



ASIA-PACIFIC NETWORK FOR
GLOBAL CHANGE RESEARCH

Final Technical Report
CBA2017-02MY-Tanimoto

Fostering of the next generation of scientists for better understanding of air quality in Monsoon Asia and Oceania region

The following collaborators worked on this project:

1. Manish Naja, ARIES, India, manish@aries.res.in
2. N. T. Kim Oanh, Asian Inst. Technol., Thailand, kimoanh@ait.asia
3. S.C. Candice Lung, Academia Sinica, Taiwan, Republic of China (ROC), sclung@gate.sinica.edu.tw
4. Erika von Schneidemesser, IASS, Germany, erika.vons@iass-potsdam.de
5. Maria Obiminda L. Cambaliza, Ateneo de Manila University and Manila Observatory, Philippines, mcambaliza@observatory.ph
6. Abdus Salam, Univ. Dhaka, Bangladesh, asalam@gmail.com
7. Mitsuo Uematsu, The Univ. Tokyo, Japan, uematsu@ori.u-tokyo.ac.jp

Copyright © 2018 Asia-Pacific Network for Global Change Research

APN seeks to maximise discoverability and use of its knowledge and information. All publications are made available through its online repository “APN E-Lib” (www.apn-gcr.org/resources/). Unless otherwise indicated, APN publications may be copied, downloaded and printed for private study, research and teaching purposes, or for use in non-commercial products or services. Appropriate acknowledgement of APN as the source and copyright holder must be given, while APN’s endorsement of users’ views, products or services must not be implied in any way. For reuse requests: <http://www.apn-gcr.org/?p=10807>

Table of Contents

Table of Contents	1
Project Overview.....	1
1. Introduction	5
2. Methodology.....	5
3. Results & Discussion	7
4. Conclusions	15
5. Future Directions	15

Project Overview

Project Duration	: 2017–2018 (2 years)
Funding Awarded	: US\$ 40,000 for Year 1; US\$ 31,500 for Year 2
Key organisations involved	: Hiroshi Tanimoto, National Institute for Environmental Studies (NIES), Japan Manish Naja, Aryabhata Research Institute of Observational Sciences (ARIES), India N. T. Kim Oanh, Asian Institute of Technology, Thailand S.C. Candice Lung, Academia Sinica, Taiwan, Republic of China (ROC) Erika von Schneidemesser, IASS, Germany Maria Obiminda L. Cambaliza, Ateneo de Manila University and Manila Observatory, Philippines Abdus Salam, University of Dhaka, Bangladesh Liya Yu, National University of Singapore, Singapore Mohd Talib Latif, Universiti Kebangsaan Malaysia, Malaysia Puji Lestari, Bandung Institute of Technology, Indonesia To Thi Hien, Vietnam National University - Ho Chi Minh City, Vietnam Bhupesh Adhikary, ICIMOD, Nepal Melita Keywood, CSIRO, Australia Muhammad Fahim Khokhar, NUST, Pakistan Hiranthi Janz, Central Environmental Authority, Sri Lanka Ohnmar May Tin Hlaing, Environmental Quality Management, Myanmar Tao Wang, Hong Kong Polytechnic University, Hong Kong Jim Crawford, NASA, USA

Project Summary

We aim to foster the community of atmospheric scientists in Monsoon Asia and Oceania region to enhance communications among the scientists in different countries and to strengthen collaborations with the international community, with particular emphasis on air quality in Asia, specifically associated with links to impacts on human health and climate change. For this purpose, we have established a regional group, which is called IGAC-MANGO (Monsoon Asia and Oceania Networking Group), under the IGAC (International Global Atmospheric Chemistry) project that is sponsored by Future Earth and iCACGP (international Commission on Atmospheric Chemistry and Global Pollution). We held the MANGO committee meeting to discuss research priorities in the region, scientific workshops to share scientific activities, and training courses for students and early-career scientists. With these activities, the project made great contributions to enhancing the capability and capacity of air quality research in the Asia-Pacific region with a special emphasis on its links to human health and climate change, including components on trans-disciplinary collaboration. The

project also greatly contributed to fostering the next generation of scientists in this region, who will tackle with air quality and regional climate change issues in future.

Keywords: atmospheric chemistry, air quality, air pollution, climate change, human health

Project outputs and outcomes

Project outputs:

- Through twice MANGO committee meetings, a single, common platform for scientists in Monsoon Asia and Oceania countries was established, and the Asian leadership was fostered by exchanging on the status of air pollution research, discuss scientific questions, and define future scientific activities
- Through our science workshops and several associated workshops, grass-roots level opportunities for Asian scientists to communicate with international scientists were provided
- Through our twice training courses, experienced scientists from the international community shared their expertise on instrumentation, modelling and handling of space-borne data with early career scientists in Asia
- A research project on air quality and human health, named Hi-ASAP, was started
- Dedicated sessions on science-policy engagement and science communication were held in 2019

Project outcomes:

- New leaders from Asia will be identified by the international committees including IGAC, Future Earth, iCACGP, SOLAS, iLEAPS, etc., in addition to more regional collaborations among Asian scientists
- Interactions will be enhanced between Asian scientists and international scientists, resulting in proposals of air quality-related field campaigns in Asia
- Increased opportunities for early career scientists to communicate with international scientists in developed countries, including pursuing PhD or research career in foreign countries
- Increased possibilities to obtain new scientific findings and tangible products to policymakers in the health impacts of PM_{2.5}
- Increased possibilities for atmospheric scientists to conduct or commit trans-disciplinary research or global sustainability-related projects in Asia

Key facts/figures

- 16 excellent scientists representing 16 countries are identified and serving on the MANGO committee
- 4 ECS from MANGO were selected and served as the committee members for the 2018 iCACGP/IGAC Early-Career Short Course and 2018 iCACGP/IGAC Early-Career Program Committee (only 7 committee members were selected from all over the world)
- In addition to the above-listed 4 members, 10 ECS from MANGO were selected to attend the 2018 iCACGP/IGAC Early-Career Short Course (only 40 participants were allowed from all over the world)
- 395 Asian scientists including 160 ECS attended the iCACGP-IGAC 2018 conference

- 32 Asian scientists including 17 ECS attended the MANGO meeting in Japan in 2018 (at the iCACGP-IGAC 2018 conference), and 24 ECS got a travel grant from APN/NIES/IGAC
- 2 ECS from MANGO were selected and served as the committee members for the 2020 IGAC Early-Career Short Course Committee (only 8 committee members were selected from all over the world)
- 35 Asian scientists including 22 ECS attended the MANGO meeting in India in 2019

Potential for further work

Monsoon Asia is facing severe environmental issues including air pollution and climate change, and the role of atmospheric scientists in understanding scientific principles and providing scientific support to policymakers has become of more importance. However, the scientists in this region are not well connected to the international science community, and there is large asymmetry between countries in the capacity conducting scientific research. In this project, a coordination across Asian nations was built, especially with a focus on countries that are not big enough to have national working groups, resulted in a cohesive network of atmospheric scientists in the Asian monsoon region. Based on this solid basis, we will facilitate collaboration between Asian and international scientists, and accelerate fostering the next generation of scientists in this region, by continuing its efforts to engage more countries from currently under-represented countries in Asia.

Publications

- Tanimoto, H., IGAC MANGO side meeting, IGAC news, 63, 16-18, 2018.
- Tanimoto, H., T. Nagashima, S. Inomata, Colette Heald, Melita Keywood, Kohei Sakata, and Sakiko Ishino, 2018 joint 14th iCACGP Quadrennial Symposium and 15th IGAC Science Conference, IGAC news, 63, 16-18, 2018.
- Schlager, H., M. Chin, M. T. Latif, F. Ahamad, Fourth Workshop on Atmospheric Composition and the Asian Monsoon (ACAM), IGAC news, 65, 13-14, 2019.
- Ishino, S., K. Sakata, A. Mbandi, M. Kumar, M. Desservettaz, M. Willis, Z. Tzompa-Sosa, 2018 iCACGP/IGAC Early Career Short Course, IGAC news, 63, 14-15, 2018.
- Willis, M., Ishino, S., M. Desservettaz, A. Mbandi, Z. Tzompa-Sosa, M. Kumar, K. Sakata, An Early Career Perspective on Fostering the Next Generation of Atmospheric Scientists in an International Community, IGAC news, 63, 21-24, 2018.
- Naja, M., L. Yu, A. Salam, and H. Tanimoto, IGAC-MANGO Meeting, Science Workshop, and Training Course 2019, IGAC news, 66, in press, 2020.

Awards and honours

Hiroshi Tanimoto, The NIES President's Award 2018, "For great contributions to international activities", National Institute for Environmental Studies, 2018.

Pull-up quote

"The 2018 conference provided me with a good surprise. I find that IGAC is a very interdisciplinary platform for Earth system scientists to collaborate with scientists in other disciplines, and this mixed collaboration of the multi-disciplinary scientists without any bias or clinging is indeed necessary to rescue the Earth's crisis. I hope you continue this initiative and foster the community to produce good

surprises and new ideas.” by Chiho Watanabe, President, National Institute for Environmental Studies, Japan

“I find MANGO is a very good place to foster Asian early career scientists and grow their enthusiasms to commit to solve serious air pollution issues in Asia. In particular, the 2018 conference and the associated events organized by this project and funded by APN would be an unforgettable memory for all the Asian participants to keep their motivations in their research and professional life. I am sure that all the Asian early career scientists funded by APN are now aware of the importance of international collaboration to solve the global environmental issues.” by Fumiko Kasuga, Director at Japan Hub, Future Earth

“Over a very short time, IGAC-MANGO has matured into a group that is having a positive impact on atmospheric chemistry in Monsoon Asia. In just a few years, they have begun to develop cooperative projects promoting the potential of small sensors for addressing air quality. They are also serving as excellent mentors to early career scientists by conducting training schools and science workshops in addition to their committee meetings. These efforts have benefitted the larger international community by highlighting atmospheric chemistry issues specific to Monsoon Asia and nucleating a group of local scientists to champion atmospheric chemistry in a region of rapid change.” by Jim Crawford, Co-Chair, International Global Atmospheric Chemistry (IGAC) project

“This project was exemplary in fostering a community of atmospheric scientists in the Monsoon Asia and Oceania Region. This was demonstrated through the high participation of scientists from the region (non-financially and financially supported) in the 2018 joint 14th Quadrennial iCACGP Symposium/15th IGAC Science Conference that took place 25-29 September 2018 as well as the two follow-up meetings supported by this project in Takamatsu, Japan and Naintal, India. In addition to fostering a community within the region, the project also worked to connect these scientists to the broader international atmospheric chemistry community to enhance international collaborations that will lead to a better understanding of air quality in the region.” by Megan Melamed, Director, International Global Atmospheric Chemistry (IGAC) project

Acknowledgments

We acknowledge NIES, ARIES, and IGAC for additional funding supports as well as in-kind and logistics contributions.

Thanks go to EUMETSAT and ACAM Training School developers including Federico Fierli at User Support and Climate Service Division, EUMETSAT, Germany, Ritesh Gautam at Environmental Defence Fund, USA, Bhupesh Adhikary at ICIMOD, Nepal, and Silvia Bucci at Laboratoire de Météorologie Dynamique, France, for providing a training course on satellite and modelling: data handling/visualization.

Thanks also go to David Koh at Universiti Brunei Darussalam, Brunei, Megan Melamed at IGAC, Erika von Schneidmesser at IASS, and Julia Schmale at Paul Scherrer Institute, for providing a training course on science-policy engagement.

Further thanks go to Tomoki Nakayama at Nagasaki University, Japan, and Iq Mead at Cranfield University, UK, for providing a lecture and hands-on training course on low-cost sensors.

1. Introduction

The monsoon Asia region is home to many countries undergoing rapid industrialization due to demanding economic growth. Because the monsoon Asia is located in a domain with copious amounts of water vapor and solar radiation, emissions associated with rapid urbanization lead to severe air pollution via complex atmospheric chemistry, causing critical environmental problems that are common among neighboring nations. In recognition of the common challenges, the International Global Atmospheric Chemistry – Monsoon Asia and Oceania Networking Group (IGAC-MANGO) was formed. IGAC-MANGO uniquely brings researchers on atmospheric chemistry and environmental changes from East, Southeast and South Asia. Priority topics identified include air quality and health, atmospheric composition and monsoon, and trans-boundary air pollution. As the group is young, there is a need to strengthen working relationships among them. Furthermore, although monsoon Asia is a “frontier” for atmospheric chemistry research, the studies have been limited by scientists in the region as well as by the international community. Hence it is important to engage different countries from the monsoon Asia region by holding meetings and capacity building workshops to foster the community and enhance communications among scientists, as well as between scientists and policymakers, and to establish close collaborations with the international community. For this purpose, we aim to foster the community of atmospheric scientists in Monsoon Asia and Oceania region including current and future generations.

2. Methodology

We made the best use of the IGAC-MANGO platform, which was developed under IGAC (Tanimoto et al, IGAC news, 54, 16-17, 2015; Tanimoto et al, IGAC news, 55, 12-13, 2015). In total 16 countries are involved in MANGO. These countries include Thailand, Malaysia, Myanmar, Singapore, Vietnam, Indonesia, Philippines (Southeast Asia), Bangladesh, India, Nepal, Pakistan, Sri Lanka (South Asia), Japan, Taiwan (ROC), China (Northeast Asia), and Australia (Oceania). In addition, MANGO has liaisons to relevant organizations or projects, and these liaisons are based in Germany and USA.

At the beginning of this project, several members were already active in IGAC, hence we leverage these leaderships and connections to IGAC or the broader international atmospheric chemistry community. Hiroshi Tanimoto is a co-lead of IGAC-MANGO as well as an SSC member (and a co-chair from 2017 onwards) of IGAC, and takes an overall leadership and acts as a liaison with IGAC and other international science communities. Nguyen Thi Kim Oanh and Manish Naja are co-leads of IGAC-MANGO as well as SSC members of IGAC, and contribute to meetings/workshops planning. Candice Lung takes a leading role in air pollution and human health component, and Erika von Schneidemesser (and her colleagues including Rupakheti Maheswar at IASS) takes a leading role in the science-policy engagement, interactions with local stakeholders, and coordinate the training module. Abdus Salam, Liya Yu, Mohd Talib Latif, and Maria Obiminda Cambaliza take an active role in coordinating science workshops and training courses.

In order to have a robust structure by both top-down and bottom-up approaches, the capacity development activities were made by means of three efforts organized by the IGAC-MANGO: (1) committee meetings (mainly for country members), (2) science workshops (mainly for all scientists including students, and early- and mid-career scientists), and (3) training courses (mainly for students and early-career scientists) including hands-on sessions and science-policy panel discussions.

(1) MANGO committee meetings:

IGAC-MANGO aims to form a cohesive network of atmospheric scientists in the Asian monsoon region, facilitate collaboration between Asian and international scientists, and foster the next generation of scientists in this region (<http://igacproject.org/MANGO>). The IGAC-MANGO committee consists of the initial members from 17 different countries including South Asia, Southeast Asia, Northeast Asia, and Oceania. In this project the role of this committee was strengthened to enhance communication between scientists in Monsoon Asia, and the collaboration of Asian community to the international community, and to explore opportunities for funding and infrastructure that are needed to foster scientific research, capacity building, and regional collaborations. The committee continued its efforts to engage more countries by inviting new members from currently under-represented countries.

(2) MANGO science workshops:

Research pertaining to atmospheric chemistry and air pollution needs a significant boost in many Asian countries. In addition, many Asian countries need to improve their understanding of changes in the regional climate, which is important in decision-making processes regarding adaptation, mitigation and sustainable development. Science workshops were held to enhance knowledge exchange and foster new knowledge for scientists, policy makers and other relevant stakeholders in Asia to help characterize regional similarity/differences in Asia, and to identify and assess air pollution and global change issues at local, national and regional levels. This fostered information exchange, and also provided a crucial opportunity for building on existing and establishing new networks and relationships between scientists, between policy-makers, and between scientists and policy-makers throughout the region. Discussion sessions with breakout groups were organized to discuss trans-disciplinary and multidisciplinary tasks.

(3) MANGO training courses:

Training courses were held for students and early-career scientists from developing countries in Asia to provide hands-on practice with emission inventory, satellite data, and urban/regional air quality modelling, as well as basic air pollution instruments. Since, presently little is known and shared about the status of air pollution; these efforts helped identify the country-specific and/or common air pollution issues and focus on the themes for future research in Asia for the next generation of scientists. Many scientific instruments are rather costly and complex to operate. Here the use of easy-to-operate instruments with affordable cost was explored for the Asian region. Domestic pollution hot spots, biomass burning, trans-boundary long-range transport can be studied using this new type sensor. Training workshop in this aspect facilitated international scientific collaboration with this new technology in the Asian region.

The course also included science-policy engagement in order to help bridge science and policy for early-career scientists including late-PhD students. Through collaboration with the IASS and IGAC, a science-policy training module was prepared. Significant transferrable elements of science-policy engagement, as well as science communications, were augmented with regionally specific aspects to provide a module for effective science-policy training in the proposed course. Best-practices, including successful examples from the region, such as in the SusKat project in Nepal, were

integrated into the module. In addition, experts were engaged to participate in the workshop through a panel discussion, to learn the relationship building process.

3. Results & Discussion

We organized two main events under a flag of IGAC-MANGO in Japan and India, in September 2018 and November-December 2019, respectively. In addition to these two events, we supported topical workshops related to IGAC-MANGO, including IGAC's ACAM (Atmospheric Composition and Asian Monsoon) workshops in 2017 and 2019 (led by Jim Crawford), and the International Conference on Atmospheric Composition and Climate Change in Asia (ICACCCA 2018) led by Universiti Kebangsaan Malaysia (Mohd Talib Latif). We also supported the development of the Hi-ASAP research project led by Academia Sinica (Candice Lung). ACAM and ICACCCA are relevant to a topic of "air quality and climate change" in monsoon Asian region, and Hi-ASAP is relevant to a topic of "air quality and human health", hence these collaborations play a complementary role with IGAC-MANGO in developing research capacity in the Monsoon Asian region.

Specific description will be given below.

June 2017, in Guangzhou, China

The 3rd workshop on ACAM (Atmospheric Composition and Asian Monsoon) was held in Guangzhou, China, 5-9 June 2017, associated with the second ACAM training school on 10-12 June 2017 (<https://www2.acom.ucar.edu/acam/guangzhou-2017>).

The ACAM workshop focused on four scientific themes related to IGAC-MANGO, in particular, air pollution and climate change in Asia. (1). Emissions and air quality in the Asian monsoon region; (2). Aerosols, clouds, and their interactions with the Asian monsoon; (3). Impact of monsoon convection on chemistry; (4). UTLS Response to the Asian Monsoon.

Since IGAC-MANGO and ACAM play complementary roles, IGAC-MANGO supported the ACAM workshop through co-sponsorship by IGAC. The MANGO members were actively involved, and encouraged interested students/early-career scientists to join the workshop and the course. Abdus Salam, Fahim Khokhar, James Crawford, Puji Lestari, Shih-Chun Candice Lung, and Mohd Talib Latif made oral presentations. The key MANGO members hold an informal meeting to discuss the project planning (i.e., confirm contents, timelines, and budget of the project). The ACAM training course focused on satellite data and modelling. This reinforced the air pollution-climate change component in our project, to be complement with our effort on air pollution-human health component.

July 2017, in Taipei, Taiwan (ROC)

A workshop on "Disaster Risk Reduction with Systems Approach for Slow-Onset Climate Disasters (AI-SOCD) - Air Pollution, Sensors, and Big Data" was organized by Shih-Chun Candice Lung at the Advanced Institute, Academia Sinica, Taipei, 10-14 July 2017. It was mainly organized by the Integrated Research on Disaster Risk, International Center of Excellence in Taipei (IRDR ICoE-Taipei) and International Council for Science, Regional Office for the Asia and the Pacific (ICSU ROAP), but co-sponsored by IGAC-MANGO. Several MANGO members participated.

The aim of “AI-SOCD - Air Pollution, Sensors, and Big Data” was to provide early to mid-career practitioners, researchers, and policy makers in Asia and the Pacific region with enhanced understanding, skills, and practical knowledge to apply systems approach in disaster risk reduction (DRR) research focusing on Air Pollution, Sensors and Big Data. This AI is a continuation of the “Future Earth Asian Perspective Symposium on Air Pollution Transdisciplinary Collaboration” held 29 February – 1 March 2016, in Academia Sinica, 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. The organizers and partners of AI-SOCD include academic institutes, citizen’s group, and private organizations

In recent years, the extreme weather events under climate changes have caused increasing causality on human societies worldwide. Air pollution is one of the major root causes of current climate disasters. On the other hand, air pollution, especially aerosols, contributes greatly to the uncertainty of climate change projection. In addition, millions of deaths worldwide were attributable to PM2.5 (fine aerosols), which is a human carcinogen and one of the major environmental health concerns, especially in Asian areas. New thinking and new technology could be used to reduce health risks from air pollution. Currently, a set of simple, low-cost and reliable sensors for PM2.5 has been developed and begun to be applied in the field. Thus, there is a huge potential to distribute these low-cost sensors (LCS) in large quantities to citizens for detection and monitoring the occurrence and progression of air pollution in their area. However, applications of these sensors and the interpretation of the big data it generates require a stronger multi-disciplinary collaboration among scientists from different fields. Also, systems thinking is an effective way to facilitate the communication among scientists from different disciplines as well as policy makers.

Therefore, this AI focused on systems thinking, PM2.5 sensory technology, and big data. Twenty-two participants from eleven countries were chosen among more than 120 applications, including researchers and policy makers. Some of them are members of IGAC MANGO. Vice President of Academia Sinica, Academician Mei-Yin Chou; Executive Director of IRDR ICoE-Taipei, SC Candice Lung; Interim Director of ICSU ROAP, Sharizad Tegnku-Dahlan; Director of Regional Center for Future Earth in Asia, Hein Mallee; co-chair of IGAC, Hiroshi Tanimoto; and representative of LESTARI UKM, Talib Latif gave the welcome address in the opening ceremony. On behalf of IGAC, Dr. Hiroshi Tanimoto, co-chair of IGAC and IGAC MANGO from National Institute for Environmental Studies, Japan, gave a presentation to give participants a perspective on the potential application of LCS in atmospheric chemistry research as well as in the transdisciplinary collaborations that IGAC promotes.

In five days, the participants learned one of the systems thinking approach, collaborative conceptual modeling (CCM) with lectures and hands-on practices on CCM diagrams. The development, case studies, and demonstrations of PM2.5 sensors in the US, Taiwan, and Africa were presented. Data security and data visualization tools, potential application and limitation of current PM2.5 sensors were discussed. After intensive interaction and discussion, the participants developed proposals targeting biomass burning in the Southeast Asia with CCM focusing on applying sensory technology to help provide solutions. Group presentations were given on the last day. Academician Chao-Han Liu of Taiwan gave closing remarks in the closing ceremony and certifications were awarded to the participants.

November 2017, in Taipei, Taiwan (ROC)

The 2017 International Symposium on Sustainability Science was organized by Shih-Chun sCandice Lung at Academia Sinica in Taipei, Taiwan, 21-22 October 2017. Hiroshi Tanimoto was invited as a panellist representing IGAC and IGAC-MANGO.

March 2018, in Kuala Lumpur, Malaysia

The International Conference on Atmospheric Composition and Climate Change in Asia (ICACCCA 2018) (<http://www.ukm.my/icaccca/>) was organized by Mohd Talib Latif and held at Universiti Kebangsaan Malaysia (UKM) in Malaysia on 27-28 March 2018. ICACCCA 2018 was jointly organised by SEADPRI and Institute for Environment and Development (LESTARI) UKM, and supported by the Asian Network on Climate Science and Technology (ANCST) with collaboration from the Faculty of Science and Technology (FST) UKM, Institute of Climate Change (IPI) UKM, Institute of Ocean and Earth Science (IOES) University Malaya, Meteorological Department of Malaysia (MetMalaysia), Department of Environment (DOE) Malaysia, and Monsoon Asia and Oceania Networking Group (IGAC-MANGO). The ICACCCA 2018 was attended by 130 participants from Malaysia, Singapore, Thailand, Indonesia, Taiwan, Pakistan, Bangladesh, Japan, United Kingdom and United States of America. They comprised researchers, academicians, members from government agencies and private sectors, and students. It was organised to provide an opportunity to share knowledge and expertise in atmospheric composition and climate change research.

The two-day conference hosted three keynote speakers, 30 oral presentations and 20 posters with discussions on topics including emissions and pollutant composition, greenhouse gases, tropospheric ozone, biomass burning episodes, sea-atmosphere interaction, effects of pollution on regional weather and climate, long-range transport of atmospheric pollutants, air pollutants and climate change, and the health and legal aspects of atmospheric composition and climate change. The three keynote speakers were Professor Dr. Peter Brimblecombe (Hong Kong City University), Professor Dr. Fredolin Tangang (UKM) and Dr. Hiroshi Tanimoto (National Institute for Environmental Studies, Japan). Prof. Dr Peter Brimblecombe's address was entitled "Effects and changes in emission and climate on air pollution"; it covered the importance of the relative balance between pollutant emissions and climate in which there would be a need to examine a complex pattern of change that can override earlier generalised claims that pollutants will necessarily increase in the future. Prof. Dr. Fredolin Tangang spoke on "Climate change and climate variability: From global to regional on science, impacts, solutions and challenges" and highlighted key findings of the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) on the science, impact and mitigation effort required to halt and slow down climate change, and what actions the country must take to avoid severe impacts in the future. Dr. Hiroshi Tanimoto delivered on "Atmospheric chemistry research and international collaborations: The International Global Atmospheric Chemistry (IGAC) Project and the IGAC Monsoon Asia and Oceania Networking Group (MANGO)". He discussed the IGAC MANGO aims to enhance communication and collaborations between scientists, and explore opportunities for funding and infrastructure to foster scientific research, capacity building, and regional collaborations.

At the end of the conference, a panel discussion was moderated by Prof. Dr. Joy Jacqueline Pereira, ANCST Director and Principal Fellow of SEADPRI with panellists Dr. Hiroshi Tanimoto, Dr. James Crawford (NASA Langley Research Center) and Prof. Dr. Abdus Salam (University of Dhaka, Bangladesh). The discussion focused on the future of atmospheric sciences and climate change research, and how environmental matters are a shared problem among countries in the same region. It

was agreed that the collaboration of researchers, data sharing and resources are crucial for understanding and resolving this issue. The discussion encourages further exploration on atmospheric modelling for researchers in this region. Focus also should be emphasized on development of young scientist in this interesting topic. As atmospheric composition and climate change are not limited to the environment alone, a more holistic approach in discussing the impact of environmental issues on other risks including health and exposures, is necessary. It all comes down to the implementation of research into policies and collaboration between researchers from different backgrounds.

September 2018, in Takamatsu, Japan

A committee meeting, science workshop, and training course were held, hosted by NIES, Japan. This event was held jointly with iCACGP and IGAC, and back-to-back with 2018 joint iCACGP Symposium and IGAC Science Conference during 25-29 September 2018, in Takamatsu, Japan (www.icacgp-igac2018.org). We had the committee meeting (intermittently through 25-30 September during the iCACGP-IGAC 2018 conference), 2018 iCACGP/IGAC Early-Career Short Course and 2018 iCACGP/IGAC Early-Career Program (as our training course, on 22-24 September for Early-Career Short Course and 25-29 September for Early-Career Program), and science workshops on the IGAC Activities and Working Groups (on 25-29 September).

The committee meeting was held to discuss priority themes and scientific activities to strongly push forward with regional collaboration in MANGO region. The topics included the changes in atmospheric composition and the resulting impacts, biomass burning, biogenic and anthropogenic emissions, air quality and health, the interplay of the Asian monsoon and atmospheric chemistry, mitigation options. The 2018 iCACGP/IGAC Early-Career Short Course was held in advance of the iCACGP-IGAC 2018 Conference, as part of our training course. This course will cover science-policy engagement and science communication. The module included a variety of teaching formats including group work, individual exercises, panel discussions including local and international representatives, active skills practice, and lectures. The science-policy/science communication module was complemented by leadership training and a demonstration of the scientific excellence of the host region. The 2018 iCACGP/IGAC Early-Career Program was held during the iCACGP-IGAC 2018 Conference. This program included talks focusing on a variety of career skills, early career mixer, lunch with established scientists, and poster and oral presentation competition.

The science workshop events were held every day throughout the conference period, in the style of side meetings introducing and discussing various science activities sponsored or endorsed by IGAC. This was good opportunities for Asian scientists to learn more and in-depth about atmospheric chemistry research led by an international framework, and to connect to global environmental issues or atmospheric sciences in the Asia-Pacific region. Ten IGAC activities were showcased to Asian scientists, for example the activities on Atmospheric Composition and the Asian Monsoon, Chemistry-Climate Model Initiative, Global Emissions Initiative, Air Pollution in the Arctic, Interdisciplinary Biomass Burning Initiative, Cryosphere and Atmospheric Chemistry, Tropospheric Ozone Assessment Report, etc., as well as other community building exercises in Latin America, Southern Hemisphere, and Japan. As Monsoon Asia, we will introduce our activities to broader audience who might be interested in joining and contributing.

May 2019, in Taipei, Taiwan (ROC)

Candice Lung organized a workshop on "Planning Meeting on Air Pollution Sensing and Health in Asia (ASHA)" at Academia Sinica, Taipei, 17-19 May 2019. This event was a kick-off of a research project on air quality and human health: Hi-ASAP. For more details, see below.

June 2019, in Kuala Lumpur, Malaysia

Mohd Talib Latif hosted a fourth workshop on "Atmospheric Composition and the Asian Monsoon (ACAM)" at Universiti Kebangsaan Malaysia (UKM) in Malaysia, 26-28 June 2019.

Atmospheric Composition and the Asian Monsoon (ACAM 2019) has been organised at Universiti Kebangsaan Malaysia (UKM) in Malaysia from 26th to 28th June, 2019, with Mohd Talib Latif as a local organizing committee chair. The workshop was attended by 153 participants from 22 countries. The overall aim of the workshop was to exchange information on the latest results in the very interdisciplinary field of ACAM science and to foster international collaborations in the Asian region and worldwide. Scientific presentations and discussions covered a broad range of topics including air quality, monsoon convection coupled to surface emissions, transport pathways of pollutants into the stratosphere, Asian tropopause aerosol layer (ATAL), and monsoon-climate interactions. Emissions in the Asian monsoon region are still increasing due to rapid population and economic growth, thus, accurate representation of the monsoon system in global chemistry-climate models is critical to predicting climate change.

The workshop program was structured according to the four ACAM themes: 1) Emissions and air quality in the Asian monsoon region, 2) Aerosols, clouds, and their interactions with the Asian monsoon, 3) Impact of monsoon convection on chemistry, 4) Response of the upper troposphere and lower stratosphere to the Asian Monsoon. The workshop included 50 oral and 90 poster presentations. All posters were also introduced in rounds of 1-minute oral presentations. Each session began with scene setting invited talks.

The workshop included also break-out meetings of the three ACAM working groups 1) "Observations and Data Sharing" which aims to identify ACAM-relevant datasets, organize data sharing, and encourage future coordinated observations, 2) "Modeling and Analysis" with the objective to foster interactions between the global and regional modeling communities and to organize ACAM related modeling and analysis, 3) "Training School" which is focusing on the development of future training opportunities for early career scientists on observations and modeling. In the working group meetings the focus of the discussions was on the best way to promote collaborations in the field of ACAM science, e.g. partnership with other modeling communities (e.g. CCMI, AEROCAM) and sharing of data from recent ACAM-related field campaigns. The outcome of the working group meetings were summarized in plenum presentations.

This was the fourth ACAM workshop following the workshops in Kathmandu, Nepal in 2013, Bangkok, Thailand in 2015, and Guangzhou, China in 2017, and provided again an excellent opportunity for ACAM scientists, in particular early career scientists, to highlight their research results. About 30 percent of the oral presentations were given by early career scientists. The discussions during the extended poster sessions and working group meetings allowed the scientists to initiate and strengthen collaborations with international partners.

November-December 2019, in Nainital, India

A committee meeting, science workshop, and training course were held, hosted by Manish Naja at ARIES, India.

Eleven current MANGO committee members, along with twenty-two early career scientists and four invited lectures, gathered in Nainital, a town of beautiful lake in a foothill of Himalaya, in India, for the IGAC-MANGO Meeting, Science Workshop, and Training Course 2019. The main objective of IGAC-MANGO is to form a cohesive network of atmospheric scientists in the Asian monsoon region, facilitate collaboration between Asian and international scientists, and foster the next generation of scientists in this region. This year, we held one-day committee meeting to discuss the updates and future directions of MANGO including membership, new activities, and funding opportunities, followed by two-day science workshop and training course that included sessions dedicated for science-policy and science communication, as well as a joint MANGO-India presentation session, posters including a 1-min flash talk, and training course for satellite data analysis and low-cost sensors. What is unique about this year's meeting is a video-clip competition by MANGO early career scientists called "MANGO Junior" or "green-MANGO".

The sessions devoted to science-policy and science communication comprise four main components: an invited talk, a panel discussion, a video presentation and a sharing talk on case-study related to science communication. The invited talk entitled "Recurrent Haze in Southern ASEAN: What more can we do to prevent it?" given by Prof. David Koh covered multifaceted elements; it overviewed the recurrent smoke emission of burning peat forest in Southeast Asia, the relevant policies built, the progression and challenges of policy implementation, and evolvement of understandings, as well as technologies of protecting public to minimize exposure to airborne smoke pollutants.

Following the invited talk, a panel discussion was convened with five invited members (Drs. David Koh, Shyam Lal, Candice Lung, MM Sarin, and Hiroshi Tanimoto) to share their individual experiences and insights on the gaps and dos-and-don'ts (for scientists) in effective communication linking science and policies. Specific points and questions addressed by the invited panel members include:

- (1) The most rewarding motivation/rationale/experiences driving scientists' participation in science-policy;
- (2) Which aspects/components deserve higher priority/attention/effort for scientists to be prepared and to participate in science-policy related work?
- (3) Suggestions/advice specifically for scientists who are interested in promoting/practicing science-policy in their home countries in the MANGO regions
- (4) When encountering obstacles during science-policy communication, what is the most important advice / encouragement for scientists?

To provide a balanced view, the panel members highlighted to early career scientists (ECS) encouraging them to concentrate on building solid scientific knowledge and research capability. Such endeavor is required to form a solid foundation to contribute to effective science-policy communication during later stages of ones' career development as scientists. In addition, consensus emerges that more discussion involving balanced voice / presence of both scientists and policy makers is needed to enhance mutual understandings and effective communication.

A 20-min video focusing on "What is Science Policy? Why do we want to engage in Science-Policy" made by Drs. Megan Melamed, Erika von Schneidmesser, and Julia Schmale was presented. This

was to ensure that the workshop delegates have proper understandings, a starting point of enhanced exposure to linkage between science and policy. The session in Science-Policy was concluded by a successful story of how scientific findings led to meaningful policy of protecting the public from being overly exposed to emission of burning incense due to religious activities in Taiwan. Dr. Candice Lung detailed local-culture-specific understandings in the mindset of public and policy makers, obstacles encountered and perseverance required to convince policy makers. This was followed with lively Q&A, encouraging all MANGO countries to endeavor dynamic practice. Some feedbacks on the overall MANGO 2019 workshop specifically and positively pointed out that the individual components in the Science-Policy session provided stimulating information, refreshing perspectives, and fruitful learning points to both ECS & MANGO members.

The MANGO 2019 workshop launched a new initiative on “MANGO Flavored Research-Educational Video Competition”. This aims to enhance effective scientific learning & sharing through video literature that demonstrate (a) novel scientific research findings in MANGO region (thus “Mango flavored”), and/or (b) better explanation & understanding of existing yet challenging scientific concepts related to scope within IGAC. The rationales, grading scheme and easy submission steps were circulated and posted at the workshop web site prior to the workshop. The organizing committee was pleased of receiving a total of 10 submissions. All the MANGO members and invited delegates participated in the viewing and marking of all submitted videos. During the last session of the workshop, as a mini “Mango-flavored Oscar awarding ceremony” the top two winning video clips were played and awarded with nicely made mementoes and certificates. Once the agreement is reached, the winning video clips can be posted to the MANGO website for viewing. Certificates of commendation award were emailed to individual awardees. The enthusiastic participation of the MANGO ECS in this initiative indicates a potential to continue this endeavor to continuously promote more effective e-video literacy.

Parallel sessions for training course on satellite data handling/visualization and on low cost sensors was also organized. Silvia Bucci gave lectures and hand-on training on satellite data retrievals with demonstration of GOME-2, Sentinel 5P, and CAMS data handling. Lectures and hand-on training on low cost sensors was done on the next day by Tomoki Nakayama and Iq Mead. “Green-MANGOs” were grouped for making observations by the low cost sensors at different places this was followed by short presentations. Low-cost sensors were also provided to interested students/scientists for observations in their own countries. Manish Naja demonstrated onsite launch of ozonesonde and radisonde.

A MANGO-India session was organized on the second day and total 14 presentations were made, including two remote presentations. This session has provided an overview on the scientific research being carried out in the members’ countries. It has helped in sharing the information on status of air pollution and will contribute in focusing on the themes for future research in Asia. It was reminded that so far, there has been only two major international observational field campaigns (INDOEX and Suskat) in the South Asia. Considering the complexity and intensity of emissions sources it is very important to have extensive observations, with open data policy, over this region where Himalayas is on North and pristine oceanic regions are on South with a huge human population in between.

Research project on air quality and human health: Hi-ASAP

“Health Investigation and Air Sensing for Asian Pollution (Hi-ASAP) Initiative” is developed under the umbrella of IGAC-MANGO. The main goal of this Hi-ASAP is to provide scientific evidence to support effective policy actions to reduce air pollution levels, in particular PM_{2.5}, in this region by

applying newly developed low-cost sensing devices. Research groups from 17 different areas in the Asia and the Pacific region have expressed their interests to join Hi-ASAP initiative.

The initiative will conduct panel-type epidemiological studies in different study areas across the Asia and the Pacific region with a common methodology in environmental and community monitoring, exposure assessment, and exposure-health evaluation with newly developed low-cost sensing devices. In addition, PM_{2.5} chemical compositions and toxicity will be assessed focusing on chosen Asian distinctive exposure sources. Different stakeholders will be engaged in each stage of this Hi-ASAP to ensure the transferability of the research findings. International comparison and synthesis will be made to evaluate key determinants of ambient PM_{2.5} levels, PM_{2.5} exposure sources and activities, and short-term PM_{2.5} damage coefficients of exposure-health relationships of the study areas. The quality assurance and quality checking (QA/QC) of low-cost sensing devices used in the Hi-ASAP will be performed before collecting any data. QA/QC procedures will be implemented to ensure meeting the data quality objectives. Data policy will be strictly enforced to ensure the quality of the scientific findings.

The first phase of Hi-ASAP spans five years, including preparation (2019), start-up (2020), intensive monitoring (2021), data analysis (2022), and publication (2023) periods. Training workshops or discussion meetings will be held every year so that all participating research groups will carry out the same methodologies across different study areas, stimulate multidisciplinary interactions, and streamline international collaboration. Eleven working groups were established with enthusiastic conveners and clear planned objectives and schedule in mind. It is our deepest wishes that the scientific findings from this research activity would ultimately lead to an effective reduction in exposure levels of air pollutants, in particular PM_{2.5}, of Asian residents and the associated health risks.

One planning meeting was held in Academia Sinica, Taipei, Taiwan on May 17-19th, 2019, in the presence of representatives of 15 research groups in the Asia and the Pacific region. The science and implementation plan of Hi-ASAP discussed was later endorsed by Regional Centre of Future Earth in Asia as a Future Earth regional research activity. The first training workshop was held in September 2-6, 2019 in Taipei, Taiwan. The second training workshop will be held in Kuala Lumpur, Malaysia in 2020.

Efforts to engage MANGO early career scientists to the international community

Mr. Kohei Sakata (Japan), Ms. Sakiko Ishino (Japan), Mr. Manish Kumar (India), and Mr. Maximilien Desservettaz (Australia) served as members of the 2018 iCACGP/IGAC Early Career Program Organizing Committee (ECPOC) at the 2018 joint 14th iCACGP Quadrennial Symposium and 15th IGAC Science Conference (<http://icacgp-igac2018.org>), to be held in Takamatsu, Kagawa, Japan, 25-29 September 2018. For more details, see <http://igacproject.org/igac-early-career-program/2018ECSC>.

Ms. Nor Hafizah Baharudin (Malaysia) and Ms. Xiang Peng (Hong Kong) will be serving as members of 2020 IGAC Early Career Short Course Organizing Committee at the 2020 16th IGAC Science Conference (<https://igac2020.com>), to be held in Manchester, UK, 14-18 September 2020. For more details, see <http://igacproject.org/igac-early-career-program/2020ECSC>.

Outreach to high-school students

In collaboration with local governments, and a local university and high-schools, the following outreach event was conducted, in conjunction with the iCACGP-IGAC 2018 Conference.

- Listen to the Nobel Lecture

High-school students were invited to a lecture entitled “Achievement and Challenges of Atmospheric Chemists” by Prof. Yuan Tseh Lee, Nobel Laureate in Chemistry, 1986, as well as President Emeritus and Distinguished Research Fellow, Academia Sinica, Taiwan, and also Former President of the International Council for Science (ICSU).

4. Conclusions

The overarching objective was to enhance capability and capacity of air quality research with emphasis on its links to human health and climate change, including components on trans-disciplinary collaboration. In order to achieve this goal, we made a coordination across Asian nations, especially with a focus on countries that are not big enough to have national working groups, resulted in a cohesive network of atmospheric scientists in the Asian monsoon region. This group is called IGAC-MANGO, under the IGAC project that is operated under the sponsorship of Future Earth and iCACGP. The IGAC-MANGO acts as a platform for developing countries (or small communities) to exchange on best practices with developed countries (or large communities). The MANGO committee oversees the scientific activities in the region, and holds scientific workshops and capacity building activities, including training courses for students and early-career scientists. With these activities the project is fostering the next generation of scientists in this region to better understand current air quality and regional climate change issues (such as PM_{2.5} and health, SLCP (Short-Lived Climate Pollutants) and near-term climate mitigation), and interact with policymakers and decision-making bodies, including national and local governments in Asia, international organization such as UNEP and WHO, and other stakeholders. In general, the project has moved smoothly. Because of the schedule conflicts with other events in our research fields, we had to change the dates and locations of the planned events. However, the two major events organized by us were very successful.

5. Future Directions

By using a cohesive network of atmospheric scientists in the Asian monsoon region as a solid basis, we will further facilitate collaboration between Asian and international scientists, and accelerate fostering the next generation of scientists in this region. We will also continue its efforts to engage more countries from currently under-represented countries in Asia, for example, Cambodia, South Korea, Bhutan, Maldives, and New Zealand. For Cambodia, South Korea, Bhutan, and Maldives, we already identified potential contacts.

Since the project is greatly relevant to environmental policy at national and regional levels, in particular air pollution mitigation policy, we will try to engage the TF-HTAP (Task Force on Hemispheric Transport of Air Pollutants), which is an international, cooperative, scientific effort to improve the understanding of the intercontinental transport of air pollution across the Northern Hemisphere, organized in 2005 under the auspices of the UNECE Convention on Long-range Trans-boundary Air Pollution (LRTAP Convention). Since there are no Asian countries participating in this

convention, the project will contribute substantially to the scientific basis needed for policymakers to consider participation in future.

The project is also relevant to global change and sustainability projects in the era of Anthropocene, specifically IGAC. In addition, the project will be able to contribute to “Health” KAN (Knowledge-Action Networks) under Future Earth. Through dialogues with these projects, we will foster the relationships needed to integrate the scientific basis into real actions in Asia.

References

Tanimoto, H., Kim Oanh, N. T., Lawrence, M. G. (2015). Planning Workshop for Developing a Framework for Cooperation Between IGAC Activities in Asia. IGAC news, 54, 16-17.

Tanimoto, H., Kim Oanh, N. T., Lawrence, M. G. (2015). Workshop for developing priority themes and activities for IGAC Monsoon Asia and Oceania Networking Group (IGAC-MANGO). IGAC news, 55, 12-13.

IGAC-MANGO website: <http://cger.nies.go.jp/gac/igac-mango/>

iCACGP-IGAC 2018 Early Career Short Course: <http://icacgp-igac2018.org/early-career-scientists/ec-short-course/>

iCACGP-IGAC 2018 Early Career Program: <http://icacgp-igac2018.org/early-career-scientists/ec-conference-program/>

Appendix

Conferences/Symposia/Workshops

Agenda and participants (including early career scientists, requested below) list for the below-listed events are attached.

“IGAC Monsoon Asia and Oceania Networking Group (IGAC-MANGO) Meeting, 29 - 30 September 2018, Takamatsu, Kagawa, Japan”

“IGAC-MANGO Meeting, Science Workshop, and Training Course, 28 November - 1 December, Nainital, India”

Funding sources outside the APN

NIES provided 15,000 USD co-funding to support travel expenses for participants. Hiroshi Tanimoto and his staffs provided in-kind contribution to support administrative help in organizing meeting and workshop.

IGAC provided 10,000 USD co-funding to support travel expenses for participants in 2018 and 2019. Megan Melamed provided in-kind contribution to support administrative help in organizing meeting and workshop.

ARIES provided 5,000 USD co-funding to host the 2019 event in India. Manish Naja and his staffs/students provided in-kind contribution to support administrative help in organizing meeting and workshop.

IASS provided in-kind support for science-policy engagement module development and implementation, with the leadership of Erika von Schneidemesser.

Academia Sinica provided in-kind support for developing the air quality-human health project, with the leadership of Candice Lung.

UKM provided in-kind contribution to support administrative help in organizing meeting and workshop, with the leadership of Mohd Talib Latif.

List of Young Scientists

List of ECS for the below-listed events are attached. For 2018, essays by 16 ECS are also attached.

“IGAC Monsoon Asia and Oceania Networking Group (IGAC-MANGO) Meeting, 29 - 30 September 2018, Takamatsu, Kagawa, Japan”

“IGAC-MANGO Meeting, Science Workshop, and Training Course, 28 November - 1 December, Nainital, India”

Glossary of Terms

IGAC: International Global Atmospheric Chemistry

iCACGP: international Commission on Atmospheric Chemistry and Global Pollution

HTAP: Hemispheric Transport of Air Pollutants

ECS: Early Career Scientists

SOLAS: Surface Ocean - Lower Atmosphere Study

iLEAPS: integrated Land Ecosystem - Atmospheric Processes Study

Detailed report is attached on “IGAC Monsoon Asia and Oceania Networking Group (IGAC-MANGO) Meeting, 29-30 September 2018, Takamatsu, Kagawa, Japan”

Publications in IGAC news are attached.

- Tanimoto, H., IGAC MANGO side meeting, IGAC news, 63, 16-18, 2018.
- Tanimoto, H., T. Nagashima, S. Inomata, Colette Heald, Melita Keywood, Kohei Sakata, and Sakiko Ishino, 2018 joint 14th iCACGP Quadrennial Symposium and 15th IGAC Science Conference, IGAC news, 63, 16-18, 2018.
- Ishino, S., K. Sakata, A. Mbandi, M. Kumar, M. Desservettaz, M. Willis, Z. Tzompa-Sosa, 2018 iCACGP/IGAC Early Career Short Course, IGAC news, 63, 14-15, 2018.
- Naja, M., L. Yu, A. Salam, and H. Tanimoto, IGAC-MANGO Meeting, Science Workshop, and Training Course 2019, IGAC news, 66, in press, 2020.

Articles in a local newspaper are also attached.

- Shikoku News, Japan – 22 and 26 September 2018
- Newspaper in Nainital, India