Progress of the model intercomparison study in MICS-Asia Phase II

Tatsuya Sakurai[1*], Kazuhide Matsuda[1], Hiromasa Ueda[2],
Zhiwei Han[1] and Hiroshi Hayami[3]

[1]Acid Deposition and Oxidant Research Center (ADORC), Niigata, Japan
[2]Disaster Prevention Research Institute, Kyoto University, Kyoto, Japan
[3]Central Research Institute of Electric Power Industry (CRIEPI), Tokyo, Japan
* Corresponding author: sakurai@adorc.gr.jp

1. Introduction

The 4th workshop on the Transport of Air Pollutants in Asia (Model Intercomparison Study; MICS-Asia) was held on October 22-23, 2001 at IIASA in Austria. This workshop reviewed the activities of Phase I. While the Phase I focused exclusively on sulfur compounds, it was recognized that a wider perspective could yield important insights including nitrogen compounds, ozone and aerosols to be critical for effective control of various environmental problems.

The 5th Workshop was held on 20-21, January 2003 at IIASA, Austria. This workshop clarified the specifics of Phase II model intercomparison study together with emission inventory intercomparison. After the workshop, ADORC established the web site of MICS Asia Phase II (http://www.adorc.gr.jp/adorc/mics.html) to announce and coordinate the model intercomparison activities. Standard input data were prepared by Dr. D. Street, ANL and Prof. G. Carmichael, CGRER (emission data), Prof. Z. Wang, IAP (reference meteorological field), Dr. T. Holloway, the University of Wisconsin-Madison (boundary condition) and ADORC as Network Center for EANET (monitoring data).

The 6th Workshop was held on 9-10, February 2004 at IIASA, Austria. The participants reported their preliminary results on the tasks of model or emission inventory intercomparison. Intensive monitoring data of LTP project were provided by Dr. Il-Soo Park, NIER. Based on the discussion on the preliminary results, the specifics were elaborated especially on the treatment of emission and the data protocol. 7 modeling groups shown in Table 1 submitted their model results according to the data protocol until November 2004.

Table 1 Participating modeling teams of MICS-Asia Phase II

Modeling teams	
Prof. G. Carmichael and Dr. N. Thongboonchoo	CGRER, USA
Dr. M. Engardt and Dr. C. Bennet	SMHI, Sweden
Dr. C. Fung and Dr. A. Chang	Hong Kong EPD, China
Dr. Z. Han	ADORC, Japan
Dr. H. Hayami	CRIEPI, Japan
Prof. Soon-Ung Park	Seoul National Univ., Korea
Prof. H. Ueda and Mr. M. Kajino	DPRI Kyoto Univ., Japan

2. The 1st Meeting of the Working Group at Kyoto Univ. in November 2004

The 1st Meeting of the Working Group on MICS-Asia Phase II was held on 18-20 November 2004 at Kyoto University, Japan. Results of preliminary analysis for the model intercomparison among the seven model results were discussed. General comments and conclusions were done as follows:

- Eight model results submitted will be analyzed by WG for the first publications. Other model results will be invited for the further comparisons after the first publications.
- There are large discrepancies among current model results. ADORC should contact the modelers to confirm some errors on unit conversion, accumulation period of deposition etc. ADORC also should contact the participants to clarify exact input data and detailed mechanism. Preliminary analysis should be done using same scale and domain. Comparison with monitoring data should be done by each site classification (remote, rural, urban). Under estimation of Russian sites and Rishiri (Hokkaido) are possibly caused by uncertainty of emissions in Russia. The forest fire of Siberia in March 2002 should be taken into account for the analysis of Case 4.
- Topics analyzed by Working Group members were clarified as follows:
  - Dr. Z. Han (ADORC): Ozone and its relevant gases
  - Dr. H. Hayami (CRIEPI): Aerosols
  - Prof. Z. Wang (IAP): Deposition
  - Dr. T. Holloway (the University of Wisconsin-Madison): Relationship with global model

After the Working Group meeting, ADORC conducted questionnaire survey to the model groups and further compilation on the model intercomparison following the suggestions from the meeting. And Working Group member analyzed the results compiled on each topic. Working Group plans to make presentations and publications on individual topics.

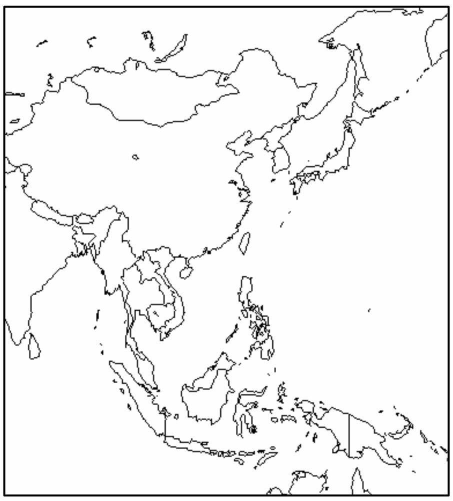
[First presentation and publication]

- Working Group member would make presentations at AASQ2005 in San Francisco and/or at Acid Rain 2005 in Prague, Czech and submit papers on each topic to the journal "Atmospheric Environment".
- Individual modelers are encouraged to make presentations and publications on their own works regarding Phase II activities.
- Presentations and publications on emission inventory intercomparison study are also encouraged.

3. Preliminary analysis

3.1. Description of intercomparison study

It was requested to run the model for the domain shown in Figure 1 during the period of March, July, and December in 2001, and March in 2002. Preliminary analysis focused on making the spatial distribution maps of concentrations, depositions, meteorological fields, and dry deposition velocities for individual model results. Moreover, the model comparison was conducted based on the monitoring data provided by EANET and LTP project.



Domain: 15S-60N, 75E-160E
Grid size: 0.5 by 0.5 deg.

Period
- March 2001
- July 2001
- December 2001
- March 2002

Figure 1 Study domain and period for MICS-Asia Phase II

Table 2 shows the basic information of individual models. Seven participating models were named from Model-1 to Model-7 according to the order of data submission.

Table 2 Basic information of individual model condition

	Number of domain	Grid resolution	Center	Map projection
Model-1	145 x 195	45 x 45 km	112E/25N	Lambert
Model-2	143 x 133	40.5 x 40.5 km	112.4E/21.21N	Lambert
Model-3	110 x 60	0.5 x 0.5 deg.	118E/36N	Lon/Lat
Model-4	110 x 60	0.5 x 0.5 deg.	118E/36N	Lon/Lat
Model-5	90 x 60	80 x 80 km	115E/25N	Lambert
Model-6	166 x 134	0.5 x 0.5 deg	116.5E/20.5N	Lon/Lat
Model-7	166 x 144	45 x 45 km	105E/25N	Lambert

3.2. Preparation of spatial distribution maps

The distribution maps and GrADS dataset (*.dat and *.ctl) of monthly averaged concentrations, depositions, meteorological fields, and dry deposition velocities were prepared within the same domain and value scale. In addition, the distribution maps of daily averaged concentrations were also prepared as reference materials.

An analysis of concentrations focused on 13 species (SO_2, NO, NO_2, HNO_3, PAN, NH_3, O_3, sulfate, nitrate, ammonium, SO_4^{2-} in precipitation, NO_3^- in precipitation, and NH_4^+ in precipitation) in the layer including the height of near surface, 300, 1500, 3000 and 6000 meters above ground level. To compare the distribution between gaseous and particulate in atmosphere, dataset of gaseous species which unit was converted from ppb to g/m^3 based on the individual meteorological fields were also prepared.

An analysis of deposition focused on 7 species (SO_2, HNO_3, NH_3, O_3, sulfate, nitrate, and ammonium) for dry deposition and 3 species (SO_4^{2-}, NO_3^-, and NH_4^+) for wet deposition.

An analysis of meteorological fields focused on the wind speed and direction, temperature, and relative humidity in the five layers. The evaluation for wind speed and direction were represented by wind vector analysis.

3.3. Monitoring data as an index for model results

The monthly averaged concentrations of 7 models were compared at 43 EANET sites using the monitoring data as an index. Detailed comparison between simulation and monitoring was made at selected sites on a daily basis. Moreover, Aircraft data of LTP project were used for an analysis of vertical profile (Presented by Dr. Han, Kyoto working group meeting in Nov. 2004).

Table 3 shows the information of selected sites. Automatic monitoring method (AT) and Filter-Pack monitoring method (FP) were applied for air concentration monitoring.

Table 3 Parameter for monitoring sites and data

Site Name	Characteristics	Lat	Lon	Country	Method	Parameter for comparison
Jinyunshan	Rural	29.82	106.37	China	AT	SO_2, NO_2
Weishuiyuan	Rural	34.37	108.85		AT	SO_2, NO_2
Hongwen	Urban	24.47	118.13		AT	SO_2, NO_2
Xiang-Zhou	Urban	22.27	113.57		AT	SO_2, NO_2
Xiaoping	LTP site	24.85	118.03		AT	SO_2, NO_X, O_3
Fujiazhuang	LTP site	38.87	121.62		AT, FP	SO_2, NO_X, O_3, Sulfate, Nitrate
Rishiri	Remote	45.12	141.23	Japan	AT	SO_2, NO, NO_2, O_3
Ogasawara	Remote	27.83	142.22		AT	SO_2, NO, NO_2, O_3
Sado-seki	Remote	38.23	138.40		AT	SO_2, NO, NO_2, O_3
Happo	Remote	36.68	137.80		AT	SO_2, NO, NO_2, O_3
Oki	Remote	36.28	133.18		AT	SO_2, NO, NO_2, O_3
Hedo	Remote	26.85	128.25		AT	SO_2, NO, NO_2, O_3
Tanah-Rata	Remote	4.47	101.38	Malaysia	FP	SO_2, HNO_3, Sulfate, Nitrate
Terelj	Remote	47.98	107.48	Mongolia	FP	SO_2, HNO_3, Sulfate, Nitrate
Los-Banos	Rural	14.18	121.25	Philippines	FP	SO_2, HNO_3, Sulfate, Nitrate
Cheju*	Remote	33.30	126.17	Korea	AT, FP	SO_2, NO_X, O_3, Sulfate, Nitrate
Ganghwa	LTP site	37.88	126.45		AT, FP	SO_2, NO_X, O_3, Sulfate, Nitrate
Taean	LTP site	36.73	126.13		AT, FP	SO_2, NO_X, O_3, Sulfate, Nitrate
Geoje	LTP site	34.70	128.58		AT, FP	SO_2, NO_X, O_3, Sulfate, Nitrate
Mondy	Remote	51.67	101.00	Russia	FP	SO_2, HNO_3, Sulfate, Nitrate
Samutprakarn	Urban	13.73	100.57	Thailand	AT	SO_2, NO, NO_2, O_3
Hoa-Binh	Rural	20.82	105.33	Vietnam	FP	SO_2, HNO_3, Sulfate, Nitrate

* Cheju has EANET and LTP monitoring data.

Sampling period of LTP monitoring was 5-15 March in 2002.

Method; AT: Automatic monitoring method, FP: Filter-Pack monitoring method

Unit; Gaseous: ppb, Particulate: g/m^3

$NO_2 = NO_X^* - NO$

3.4. A questionnaire survey for the model excursion

Shown in Table 2, domain size and grid resolution were various for each models. In addition, every modeling team used own meteorological fields. On the other hand, input emission inventory was the same for every model and 6 modeling teams used standard boundary conditions based on MOZART calculated by Dr. T. Holloway.

In order to support the analysis by Working Group, a questionnaire survey about the mechanism and detailed input data for the model excursion was conducted. By the survey, scheme of processes and condition for simulation like vertical coordinate, volcanic emission, or meteorological reanalysis data could be considered for comparison analyses.

Acknowledgement

Finally we would like to extend our heartfelt thanks to great supports and efforts for MICS-Asia study by all of participants.

General results of preliminary analysis

http://www.adorc.gr.jp/adorc/mics/analyses/