The Twenty-first Session of the Scientific Advisory Committee
on the Acid Deposition Monitoring Network in East Asia
26-28 October 2021, Virtual Meeting

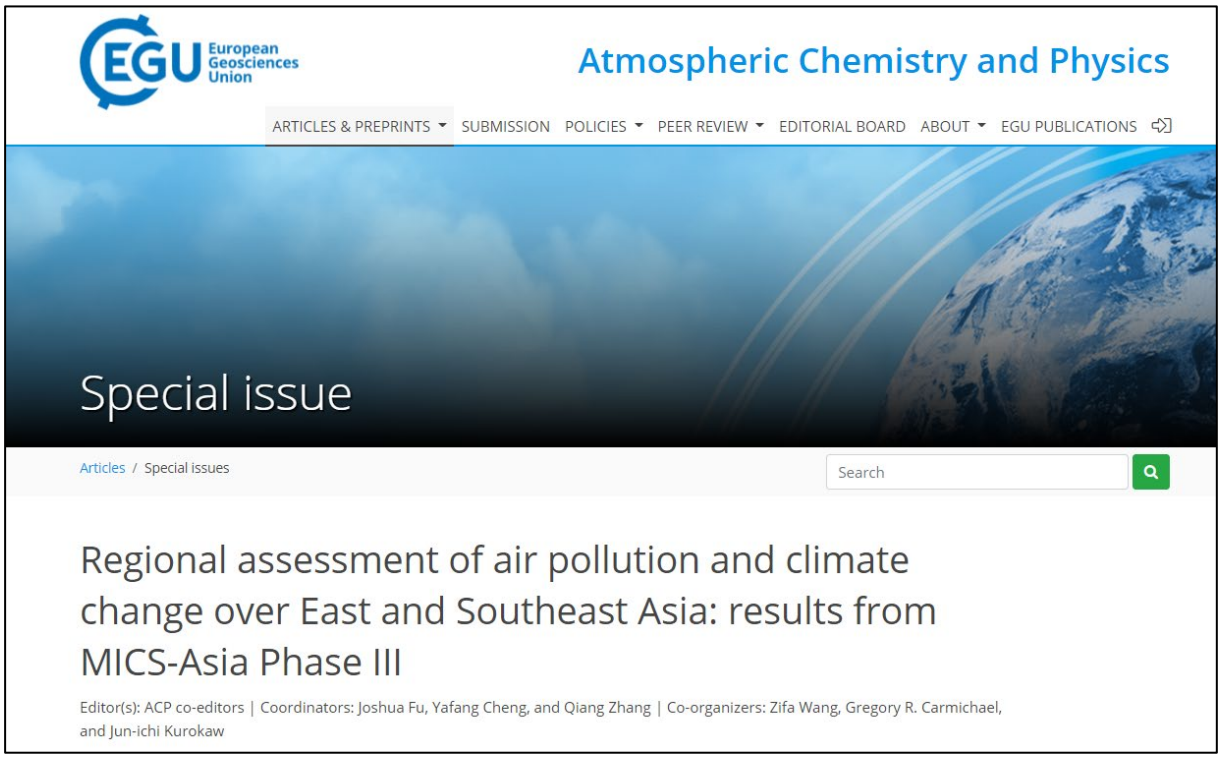
PROGRESS OF THE JOINT RESEARCH ACTIVITIES ON MODEL INTER-COMPARISON STUDY FOR ASIA (MICS-ASIA)

I. BACKGROUND

1. Air pollution and demand for energy, motorization, industrial and agricultural products is a serious problem in Asia, especially its impact on public human health. In addition, the huge growth of anthropogenic emissions in Asia affects local air pollutions and regional, intercontinental, and global air quality and climate change. Air quality and climate models are effective scientific tools for understanding the atmospheric environment's status and evaluating the effects of mitigation measures. However, current modeling systems have problems in reproducibility of monitoring results and differences among simulated results by different models. Therefore, understanding current model performances and uncertainties in Asia and improving the modeling system is essential for utilizing atmospheric models, especially for international air pollution and climate change problems.

2. Under such backgrounds, MICS-Asia Phase I (1998-2000) for sulfur compound, Phase II (2004-2009) including nitrogen compounds, ozone, and aerosols, and Phase III (2010-2020), further including relationships between air pollution and climate change were carried out as international initiatives of model inter-comparison study. The findings of the Phase II activities were published in Atmospheric Environment in 2008 (Carmichael and Ueda, 2008: https://doi.org/10.1016/j.atmosenv.2007.10.003). Those of Phase III was published in the Special Issue in Atmospheric Chemistry and Physics titled "Regional assessment of air pollution and climate change over East and Southeast Asia: results from MICS-Asia Phase III" (Fig.1). Finally, 26 scientific papers were published in the Special Issue of MICS-Asia Phase III.

3. In MICS-Asia Phase III, the International Workshop on Atmospheric Modeling in East Asia organized by the Asia Center for Air Pollution Research and the Chinese Academy of Sciences/Institute of Atmospheric Physics was held every year to discuss basic strategies and work plans, results, related scientific researches and next steps of MICS-Asia. The 11th International Workshop on Atmospheric Modeling in East Asia was supposed to be held in early 2020, but it was canceled due to the COVID-19 pandemic. Instead, the virtual meeting among key members was held in March 2020. At the meeting, review comments and responses to papers submitted to the Special Issue were sheared, and based on them, potential targets and research themes of Phase IV were discussed. Unfortunately, because of the unstable situation of the COVID-19, it was still difficult to hold the face-to-face event. The 11th International Workshop on Atmospheric Modeling in East Asia (hereafter the 11th MICS-Asia Workshop) was held in March 2021, calling for all interested participants in MICS-Asia activities. After reviewing specific scientific and project management issues related to MICS-Asia Phase III, basic strategies and how to proceed MICS-Asia Phase IV were discussed at the workshop. Results of the workshop are reported in this document.



II. REVISE OF ISSUES IN MICS-ASIA PHASE IV AND BASIC STRATEGIES OF MICS-ASIA PHASE IV

4. At the beginning of the 11th MICS-Asia Workshop, major scientific issues pointed out in Phase III that need to be considered in Phase IV were confirmed. The major ones were as follows:
   - The spatial resolution of models in Phase III (45 km) is not enough for detailed analysis. Simulations in higher resolution are necessary for Phase IV.
   - Contributions of different physical and chemical processes need to be analyzed. Necessary sensitivity simulations and model output data for process-oriented analysis should be discussed.
   - It is necessary to collect more observation data for model analysis in Phase IV, such as local data, satellite observation data, chemical reanalysis data, etc.
   - Analysis of specific events is important, and more case studies are necessary.

5. In addition, to specific scientific issues, problems in the project management of Phase III were also reviewed. Major points were as follows:
   - It is very important in Phase IV to speed up the progress of implementation of actual works.
   - Targets for analysis should be more flexible than those in Phase III.
   - Communication among participants must be improved.
   - Linkages with related communities should be established more.
   - Outreach activities need to be more focused.

6. Considering discussed what should be learned from Phase III, basic strategies of Phase IV was discussed, and major topics were summarized as follows:
   - Inter-comparison studies for air quality models
   - Inter-comparison studies for air quality and climate change models
   - Development of emission inventories in Asia
   - Collecting and analyzing observations in Asia
   - Improvement and development of air quality and climate change models.
   - Capacity-building activities
   - Outreach activities such as websites and publications

7. Working groups were established for the following four major topics:
   - Inter-comparison studies for air quality models
   - Inter-comparison studies for air quality and climate models
   - Development of emission inventories in Asia
   - Collecting and analyzing observations in Asia

III. OUTLINE OF WORKING GROUPS OF MICS-ASIA PHASE IV

Air Quality Model Working Group

8. This working group is the successor of Topic 1 of Phase III, and Topic 4 of Phase III is merged into this working group. Leading researchers are Dr. Tatsuya Nagashima of National Institute for Environmental Studies, Japan, Syuichi Itahashi of Central Research Institute of Electric Power Industry, Japan, Jie Li and Baozhu Ge of Institute of Atmospheric Physics/Chinese Academy of Science, China.

9. It was introduced at the 11th MICS-Asia Workshop that preparing the list of Target (species), Focus (problems in model simulated results), and Requirements (diagnostic, variable, experiment, observations, etc.) is the first step to develop the work plan. Experimental designs for Phase IV simulations should be based on the requirements. It was also noted that links to other international projects such as Tropospheric Ozone Assessment Report (TOAR), The Task Force on Hemispheric Transport of Air Pollution (TH HTAP), The Measurement-Model Fusion for Global Total Atmospheric Deposition (MMF-GTAD) are important. Furthermore, it was pointed out that analysis related to COVID-19 and carbon-neutral issues could be a target of Phase IV.

10. The work plan in 2021 was proposed as follows:

    - Preparation of lists of targets, focus points, and requirement for analysis
    - Design of simulations (Domain, period, list of history output, etc.)
    - Preparation of model input data (meteorological fields, lateral boundary, emission data, etc.)
    - Preparation of observation data for model validation

Air Quality and Climate Change Model Working Group

11. This working group is the successor of Topic 3 of Phase III. Leading researchers are Dr. Meng Gao of Hong Kong Baptist University, China, and Zhiwei Han of the Institute of Atmospheric Physics/Chinese Academy of Science, China.

12. At the 11th MICS-Asia Workshop, the following science issues were discussed:

- Assumptions in aerosol's mixing state (and size distribution) are very important in the model inter-comparison study and should be focused more on in Phase IV.
- Relationships of O_3 and PM formation are very important both through radiative effects and aerosol surface chemistry.
- Indirect effects which were not studied in Phase III (wintertime haze episodes) would be a research topic in Phase IV (summertime episodes).
- Future projected simulation requires more computational costs. Therefore, it should be considered how many participants are interested in it, and further discussions on targets such as target years and scenarios are necessary among them. Scenarios created by IIASA for carbon and agricultural policies are interesting for future projected simulations.
- Vertical distribution and boundary layer processes related to the analysis of climate change are important.
- India and studies related to carbon neutral and SGDs are also considered as potential topics.

13. The work plan in 2021 was proposed as follows:

- Establishment of research topics such as:
  - Examination of factors of uncertainties in air quality and climate change model
  - Evaluation of interaction between $PM_{2.5}$ and O_3
  - Evaluation of indirect effects
  - Analysis focusing on India
  - Future projected simulations
  - Carbon neutral
- Establishment of small groups for specific air quality and climate change topics
- Relationship with other research communities such as AeroCom (Aerosol Comparisons between Observations and Models), Air Quality Modelling Evaluation International Initiative (AQMEII), Chemistry-Climate Model Initiative (CCMI), etc.

Emission Inventory Working Group

14. This working group is the successor of Topic 2 of Phase III. Leading researchers are Dr. Meng Li of National Oceanic and Atmospheric Administration (NOAA), US, Qiang Zhang of Tsinghua University, China, and Jung-Hun Woo of Konkuk University, Republic of Korea.

15. At the 11th MICS-Asia Workshop, the design and components of MIX (Mosaic Asian anthropogenic emission inventory for MICS-Asia) version 2 were reviewed. General information of MIXv2 is as follow:

- Target Year: 2010-2017 or 2018
- Target Region: East and South Asia
- Target Sources: Major anthropogenic sources (Fuel combustion, Industrial process, Agricultural activities, etc.)
- Target Species: SO_2, NO_x, CO, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, BC, OC, and CO_2
- VOC Speciation: SAPRC99, SAPRC07, and CB05
- Spatial Resolution: 0.1 degree by 0.1 degree
- Temporal Resolution: Monthly

16. The work plan in 2021 was proposed as follows:

- Development of the first version of MIXv2
- Development of natural emission data (if possible)
- Preparation of other emission data (biomass burning, international navigation, aviation, etc.)

Observation Working Group

17. This working group is newly established from Phase IV. Currently, only Dr. Keiichi Sato of Asia Center for Air Pollution Research, Japan, is a leading researcher of this working group. More researchers need to be invited to the leaders.

18. At the 11th MICS-Asia Workshop, the following opinions were raised:

- It was pointed out collaboration with the TOAR-II East Asia working group is important. MICS-Asia and TOAR compensate each other.
- Model-measurement fusion (MMF) is also an important activity. WMO research project focuses on ozone and nitrogen and sulfur depositions, but concentrations should be included in MICS-Asia This activity is related to SDGs such as agriculture and ecosystem. The small group for MMF should be organized.
- Organic nitrogen observation data is currently missing.
- It was pointed out that considering observation campaign data such as NO_y, HONO, and HNO_3 is important. It was informed that hourly observation of NH_3 was conducted at five stations in China after 2017. MAX-DOAS observations are implemented in China, which show the vertical profile of gaseous species. These data are helpful for model validations.
- It was pointed out that we should think about how to collect and use satellite data for MICS Asia Phase IV and discussion with experts of satellite observation is necessary.

19. The work plan in 2021 was proposed as follows:

- Call for researchers interested in the observation working group
- Preparation of catalog list of available observation data (such as ground, vertical, and satellite observation) for model validation in MICS-Asia Phase IV
  - EANET data
  - National monitoring data
  - Research base data, including campaign data
  - Collaboration with TOAR (Tropospheric Ozone Assessment Report)-II East Asia Focus Working Group
  - Others
- Collaboration with modeling researchers for such as MMF and Reanalysis data.

IV. NEXT STEPS

20. It was proposed to hold the 12th MICS-Asia Workshop as follows:

- Date: on the second half of February 2022
- Venue: Web conference (or hybrid style considering the situation of COVID-19)
- Agenda:
  - Progress reports of each working group and discussion on next steps
  - Research presentations from participants of MICS-Asia
  - Presentations from invited researchers outside MICS-Asia and discussion on future collaboration (In addition to other modeling communities, researchers of related fields will be invited.)