOAA/ESRL/CSD, Boulder, CO, USA

HOST INSTITUTION AND FUNDING

JÜLICH FORSCHUNGSZENTRUM

FUNDING

PARTICIPANTS

Germany, United Kingdom, United States, Sweden, Norway.

BACKGROUND

TOAR tropospheric ozone assessment report

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

Fourth TOAR Workshop

Workshop Participants

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

TOAR Workshop 1.04 (fourth workshop of the first TOAR initiative) was held at Forschungszentrum Jülich, Germany, April 25-28, 2016 and was hosted by Dr. Martin Schultz and the Institute of Energy and Climate Research: Troposphere (IEK-8). The goal of the workshop was to begin the analysis of the TOAR database and was attended by ten scientists representing five nations in Europe and North America.

Workshop Location

The TOAR database (**https://join.fz-juelich.de**), designed and built by Dr. Martin Schultz's team at Forschungszentrum Jülich, is the world's largest collection of ozone exposure and dose metrics; at the time of the workshop the database listed 9497 ozone time series at 9489 stations worldwide. The data were provided by dozens of scientists around the world representing air quality monitoring networks and long-term scientific research stations. Most of the data are from air quality monitoring networks in the USA, EU, Canada, Japan and South Korea but significant contributions from multiple stations were also made by China, Israel, Australia, New Zealand, South Africa, Brazil, Chile, Iran and Mexico. Ozone observations from many remote locations were made available by the World Meteorological Organization's Global Atmosphere Watch program. Through an interactive web interface any member of TOAR can select a monitoring site and download ozone metrics, such as the daily maximum 8-hour average ozone value or mean, median, 95th percentile etc., for a variety of time periods: daily, monthly, seasonal, annual. The user can then apply the ozone metrics to his or her research. Importantly the ozone metrics at all stations are calculated using the same consistent methodology to allow direct comparison between sites, no matter their network of origin. Once the TOAR initiative is completed in 2017 the database will be opened to the public so that any scientist or member of the public can download the ozone metrics of their choosing.

During the workshop participants wrote python code for generating output files containing annual and seasonal ozone metrics for every site in the database. These output files will then be made available to the TOAR community so that the data can be analyzed and published in the assessment report, scheduled for publication in 2017. Importantly, participants also worked with a series of high-resolution, gridded global data sets to generate consistent site characteristics and classifications. For example, datasets such as NOAA's nighttime lights of the world (1 km global resolution), OMI tropospheric column NO_2 (10 km resolution) and global population density (5 km resolution) were used to classify sites as rural or urban. The database also contains information on land use, climatic zone and anthropogenic NOx emissions at the location of each monitoring site.

The next step for TOAR is to complete the Big Data analysis of the ozone metrics in the TOAR database during summer 2016. This analysis will form the backbone of the assessment report and will reveal the regions of the world where ozone pollution reaches levels that harm human health and crop/ecosystem productivity. The 8 chapters of the report are scheduled for submission to a peer-reviewed journal by December, 2016.

AUTHORS

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Yinon Rudich, Weismann Institute, Israel

FUNDING

NSERC CRSNG

BACKGROUND

SPARTAN Global Particulate Matter Network

IGAC recently endorsed the Surface PARTiculate mAtter Network (SPARTAN). IGAC believes SPARTAN is providing an important contribution to research on air quality and human health by investigating the long-term relationship between columnar aerosol optical depth (AOD) from satellites and ground-level "dry" $PM_{2.5}$ composition to better understand the uncertainties and limitations of using satellite observations for global health applications.

SPARTAN: An Emerging Global Particulate Matter Network

Fine particulate matter ($PM_{2.5}$) is a robust indicator of mortality and other adverse health effects associated with ambient air pollution. Research on long-term exposure to ambient $PM_{2.5}$ has documented serious adverse health effects, including increased mortality from chronic cardiovascular disease, respiratory disease, and lung cancer. The Global Burden of Disease 2013 estimated that outdoor $PM_{2.5}$ caused 3 million deaths (3.0% of all deaths) and 70 million years of lost healthy life on a global scale in the year 2013. Given the implications and uncertainties of this estimate, additional attention is needed to improve global estimates of $PM_{2.5}$ exposure.

Research on long-term exposure to ambient $PM_{2.5}$ has documented serious adverse health effects, including increased mortality from chronic cardiovascular disease, respiratory disease, and lung cancer. The Global Burden of Disease 2013 estimated that outdoor $PM_{2.5}$ caused 3 million deaths (3.0% of all deaths) and 70 million years of lost healthy life on a global scale in the year 2013.

Satellite remote sensing of ground-level particulate matter, when combined with aerosol vertical profiles from chemical transport models, has emerged as a promising solution to this need. This hybridized detection method is being increasingly applied in epidemiologic research and risk assessment. However remote sensing requires additional evaluation to support its widespread use for health-related applications on a global scale. There are outstanding questions about the accuracy and precision with which ground-level long-term $PM_{2.5}$ mass concentrations can be inferred from discontinuous AOD observations. Measurements of ground-level $PM_{2.5}$ collocated with AOD measurements in diverse settings with different PM sources are needed to evaluate model calculations of $PM_{2.5}$/AOD ratios and, in turn, improve estimates of surface $PM_{2.5}$ from satellite AOD retrievals. Composition information is also needed, to link $PM_{2.5}$ composition to health outcomes and to improve source attribution to support mitigation policies. Particulate matter composition is also useful for understanding aerosol formation processes. To our knowledge, prior to SPARTAN, only two sites worldwide routinely measured and made publicly available collocated measurements of AOD, $PM_{2.5}$ mass and composition.

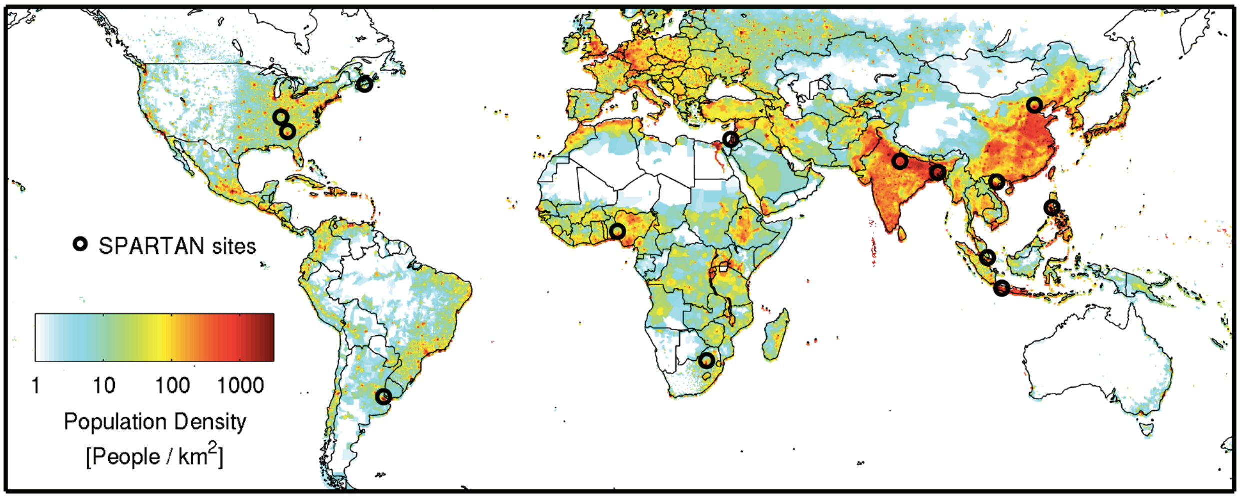

FIGURE 1 **SPARTAN measurement sites superimposed on global population density for 2010. Sites in North America are for testing purposes**

SPARTAN filters are analyzed for mass, black carbon, water-soluble ions, and metals. These measurements provide… the key data required to evaluate and enhance satellite-based PM2.5 estimates used for assessing the health effects of aerosols.

We have initiated a global network of ground-level monitoring stations designed to evaluate and enhance satellite remote sensing estimates for application in health effects research and risk assessment. This Surface PARTiculate mAtter Network (SPARTAN; Snider et al., 2015; 2016) includes a global federation of ground-level PM2.5 monitors situated primarily in highly populated regions and collocated with existing ground-based sun photometers that measure AOD. The instruments, a three-wavelength nephelometer and impaction filter sampler for both PM2.5 and PM10, are highly autonomous. Hourly PM2.5 concentrations are inferred from the combination of weighed filters and nephelometer data. SPARTAN filters are analyzed for mass, black carbon, water-soluble ions, and metals. These measurements provide, in a variety of regions around the world, the key data required to evaluate and enhance satellite-based PM2.5 estimates used for assessing the health effects of aerosols. SPARTAN data are being made publicly available along with instrument protocols at **spartan-network.org**.

Figure 1 shows SPARTAN sites to date spanning regions with low (e.g. Manila and Halifax) to high (e.g. Beijing and Kanpur) PM2.5. Locations include regions impacted by biomass burning (e.g. West Africa, South America), biofuel use (e.g. South Asia), monsoonal conditions (e.g. West Africa, Southeast Asia) and mineral dust (e.g. West Africa, Middle East). The sites of Halifax, Atlanta, and Mammoth Cave are included for instrument inter-comparison purposes. The network continues to grow. We welcome expressions of interest to join this grass-roots network.

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early career scientist profile

Audrey Gaudel

Audrey Gaudel is a research scientist at the Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado and is based at the Chemical Sciences Division of NOAA ESRL. Audrey was born and grew up in Paris, France and received her Bachelor's, Master's and Doctorate degrees from Universite Pierre et Marie Curie in Paris, France. Her PhD was on the "Inter-annual variability of 20 years of tropospheric ozone concentrations measured by lidar and electrochemical sondes at the Observatoire de Haute Provence (OHP)". Currently, Audrey's area of research is the assessment of the global tropospheric ozone burden using different types of instruments such as aircraft, ozonesondes, lidar, umkehr, FTIR, and satellite data. The results of this research will be part of the Tropospheric Ozone Assessment Report (TOAR).

Audrey Gaudel attended the Third TOAR Workshop and is an author on the assessment report.

TOAR
tropospheric ozone assessment report

What has been the most exciting part about being involved in a large international assessment?

To me the most exciting part about being involved in a large international assessment is to work with people from many different countries to answer key scientific questions regarding atmospheric chemistry.

Who throughout your life has had the greatest impact on you deciding to pursue a career in atmospheric science?

I have more than one person who has impacted my decision to pursue a career in atmospheric science. The first one is Dr. Francis Codron, he was one of my first professors in Physics. The first day, he introduced himself saying that he was working at the Dynamical Meteorology Laboratory. I don't know why exactly but the word "Meteorology" had already been intriguing to me. The words that Dr. Codron used to describe clouds, cyclones, precipitation, temperature, atmospheric pressure and wind inspired me while I was studying the rather dry subjects of thermodynamics, electromagnetism and quantum physics for my fundamental physics degree. During my Bachelor's degree I always chose courses in the atmospheric sciences. At the end of my first three years at university, I requested an internship in atmospheric science. Dr. Alain Protat had a subject which I could work on and he became my supervisor. He was the one who made me realize how much I love research and working in a laboratory trying to answer scientific questions. I will probably never forget our exchanges. I was studying microphysics and radiative properties of ice clouds by cloud Doppler radar. It was a very short internship but intense and very exciting. Later on, during my Master's degree in atmospheric science, I discovered the long-range transport of air pollution with Dr. Gerard Ancellet, which was fascinating for me and I decided to start a PhD in this topic.

To you, what is the ultimate goal of science? Does this goal have anything to do with why you became a scientist?

To me the ultimate goal of science is to better understand the world where we live and to better respect it. For sure, this goal has something to do with why I became a scientist. I think atmospheric science is one of the fields that pushes people from different countries, cultures and generations to work together. Many multi-cultural friendships are the result of these efforts and I think it is one of the most important things to help people open their minds and be tolerant of other viewpoints.

Where are you most at home? Is it in the lab, writing papers, doing field research or in front of a crowd giving a talk on your research?

I am not sure where I feel the most at home. I feel I am very active, productive and learn a lot in the lab, writing papers, and preparing talks. Although giving a talk on my research is maybe not the easiest part of my work, it is a very exciting moment that I am learning to appreciate more and more. I also enjoy very much discussions at poster sessions. I haven't done field research yet and I would love to be part of such a mission in the future.

Outside of science, what are some of your other interests/hobbies?

I love travelling and discovering a lot of different cultures and languages. I am passionate about theatre and cinema. I love dancing. Since moving to Boulder a year ago, I have discovered outdoor and mountain sports which I never experienced in Paris.

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BACKGROUND

FUNDAMENTALS

ATMOSPHERIC CHEMISTRY

IGAC is reprinting the introduction of this evaluation as part of the IGAC activity on Fundamentals of Atmospheric Chemistry, which emphasizes the importance of and fosters fundamental research in advancing the field of atmospheric chemistry. IGAC hopes to make its community members more aware that a new data evaluation has been released. The introduction is reprinted with permission from JPL, NASA.

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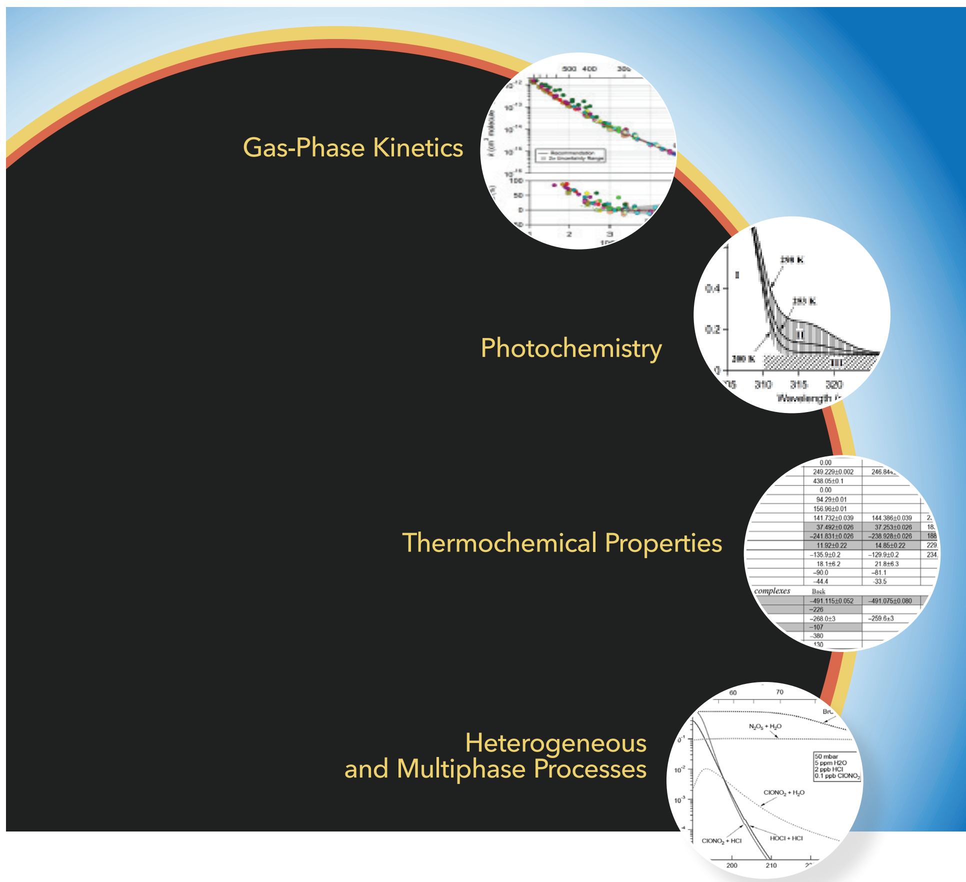
Chemical Kinetics and Photochemical Data for Use in Atmospheric Studies: Evaluation Number 18



INTRODUCTION

This compilation of kinetic and photochemical data is the 18th evaluation prepared by the NASA Panel for Data Evaluation. The Panel was established in 1977 by the NASA Upper Atmosphere Research Program Office for the purpose of providing a critical tabulation of the latest kinetic and photochemical data for use by modelers in computer simulations of atmospheric chemistry.

1.1 Basis of the Recommendations

In so far as possible, all recommendations are based on laboratory measurements. In order to provide recommendations that are as up-to-date as possible, preprints and written private communications are accepted, but only when it is expected that they will appear as published journal articles. Recommendations are not adjusted to fit observations of atmospheric concentrations. The Panel considers the question of consistency of data with expectations based on the theory of reaction kinetics, and when a discrepancy appears to exist this fact is pointed out in the accompanying note. The major use of theoretical extrapolation of data is in connection with three-body reactions, in which the required pressure or temperature dependence is sometimes unavailable from laboratory measurements, and can be estimated by use of appropriate theoretical treatment. In some cases where no experimental data are available, the Panel may provide estimates of rate constant parameters based on analogy to similar reactions for which data are available.

1.2 Scope of the Evaluation

In the past (releases 1-12 of this evaluation), it was the practice of the Panel to reevaluate the entire set of reactions with individual Panel members taking responsibility for specific chemical families or processes. In recent years, the upper troposphere and lower stratosphere (UT/LS) have become the primary areas of focus for model calculations and atmospheric measurements related to studies of ozone depletion and climate change. Because the UT/LS is a region of relatively high chemical and dynamical complexity, a different approach was adopted for subsequent releases of the evaluation. Specifically, the entire reaction set of the data evaluation is no longer re-evaluated for each release. Instead, specific subsets are chosen for re-evaluation, with several Panel members working to develop recommendations for a given area. This approach makes it possible to treat each subset in greater depth, to examine the consistency of the recommended parameters within a given chemical family, and to expand the scope of the evaluation to new areas. It is the aim of the Panel to consider the entire set of kinetics, photochemical, and thermodynamic parameters every three review cycles. Each release of the evaluation will contain not only the new evaluations, but also recommendations for every process that has been considered in the past. In this way, the tables for each release constitute a complete set of recommendations.

It is recognized that important new laboratory data may be published that lie outside the specific subset chosen for re-evaluation. In order to ensure that these important data receive prompt consideration, each evaluation will also have a "special topics" category. Feedback from the atmospheric modeling community is solicited in the selection of reactions for this category.

For the current evaluation, the specific subsets include the following:

- Reactions of O(1D)
- Reactions of OH with halocarbons
- Reactions of sulfur compounds
- Initial steps in isoprene oxidation
- Photochemistry of O_3, organic compounds and halogen oxides
- Heterogeneous processes on liquid water, water ice, alumina and solid alkali halide salts
- Gas-liquid solubility (Henry's Law Constants)
- Thermodynamic parameters (entropy and enthalpy of formation)

1.3 Format of the Evaluation

Changes or additions to the data tables are indicated by shading. A new entry is completely shaded, whereas a changed entry is shaded only where it has changed. In some cases, only the note has been changed, in which case the corresponding note number in the table is shaded.

The notes associated with each bimolecular reaction are an essential component of the evaluation. Thus, the reader is strongly encouraged to consult these notes as they contain important kinetic / numerical information that could not conveniently be included in the Table of recommended parameters. In several cases the note for a bimolecular reaction contains a three-parameter Arrhenius expression that better represents the accepted experimental data over a much broader temperature range than the two-parameter Arrhenius expression given in the table, whose applicability is limited to a narrower temperature range as indicated in the note. Table entries for some reactions provide rate constant recommendations for individual reaction channels. In these cases the recommendation for the total reaction rate constant is given separately in the note.

Every note in Tables 1-3 and in the photochemistry section includes a "time stamp" indicating the latest revision date for changes in the recommendation or in the note as well as the date of the most recent evaluation. In some cases, a reaction may have undergone a complete re-evaluation without changes in the recommendations (i.e., Table entries) or in the note. For such reactions, the date of the evaluation will be updated even though the re-evaluation did not result in any changes.

1.4 Computer Access

This document is available online in the form of individual chapters and as a complete document in Adobe PDF (Portable Data File) format. Files may be downloaded from **http://jpldataeval.jpl.nasa.gov/**. This document is not available in printed form.

The tables of recommended photochemical cross sections from this evaluation can be downloaded from the spectral atlas of the Max-Planck Institute for Chemistry at: **http://satellite.mpic.de/spectral_atlas**.

To receive email notification concerning releases of new publications and errata, a mailing list is available. To subscribe, send a blank message to **sympa@list.jpl.nasa.gov** with "subscribe jpl-dataeval" (without quotes) in the subject line.

For more information, contact Stanley Sander (**Stanley.Sander@jpl.nasa.gov**) or James Burkholder (**James.B.Burkholder@noaa.gov**).

1.5 Data Formats

In Table 1 (Rate Constants for Bimolecular Reactions) the reactions are grouped into the classes O_x, HO_x, NO_x, Organic Compounds, FO_x, ClO_x, BrO_x, IO_x, SO_x, and Metal Reactions. The data in Table 2 (Rate Constants for Association Reactions) are presented in the same order as the bimolecular reactions. The presentation of photochemical cross section data follows the same sequence.

1.6 Units

Rate constants are given in units of concentration expressed as molecules per cubic centimeter and time in seconds. That is, for first-, second-, and third-order reactions, units of k are s^{-1}, cm^3 $molecule^{-1}$ s^{-1}, and cm^6 $molecule^{-2}$ s^{-1}, respectively. Absorption cross sections are expressed as cm^2 $molecule^{-1}$, base e.

1.7 Noteworthy Changes in this Evaluation

The layout of the evaluation has been revised to include with each note the full citations for the references cited within that note. In addition, complete section bibliographies are included at the end of each section and a Master Bibliography for the entire document is given in Section 7. Hyperlinks have been added to Table 4-1 of the Photochemistry section, Henry's Law section, and the Thermochemistry section to facilitate improved navigation within these sections.

1.7.1 Bimolecular Reactions (Section 1)

A comprehensive review of the $O(^1D)$ reactions was included in this evaluation. The $O(^1D)$ reaction entries and recommendations were expanded to include the total rate coefficient (i.e., $O(^1D)$ loss) and the product branching ratios and estimated uncertainties, where experimental data were available. The basis for the branching ratio recommendations is provided in the note for each reaction. The current recommendations build on those given in the SPARC (2013) Lifetime Report[13] for a sub-set of the molecules included in Table 1. New entries include HCN, CH_3CN, CH_3Cl, CH_3CCl_3, 1,2-*c*-$C_4Cl_2F_6$ (*E*,*Z*), CF_3CHFCF_3 (HFC-227ea), and $CHF_2CH_2CF_3$ (HFC-245fa).

A comprehensive review of the FO_x, ClO_x, and BrO_x reactions in subsections E1, F1, and G1 respectively was conducted for this evaluation with particular emphasis on the reactions of OH and Cl with hydrocarbons and halocarbons (including halogenated ethers, alcohols, etc.). For several of these reactions, recommendation updates were made for consistency with the 2013 SPARC Lifetime Report.[13] In a few cases, the SPARC recommendations themselves were updated. Many of the recommendations are based (at least in part) on relative rate investigations in which the derivation of the target rate constant was based on the rate constant for one or more reference reactions. In cases where significant revisions were made in the recommended rate parameters for reactions that were used as references in relative rate studies, the effect on other reaction recommendations was tracked and appropriate revisions were made. For all reactions, careful attention was paid to providing the most realistic values for the uncertainty parameters, f(298 K) and g, given in Table 1. More details regarding the selection of these values are provided to the introduction to Section 1.

Subsection H1 on IO_x reactions was not a focus of this evaluation but one important reaction, IO + HO_2, has been re-evaluated.

The section on sulfur reactions includes eleven reactions that had not been evaluated previously: five reactions related to the atmospheric oxidation of methyl ethyl sulfide ($CH_3SC_2H_5$), reactions of the three simplest Criegee intermediates (CH_2OO, *syn*-CH_3CHOO, and *anti*-CH_3CHOO) with SO_2, the reaction of OH with methane sulfonic acid (MSA, CH_3SO_3H), and reactions of CH_3S radicals with CO and Br_2. In addition, recommendations and notes for the OH + OCS and S + O_2 reactions have been updated, as have notes for nine other sulfur reactions.

Evaluations for reactions of O_3, OH, NO_3, Cl, and Br with isoprene were included in Evaluation 17 for the first time. Recommendations for all five of these isoprene reactions are updated and reactions of the first generation isoprene oxidation products methyl vinyl ketone (MVK, $CH_3C(O)CH=CH_2$) and methacrolein ($CH_2=C(CH_3)CHO$) with O_3, OH, NO_3, Cl, and Br are evaluated for the first time. Also evaluated for the first time are reactions of the three simplest Criegee intermediates with water and water dimer. In addition, notes for reactions of OH with HCN and CH_3CN are updated to include available information about reaction mechanisms.

1.7.2 Termolecular Reactions (Section 2)

Several new reactions have been added to Table 2. These include the self-reaction of CH_2OO radicals (the simplest Criegee intermediate) and the reaction of CH_2I radicals with O_2 (which produces the CH_2OO and other products). In addition, the adduct-forming reactions of OH + olefins has received special attention. The reaction of OH with ethylene has been re-evaluated and new evaluations are reported for the reactions of OH with propene, 1-butene, iso-butene, and *cis*- and *trans*-2-butene. New entries also appear for $CH_3S + O_2$, for Hg + Br, and for Br + isoprene and 1,3-butadiene. Several entries have been up-dated, including $OH + NO_2$, $HO_2 + NO_2$, $NO_2 + NO_3$, ClO + ClO, and $BrO + NO_2$.

1.7.3 Equilibrium Constants (Section 3)

Several new entries have been added to Table 3. These include the equilibrium constants for formation of the water dimer; for HO_2 complexes with formaldehyde, acetaldehyde, and acetone; for complexes of Br with isoprene and 1,3-butadiene; for $CH_3S + O_2$; for $IO + NO_2$ and for Hg + Br. Previous entries for $NO_2 + NO_3$ and for ClO + ClO have been updated.

1.7.4 Photochemical Data (Section 4)

Notes have been revised and updated as indicated in Table 4-1. The previously included table of uncertainty (absorption cross section x photolysis quantum yield) for a number of key species has been deleted. The recommended uncertainty estimates for the absorption cross sections and photolysis quantum yields are now included separately within the notes. (However, not all molecules include uncertainty estimates.) Absorption cross section uncertainty factors are primarily based on the wavelength regions most critical to atmospheric photolysis. New entries have been added in the Organic, FO_x, ClO_x, and IO_x Photochemistry sub-sections. On the basis of a recent study, the recommendation for the ClOOCl UV absorption cross sections, which are important for modeling polar stratospheric ozone depletion, was revised.

1.7.4 Heterogeneous Chemistry (Section 5)

In this evaluation, selected uptake processes occurring on alumina, liquid water, water ice, solid salt, and salt solutions have been added or updated. The compilation of Henry's law parameters for pure water has been extended to include a large number of additional oxygenated organic, halo-organic, organic amine, and organic sulfide compounds. The compilation of Henry's law parameters in sulfuric acid solutions have been added or updated for a few oxygenated organics. A new compilation of Henry's Law constants for uptake into seawater (or into NaCl solutions at about 35‰ salinity) has been added, with a particular emphasis on halogenated organics.

1.7.5 Thermodynamic Parameters (Section 6)

The Table of Thermodynamic Properties has been further expanded to almost 800 species, now including mercury compounds. The additions include mercury-halogen, mercury-halogen-oxygen, and mercury-halogen-nitrogen oxide species, which may be important for predicting which reactions can be of significance in the atmosphere. Since all of these entries are new, they have not been shaded to indicate a change or insertion. The Table has been divided into 90 groups, each linked to the notes for those species. The references for each group are at the end of the notes for that group. In addition, there is a list of groups at the beginning of the Table, with links to the individual groups.

1.7.7 Bibliography – Master (Section 7)

In addition to the bibliographies included at the end of each section, all references cited within the evaluation (~5000) are summarized in this section. References have been updated to include full titles and doi's for most post-2000 publications. Doi's for older references are provided in some cases and will be updated in future evaluations.

1.8 Acknowledgements

The Panel wishes to acknowledge the technical support provided by Liz Juvera and Samantha Ozyildirim. Financial support from the NASA Upper Atmosphere Research and Tropospheric Chemistry Programs is gratefully acknowledged.

29 FEBRUARY - 1 MARCH 2016
TAIPEI, TAIWAN

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HOST INSTITUTION

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PARTICIPANTS

Bangladesh, China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Myanmar, Philippines, Singapore, Taiwan, Thailand, and Vietnam.

BACKGROUND

Members of the IGAC Monsoon and Oceania Networking Group (MANGO) led and participated in this workshop in order to gain perspective on activities it could lead moving forward to foster transdisciplinary collaboration on air pollution in Asia.

Future Earth Asian Perspective Symposium on Air Pollution Transdisciplinary Collaboration

Background

"Future Earth Asian Perspective Symposium on Air Pollution Transdisciplinary Collaboration" was held on February 29 and March 1, 2016, in Academia Sinica (AS), Taipei, Taiwan with the aim to establish air pollution transdisciplinary collaboration under the framework of Future Earth in Asia for sustainable development of Asian countries. It was sponsored by the Ministry of Science and Technology, Executive Yuan, Taiwan and co-organized by Center for Sustainability Science (CSS), AS; Research Center for Environmental Changes (RCEC), AS; and the National Committee of Future Earth, Academia Sinica, Taipei, for Future Earth, International Council for Science (shorten as Future Earth, Taipei). The main local organizers were Academician Dr. Chao Han LIU, Director Pao K. WANG (Director of CSS), and Dr. Shih-Chun Candice LUNG (Research fellow of RCEC). More than 100 participants from 14 countries/regions participated in this event, including scientists from Bangladesh, China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Myanmar, Philippines, Singapore, Taiwan, Thailand, and Vietnam.

Setting the Stage of Future Earth Framework

The aim of this symposium was to establish air pollution transdisciplinary collaboration under the framework of Future Earth in Asia. Thus, background information of Future Earth was introduced in the beginning of the symposium. The Chair of Future Earth, Taipei, Academician C.H. Liu, gave the welcome address in the opening ceremony. Nobel Prize laureate President Yuan T. LEE, former President of International Council for Science (ICSU), also spoke on 'Expectation on Future Earth'. Dr. Tetsuzo YASUNARI, Director General of Research Institute of Humanity and Nature (RIHN), Kyoto, Japan, introduced Regional Office of Future Earth in Asia. And Dr. Nordin HASAN, Chair of Regional Advisory Committee, Future Earth in Asia, and Director of ICSU Regional Office for Asia and the Pacific, talked about the 'Expectation of Future Earth in Asia'. These presentations set the stage for the following presentation and discussion focusing on air pollution transdisciplinary collaboration under the framework of Future Earth.

Presentation Focusing on Air Pollution Issues

In order to emphasize science-policy interface of air pollution issues, we invited Minister of Taiwan Environmental Protection Administration (EPA), Executive Yuan, Dr. Kuo-Yen WEI, as the distinguished guest to give an opening address in this symposium. He participated in one of the IGBP core projects PAGES and knew well about IGBP and Future Earth. His welcome remark emphasized the importance of establishing international collaboration and science-policy interfaces, especially for air pollution issues. Afterwards, Dr. Hiroshi TANIMOTO, Chair of Committee of International Global Atmospheric Chemistry (IGAC)- Monsoon Asia and Oceania Networking Group (MANGO), presented the 'Research Challenges for Air Pollution in Asia'. And Dr. Shih-Chun Candice LUNG, Member of Regional Advisory Committee, Future Earth in Asia, and member of IGAC-MANGO gave a presentation on 'Research Opportunity of Air Pollution from Co-benefit Perspectives'. The above two presentation gave an overview of the air pollution challenges in Asia as well as potential opportunities via transdisciplinary collaboration.

In order to understand country-specific air pollution issues and identify focused themes for future research in Asia, representatives from 13 countries in this region gave presentations on the overview of their country profile such as geographic location and population; the major air pollution issues including major sources, species, episodes and trends; status of current governmental and institutional monitoring networks, and current air quality management policy; current focused air pollution research topics, capability, and international collaboration; and needed transdisciplinary collaboration to solve current air pollution problems (What is the critical scientific information that regulatory agency needs to make adequate air pollution abatement policy? What are the benefits and expected outcomes from working together with research teams of other disciplines and countries?). Based on their presentations, the major air pollution challenges in this region are transboundary haze and air pollution, urban pollution, emission inventory, and biomass burning.

Future Earth emphasizes stakeholder engagement. Thus, in order to facilitate stakeholders' involvement, not only the Minister of Taiwan EPA gave an opening remarks in this symposium, but several officials of Taiwan EPA were also participated this symposium to strengthen the dialogue of science and policy. Moreover, we invited representatives from Taiwan EPA and citizen's groups to speak from their perspectives. Dr. Wei-Ming Huang, Senior Technical Specialist of Air Quality Protection and Noise Control Department in Taiwan EPA, spoke from the perspectives of policy formulators. He presented the plan of Taiwan EPA to improve air quality based on scientific monitoring and modeling efforts over the years. Dr. Ly-yun CHANG, Founder of Taiwan Healthcare Reform Foundation, presented 'Air Pollution and Its Health Impact: A Health Inequality Perspective'. She pointed out the social inequality and environmental inequality of air pollution exposure in this region. And Dr. Ling-Jyh CHEN, Contributor of LASS project in Makers' Group, spoke on 'Participatory Science with Innovative Technology for Air Pollution Monitoring'. He introduced an inexpensive and light-weight $PM_{2.5}$ sensor, a product of the transdisciplinary collaboration of an internet voluntary group and experts of information technology and atmospheric chemists in Taiwan. A prototype was demonstrated on-site. The sensor data could be transmitted to a cloud server maintained by AS and can be checked via cell phones. Taipei City Government has begun to use this type of sensor in participatory research to assess air pollution distribution in fine spatial scale. This is a successful case of multiple stakeholder involvement with the significant contribution of scientists in air pollution and information sciences.

Discussion of Potential Air Pollution Transdisciplinary Collaboration

After all the above presentation, several members of Regional Advisory Committee of Future Earth in Asia (Dr. Kusumita ARORA from India, Dr. Nordin HASAN from Malaysia, Dr. Shih-Chun Candice LUNG from Taiwan, Dr. Roberto dela Fuente RANOLA from the Philippines, and Dr. Soon-chang YOON from Korea) also gave their suggestions and comments on potential air pollution transdisciplinary collaboration, anticipated improvement on air quality, and expected advancements on different disciplines. It was a consensus that air pollution is an important scientific challenge that Asian society faced. Not only scientific communities should enhance collaboration among different disciplines and countries, but also governments in this region should work together to solve air pollution problems. It would be great if countries in this region would agree on universal international standards and regulations.

During this symposium, it was emphasized that air pollution is getting worse in spite of the scientific publications in Asia focusing on air pollution is increasing (Figure 1, *see p. 22*). Therefore, new type of air pollution research needs to take place, i.e. air pollution transdisciplinary collaboration. In other words, air pollution scientists should work together with scientists

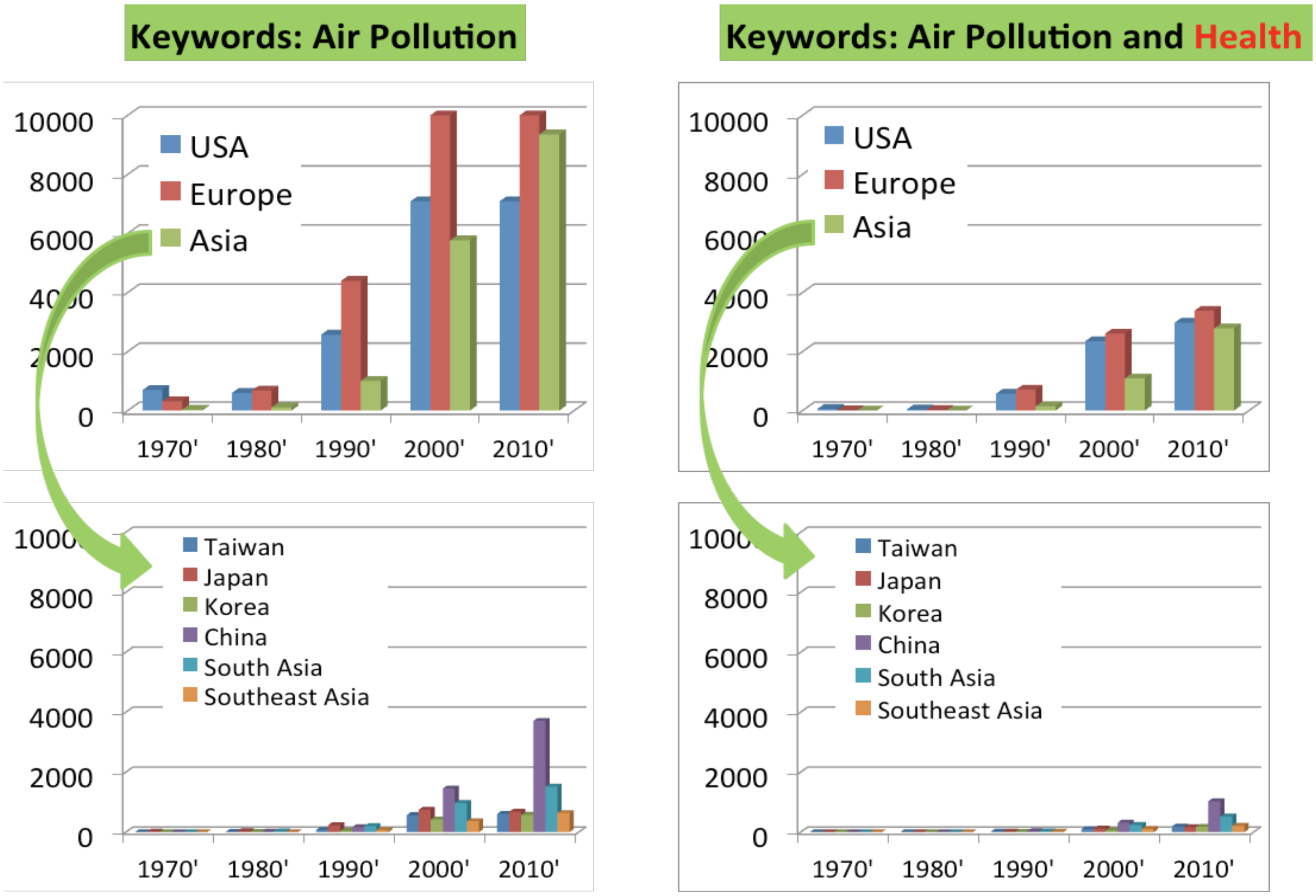

FIGURE 1 **Numbers of publications focusing on air pollution (left panel) and air pollution and health (right panel)**

from other disciplines as well as stakeholders including local citizens, governmental officials, non-governmental organizations, etc., in order to provide scientific evidences to advance regulatory efforts to solve air pollution problems on the ground. Two discussion sessions with break-out groups were held, one on 'Co-designing Solution-oriented Air Pollution Research for Sustainable Development Goals (SDGs)' and another on 'Moving Forward: International Collaboration on Air Pollution within Future Earth in Asia'. The main points were to identify disciplines that air pollution scientists can work together in order to reach one of the SDGs. The identified disciplines include environmental sciences, medical sciences and public health, engineering, sociology, education, history, media, public policy science, energy engineering, urban design/urban planning (focus on transport), information technology people, and lawyers or who knows better political governances. And eight of the 17 SDGs could be reached under such collaborations; they are (3) good health and well-being, (4) quality education, (7) affordable and clean energy (9) industry, innovation and infrastructure, (11) sustainable cities and communities, (12) responsible consumption and production, (13) climate action, and (17) partnerships for the goals (Figure 2, *see p. 23*). In addition, the issues of funding support for such a transdisciplinary collaboration and cultivation of young generation of scientists were raised during the discussion.

Path Forward

Based on excellent presentations and productive discussion of scientists and stakeholders from different perspectives, a round-table discussion was held in the end of the symposium with Academician Dr. Yuan T. LEE, Academician Dr. Chao Han LIU, Academician Dr. Shaw C. LIU, Dr. Nordin HASAN, Dr. Tetsuzo YASUNARI, and Dr. Hiroshi TANIMOTO. Two concrete conclusions with action plans were made in response to the questions and needs raised during the discussion. The first one responded to the need for a data center of air pollution monitoring data and emission inventories of all countries

FIGURE 2 **Seventeen Sustainable Development Goals (SDGs) [UN, 2015]**

in this region. Dr. Tetsuzo YASUNARI agreed to explore the possibility of including air pollution emission and monitoring data in ICSU's Data Center in Japan, as an information platform for air pollution research. The second conclusion was the announcement that first young scientists training workshop for Air Pollution Transdisciplinary Collaboration will be held next summer (2017) in Guangzhou which will be hosted by Academician Shaw Chen Liu. The detailed plan will be made later.

It is worthy noted that two follow-up developments after this symposium. One is the consensus made in the meeting of Regional Advisory Committee, Future Earth in Asia, held on April 25, 2016, Seoul, Korea, that air pollution is definitely a regional priority issue and Asian scientists should work together with policy makers and citizen's group to tackle the challenge and improve air quality. In addition, a follow-up collaboration sprang out of interactions during this symposium; a small and inexpensive PM2.5 sensor with Wifi transmission to a cloud website integrated by Taiwanese Maker Group LASS, as a gift from LASS based on crowdfunding, was mailed to every international guest who was willing to participate. Currently, scientists from 11 countries in Asia are testing this sensor which could serve as a pilot study of regional air pollution participatory research with collaboration of the general public and scientists from air pollution and information technology fields. Drs. Candice LUNG, Ling-Jyh CHEN, Mr. Wuu-Long SHEU (Founder of Makers' Group) will follow up to check the accuracy, reliability and durability of this type of sensor. If all is well, a follow-up training workshop will be held in Taiwan near the end of 2016.

Save the Date!

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

Bermuda's Tudor Hill Marine Atmospheric Observatory

Restored and Ready for Next Chapter of Atmospheric Research

AUTHOR
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HOST INSTITUTION
BIOS
Bermuda Institute of Ocean Sciences

FUNDING
NSF

This spring, renovations were completed at Bermuda's **Tudor Hill Marine Atmospheric Observatory.** With funding from the U.S. National Science Foundation's Chemical Oceanography and Atmospheric Sciences divisions, and a new-to-Bermuda tower donated by University of Virginia research professor Bill Keene, long-term monitoring projects have been fully restored after the hiatus caused by Hurricane Gonzalo in October 2014.

While all the instrumentation had been safely removed prior to the hurricane's landfall, the original 23-meter aluminum tower was flattened.

"The hurricane damage allowed us to really look at the site and renovate completely, so it's a blessing in disguise," said Dr. Andrew Peters of the Bermuda Institute of Ocean Sciences, who runs the Tudor Hill facility. In addition to the new tower structure, improvements at the site include a new habitation unit complete with kitchen and bunks for researchers who conduct intensive sampling campaigns.

The final platform is raised on the new tower at the renovated Tudor Hill Marine Atmospheric Observatory site.

Since the walk-up tower at Tudor Hill was established in 1988 as part of the Atmosphere-Ocean Chemistry Experiment (AEROCE), it has hosted many international and collaborative efforts to study aerosols, precipitation, and ocean-atmosphere interactions. The Tudor Hill tower has continuously collected long-term measurements of ozone and greenhouse gases for NOAA's Earth Systems Research Laboratory, measurements of aerosol optical depth for NASA's AERONET program, and monitored persistent organic pollutants for the Global Atmosphere Passive Sampler (GAPS) Network operated by Environment Canada. In 2011, the installation of a continuous in-situ laser spectrometer established what is now the world's longest continuous water vapor stable isotope record.

As winds shift back and forth over time, Bermuda is an ideal location to contrast clean marine air from the east with more polluted North American air from the west. Consistent wind patterns have enabled researchers to study the fate and transport of pollutants and micronutrients alike, from heavy metals generated by North American refineries and automobiles, to the impact of Saharan dust on marine primary production. Most recently, research at the Tudor Hill facility is fundamentally changing the attribution of nitrogen sources to the ocean. Isotope analysis of rainwater collected at the tower revealed that ammonium, organic nitrogen and nitrate each reflect different levels of anthropogenic influence. If the Bermuda data is scalable, it suggests that nitrogen from anthropogenic sources only constitutes about 30% of atmospheric nitrogen, as opposed to previous estimates that 80% of nitrogen was anthropogenically sourced.

Data from Tudor Hill are important for climate projections and have been used in aerosol forcing models for the IPCC climate assessments. While marine aerosols constitute the biggest flux of particles to the atmosphere, marine aerosol production is poorly constrained in most global climate models and thus an active and critical area of research. The Tudor Hill facility is unique in providing the ability to make year-round, complex measurements of particles and gases in the atmosphere over the ocean without the use of a research ship or buoy mooring. At the same time rich, long-term marine data can still be accessed from the **Bermuda Atlantic Time-series Study** site.

To learn more about opportunities at the Tudor Hill Marine Atmospheric Observatory, contact Dr. Andrew Peters (**andrew.peters@bios.edu**).

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POTSDAM, GERMANY

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Austria, the Czech Republic, Finland, France, Germany, Italy, the Netherlands, Norway, Poland, Russia, Sweden, Switzerland, Turkey, the United Kingdom, and the United States

BACKGROUND

IGAC strives to collaborate with other international organization to help facilitate atmospheric chemistry research. The Task Force on Hemispheric Transport and Air Pollution (TF HTAP) and the Arctic Monitoring Assessment Program are two such international organizations that IGAC collaborates with. In particular, the IGAC/SPARC Chemistry-Climate Model Initiative (CCMI) as well as the IGAC/IASC air Pollution in the Arctic: Climate, Environment, and Societies (PACES) activity were present at this workshop to help fosters these collaborations.

REPORT ON JOINT HTAP AND AMAP WORKSHOP

Strengthening Cooperation on Air Pollution Impacts in the Arctic and Beyond

Strengthening collaboration between TF HTAP and AMAP.

Air pollution has a wide variety of impacts, affecting human health, ecosystems, and climate both near the source and far away. Over the last 10 years the Task Force on Hemispheric Transport of Air Pollution (TF HTAP) under the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (CLRTAP) has worked with an international scientific network of experts from Europe, North America, and Asia to improve the understanding of the intercontinental transport of air pollution across the Northern Hemisphere, through systematic modelling intercomparisons, assessment of observational evidence and development of impact assessment methods. Although HTAP's efforts cover the entire Northern Hemisphere, only some work has been performed to also evaluate impacts on the Arctic.

The Arctic Monitoring and Assessment Program (AMAP) is the Working Group of the Arctic Council that is responsible for monitoring and assessing the status of the Arctic region with respect to pollution and climate change issues. Over the past 25 years, the AMAP monitoring programme has documented pollution levels and trends, pathways and processes, and effects on ecosystems and humans. The results of this monitoring effort have formed the basis for a series of AMAP assessments prepared by independent groups of scientific experts. These assessments

IASS, Potsdam, Germany

cover a range of air pollution issues including Acidification and Arctic haze, Mercury and other trace metals, Persistent Organic Pollutants, and most recently Short-lived Climate Forcers (Black Carbon and Ozone, and Methane). These scientific outreach products and policy-makers summaries typically also propose actions to reduce associated threats and are specifically developed to inform decision-makers of the Arctic Council, governments and other relevant international fora.

During the first day of a recent workshop, hosted by the IASS in Potsdam, Germany, the TF HTAP and AMAP explored opportunities to strengthen their cooperation on future scientific work to assess the (human) health, ecosystem, and climate impacts of air pollution. Among the topics for enhanced collaboration are new modelling efforts to support evaluation of mitigation strategies for mercury, persistent organic pollutants, and short-lived climate pollutants (including black carbon and methane). This modelling work will also incorporate dedicated scenario studies for Arctic development and impact studies. By working together, HTAP and AMAP can provide better understanding of processes and uncertainties, as well as information to international bodies responsible for developing policy measures to exploit the benefits of mitigation strategies in the Arctic and outside.

The second and third day of the workshop were dedicated to evaluate methodologies to better quantify impacts of air pollution on human health, ecosystems (including crops) and climate. Presentations given by representatives of variety of communities, including CCMI (climate modelling communities); health impacts (overview of GBD, WHO efforts) and the emission scenario communities (e.g. GAINS as well as SSPs) were informing on the possibilities of exchanging information between the various efforts, and to promote the use of joint methods for the variety of assessments foreseen in the coming years.

Further information on HTAP and meeting presentations are available via **www.htap.org**.

community

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Calendar

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

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