The Fifth Senior Technical Managers' Meeting
of the Acid Deposition Monitoring Network
in East Asia
28-30 September 2004, Niigata, Japan

Review of Ongoing Research Activities

I. Joint research project with Russia

INC/NC started implementing to the joint research project Phase 1 on "Standardization and Advancement of Assessment Methods of Acid Deposition in Frigid Zone" with the Limnological Institute, Russian Academy of Science, Siberian Branch (RAS/SB) at 1998. Main objective of the project was to obtain basic information for improving monitoring methodologies applicable to frigid zone by implementing test monitoring in accordance with the technical manuals on Acid Deposition Monitoring Network in East Asia (EANET). This project had continued until 2001.

NC has been implementing the joint research project Phase 2 on "Evaluation of Atmospheric Environment in East Siberia and Primorsky Region" with the Limnological Institute since 2002. The objective of the project is to obtain basic information on atmospheric environment in East Siberia and Primorsky Region and on trans-boundary air pollution over North East Asian/Pacific part in Northern Hemisphere. In the project, data analysis of wet and dry deposition in East Siberia and Promorsky Region has been carried out using monitoring data obtained by the method developed on the previous project[1)].

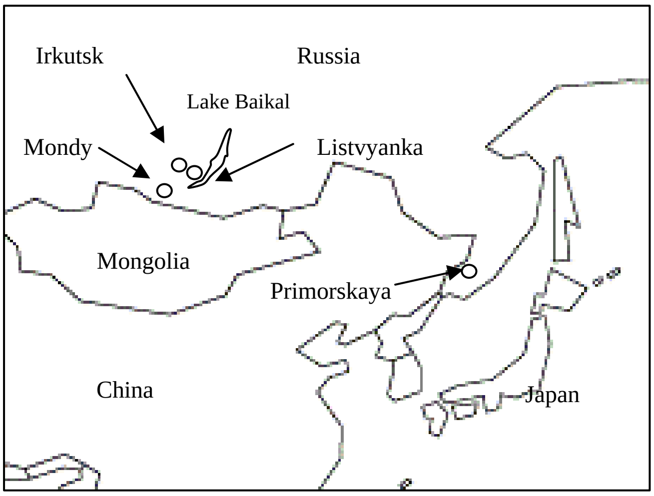


Fig.1 Location of monitoring sites

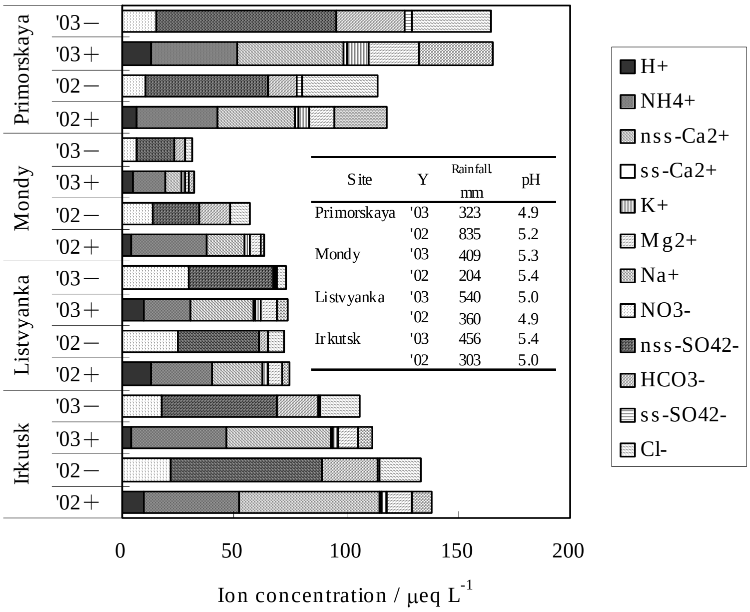
This project will be continued until 2004. The summary of 2002 and 2003 research activities is as follows.

1. Introduction

East Siberia and Primorsky Region in Russia are located in northeastern part of Eurasian continent. Their atmospheric environment may be influenced by European sources of pollution and affect air quality in Japan. Therefore, it is important to clarify atmospheric environment there in order to evaluate long-range transportation of air pollutants. For these reasons, data analyses of wet deposition and gas/aerosol concentration monitored annually at a remote site (Mondy, MO), a rural site (Listvyanka, LI), an urban site (Irkutsk, IR) in East Siberia, and a rural site (Primorskaya PR) in Primorsky Region were carried out (Fig. 1).

2. Data analysis of wet deposition in East Siberia and Primorsky Region

Annual precipitation amounts ranged from 204mm to 835mm with seasonal variation, high in summer and low in winter (Fig.2). Annual mean pHs ranged from 4.9 to 5.4. Precipitation was acidified mainly by sulfuric acid. Wet deposition amounts of major components varied with season, high in summer and low in winter harmonizing with variation of precipitation amount. Although annual mean concentrations of nss-SO_4^{2-}, NO_3^-, and NH_4^+ in precipitation in these sites were at same level or higher than that in Japan[2)], annual deposition amounts of these ions were smaller than that in Japan due to small precipitation amounts (Fig.3).



Site	Y	Rainfall. mm	pH
Primorskaya	'03	323	4.9
	'02	835	5.2
Mondy	'03	409	5.3
	'02	204	5.4
Listvyanka	'03	540	5.0
	'02	360	4.9
Irkutsk	'03	456	5.4
	'02	303	5.0

Fig.2 Annual mean composition of wet deposition collected in East Siberia and Primorsky region in Russia

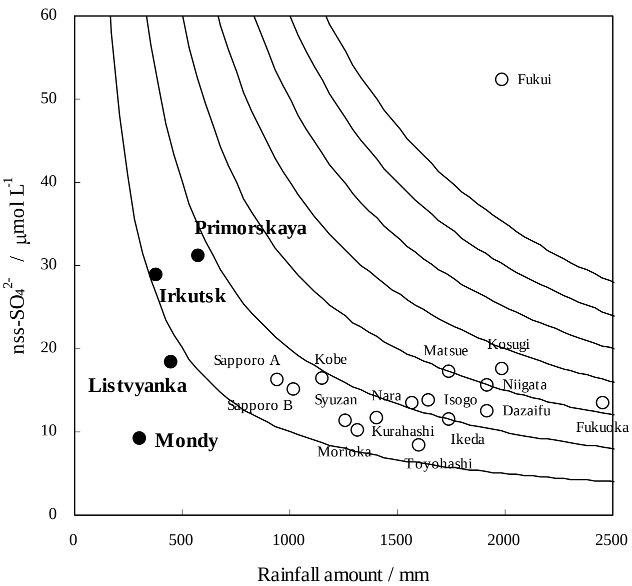


Fig.3 Relationship between annual rainfall amount and average concentration of nss-SO_4^{2-}, NO_3^-, and NH_4^+ (●: Russia: 2002-2003, ○: Japan: 1999JFY)
Solid lines show the scale of deposition corresponded to 10, 20, 30, 40, 50, 60 and 70 mmol m-2

3. Data analysis of gas and aerosol concentration in East Siberia and Primorsky Region

SO_2 and nss-SO_4^{2-} aerosol were major components of acidic substances in the atmosphere in these regions. SO_2 concentration rose in winter in all sites. NH_3 and NH_4^+ aerosol were main components of basic substances in the atmosphere. NH_3 emission amounts seemed to be large in summer because NH_3 concentration was high in summer in spite of large precipitation amount in this season. Sum of concentration of acidic substances was higher in winter and lower in summer than that of basic substances. Sum of concentration of acidic substances was lower than that in Japan[2)] (Fig. 4). Concentrations of both acidic and basic substances in Mondy were the lowest in all sites evaluated.

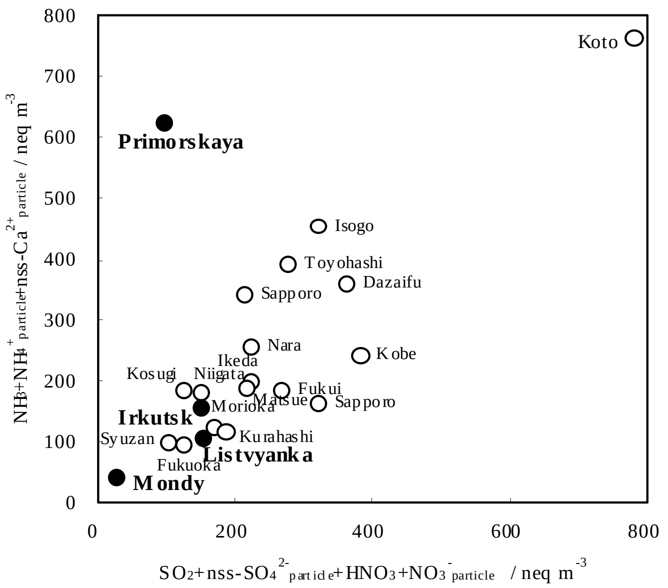


Fig.4 Relationship between concentration of acidic and basic substances in the atmosphere (●: Russia 2002-2003, ○: Japan 1999JFY)

4. Estimation of dry deposition

Dry deposition amounts of sulfur compounds (SO_2 and nss-SO_4^{2-} aerosols), ammonia/ammonium aerosols, and nitric acid/nitrate aerosols estimated by inferential method[3)] were 70 to 130% of wet deposition in that region (Fig.5). These percentages were higher than that in Japan[4)].

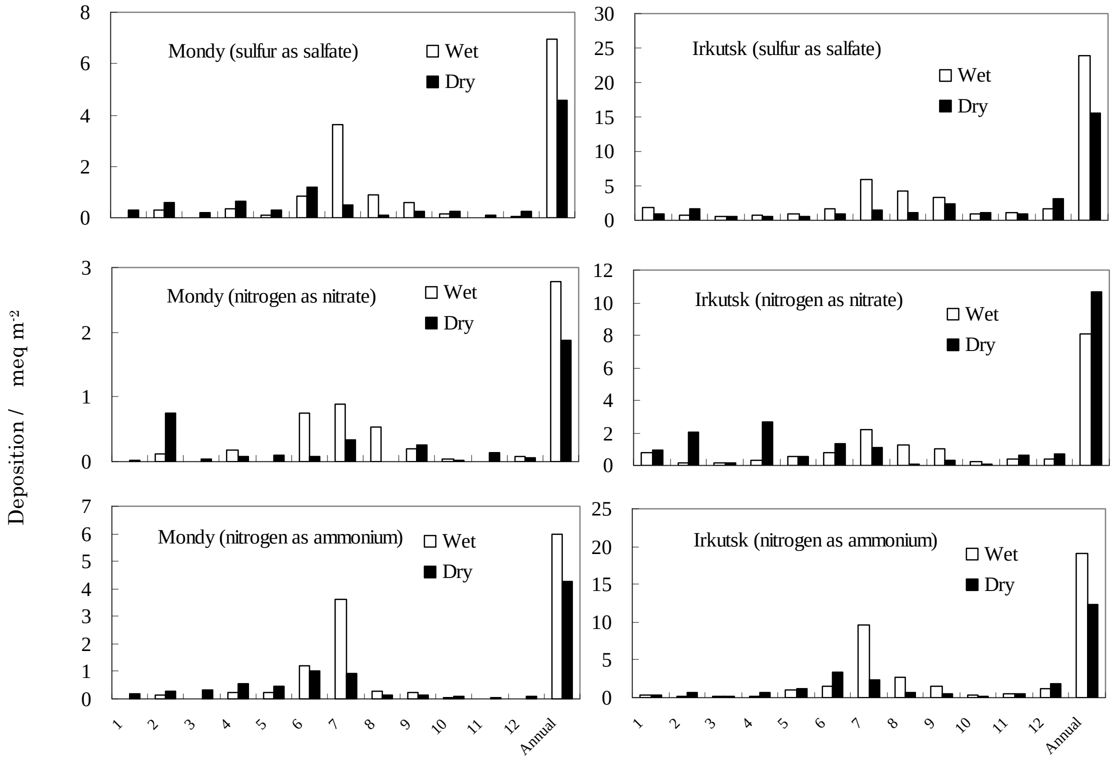


Fig.5 Wet and dry deposition at Mondy and Irkutsk in Russia (2003)

5. Air mass trajectory

To evaluate long-range transportation of air pollutants, backward and forward air mass trajectories were estimated in Mondy by CGER-GMET system of NIES, Japan. Since air masses in summer time didn't move long distance, local emission sources were considered to contribute high concentration of NH_3 in summer (Fig.6). On the other hands, air masses in wintertime moved long distance. It was found that winter air masses usually moved from Europe to East Siberia within only 3 days and moved from East Siberia to Japan within 3 days.

The two years monitoring data are analyzed for the first step to clarify the atmospheric environment in East Siberia and Primorsky Region in Russia that occupy large area in East Asia. These analytical methods may be useful for data analysis of EANET. Further data accumulation there, however, are necessary because these regions are very important as a transition area where long-range transportation of air pollutants from Europe and industrial regions of Russia to East Asia can be monitored.

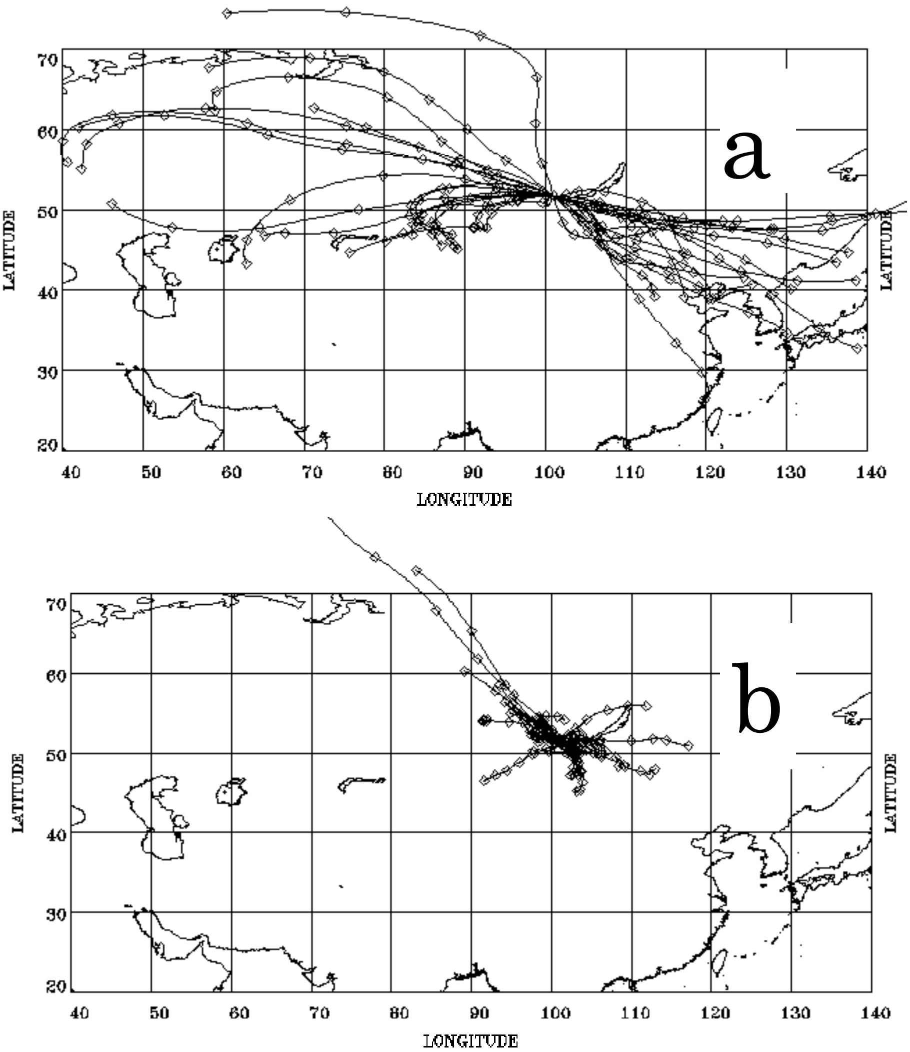


Fig.6 Typical air mass trajectory through Mondy in winter (a: February 3rd 2003-February 17th 2003) and summer (b: July 1st 2003-July 11th 2003)

6. Reference

1) Norio Fukuzaki, Tamara V. Khodzher and Hiroshi Hara, Quality Control of Chemical Analysis in Acid Deposition Monitoring -Improvement in Ion Balance by Hydrogenecarbonate Determination-, Journal of Japan Society of Atmospheric Environment, 37, 393-401 (2002).
2) Research Committee on Acid Deposition, Japan Environmental Laboratories Association, Report on Nationwide Acid Deposition Survey Phase 3 (1999JFY), Journal of Japan Environmental Laboratories Association, 26, 66-116 (2001).
3) Kazuhide Matsuda, Norio Fukuzaki and Masahito Maeda, A Case Study on Estimation of Dry Deposition of Sulfur and Nitrogen Compounds by Inferential Method, Water, Air, and Soil Pollution, 130, 553-558 (2001).
4) Committee on Acid Deposition, General Report of Japan Acid Deposition Survey 20 years (2004).

II. Joint research program with Thailand

1 Introduction

In order to research on dry deposition flux and velocity above surfaces typical in East Asia, Network Center has been promoting a joint research program on dry deposition flux with Pollution Control Department, Thailand since January 2000 (JFY1999). The program is one of the activities following the Strategy Paper for Future Direction of Dry Deposition Monitoring of EANET that was endorsed by ISAG through the diplomatic channel in September 1999.

The experiments have been performing in a teak forest in Mea Moh (18.28ºN, 99.72ºE), Lampang province, Thailand, located about 550 km north of the Bangkok metropolitan area. The climatic zone of northern Thailand is classified into tropical savanna climate with dry and wet seasons each year. The vegetation of this climatic zone is mainly subtropical deciduous forest, and forested teak is a typical tree species in this area.

An observational station was established in the teak forest in 2001. Observations were regularly started in December 2001. In 2003, analyzed data on O_3 dry deposition from December 2001 to September 2002 were reported at STM4 and SAC3. In this time, some preliminary results in 2003 regarding SO_2 as well as O_3 dry deposition are introduced.

2 Methods

2.1 Experimental description

The study field is located approximately 5 km south from Mae Moh Thermal Power Plant. Observational station was constructed in a Teak (deciduous) forest in the area. The forest is flat and uniform as far as a distance of 1 km in main upwind directions. Density of the forest is about 625 trees/ha, and its height is about 12 meters. An observational tower (24 meters) is constructed in the forest.

The measurement system consists of an ultrasonic anemometer, radiometers, ventilated wet and dry thermo meters (for temperature difference measurement), soil heat flux meters, a SO_2 monitor (UV fluorescence method), an O_3 monitor (UV photometric method) and a sampling changer. Differences of concentrations for SO_2 and O_3 were measured by using the sampling changer. In the system, Bowen ratio and gradient methods are available to output the fluxes.

2.2 Computation of fluxes and deposition velocities

In this time, results from gradient method are introduced.

All measured parameters were averaged every 30 min, and then fluxes, F, were computed, using the following equation (Erisman and Draaijers and 1995):

$$F = - u_* c_*, \qquad (1)$$

where u_* is the friction velocity, and c_* is the eddy concentration. The c_* is expressed by the following equation (Feliciano et al., 2001):

$$c_* = k \Delta c / [\ln(z_2\text{-}d / z_1\text{-}d) - \Psi_h(z_2\text{-}d / L) + \Psi_h(z_1\text{-}d / L)], \qquad (2)$$

where Δc is the differences of ozone concentrations at a height between z_2 (23 m) and z_1 (15 m), d is displacement height, k is the Von Karman constant, L is the Monin-Obukhov length and Ψ_h is the integrated stability correction function for heat defined by Erisman and Draaijers (1995).

The deposition velocity, V_d, is determined by the following equation:

$$V_d = - F / C, \qquad (3)$$

3 Results

Figures 1 and 2 show seasonal variation of O_3 and SO_2 at Mae Moh from November 2002 to February 2004. Regarding O_3 concentration, seasonal change with dry season maximum and wet season minimum was clearly observed as well as the results of observation from December 2001 to September 2002 that was reported in STM4 and SAC3. In this period (Nov. 2002 to Feb. 2004), SO_2 concentration could be measured. SO_2 concentration ranged from non-detected level to 30 ppb. The concentrations increased sporadically influenced by inflows of SO2 from the Power Plant.

Figures 3 and 4 show median diurnal variations of O_3 and SO_2 deposition velocities in December 2003 as preliminary results. Further sophisticated data screenings are necessary to these results. The diurnal variation and level of O_3 deposition velocities were similar to the results of 2002 experiment. These diurnal variation and level obtained were reasonable compared with previous studies (eg. Pio et al., 2000; Padro et al., 1992). Although the diurnal variation of SO_2 deposition velocities was not clear, its level ranged within reasonable level almost from zero to 2 cm/s (Erisman, 1994). During the periods when the fluxes or concentrations are small, measurements usually show a high uncertainty, due to the relative high errer in the concentration gradient (Erisman, 1994; Matsuda et al., 2002). The results of SO_2 deposition velocities were probably more uncertain that those of O_3. An analysis summed up long-term data may be effective to obtain more certain values.

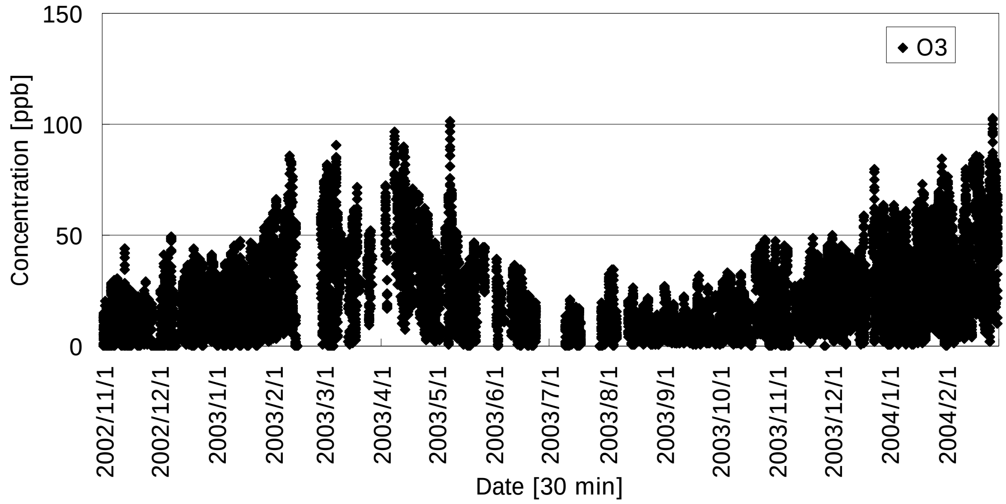


Fig. 2 Seasonal variation of O_3 at Mae Moh from November 2002 to February 2004

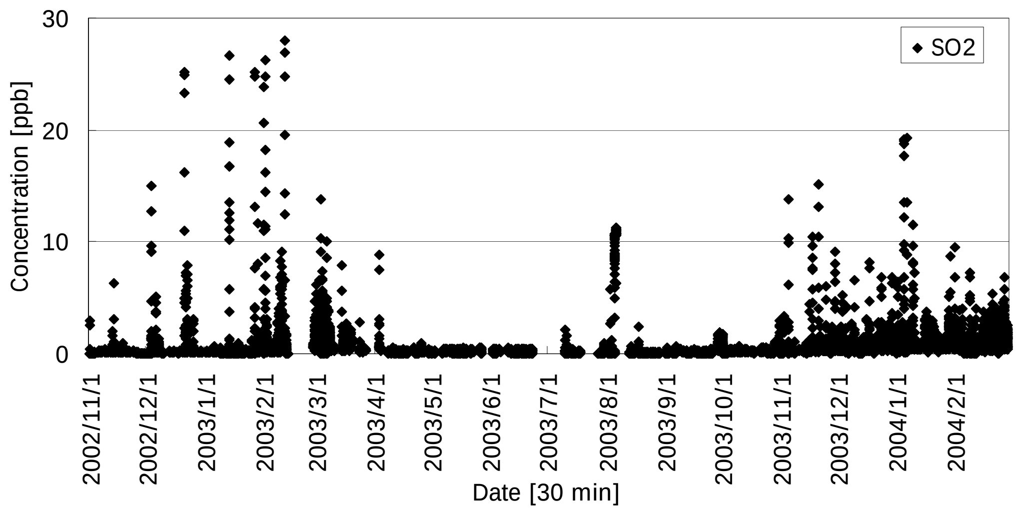


Fig. 2 Seasonal variation of SO_2 at Mae Moh from November 2002 to February 2004

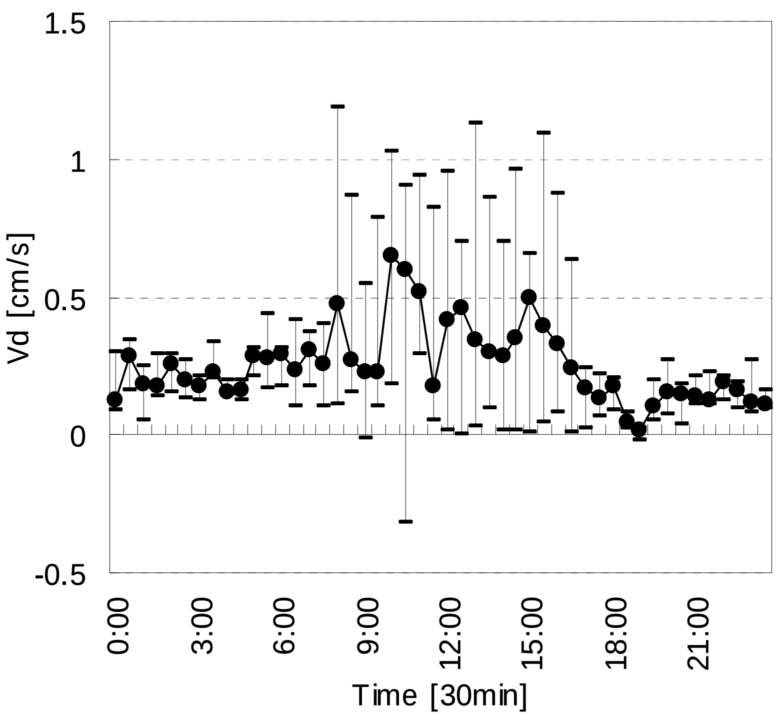


Fig. 3 Median diurnal variation of O_3 deposition velocities in December 2003 (preliminary result). The lower and upper bars represent 30th and 70th percentiles, respectively.

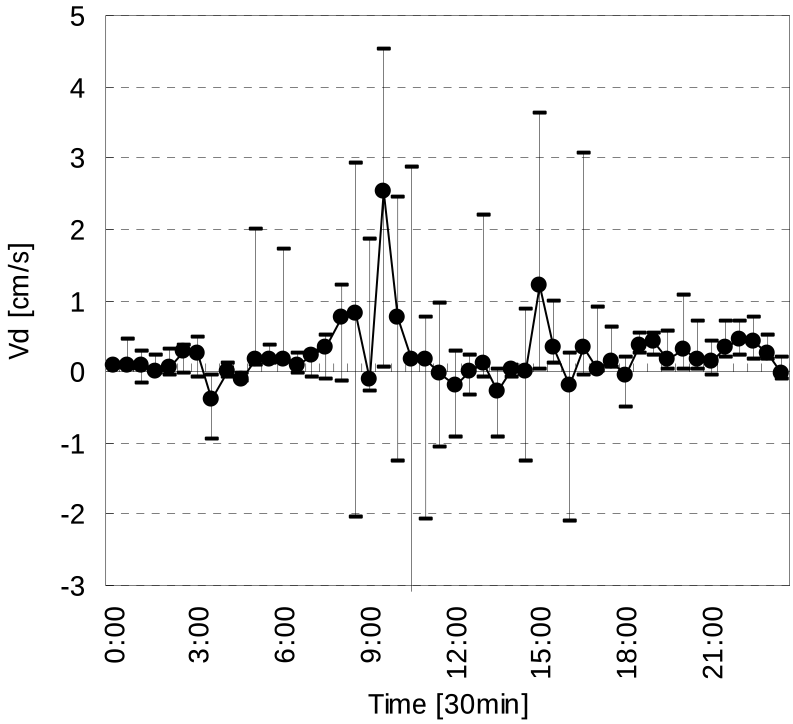


Fig. 4 Median diurnal variation of SO_2 deposition velocities in December 2003 (preliminary result). The lower and upper bars represent 30th and 70th percentiles, respectively.

4 Next step

- Further analysis on the long-term data sets about 2 years of the Mae Moh experiment would be done. Observed Vd would be compared with modeled Vd.
- Another technique of flux calculation (Bowen ratio method) would be attempted.
- Additional parameters of rainy period and precipitation amount, which were started to measure from March 2004, would be used for the SO2 flux analysis.
- ADORC and PCD are considering establishing another experimental site in Thailand for research on dry deposition above a different surface.

5 References

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Erisman J.W., 1994. Evaluation of a surface resistance parametrization of sulphur dioxide. Atmospheric Environment 28, 2583-2594.

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III. Joint Research Project with Mongolia

1. Objectives

East Asian Region is latitudinally wide area, and ecosystems are quite divers depending on climatic zones. For evaluating direct effects of acid deposition on plant, it is necessary to accumulate information on plant sensitivity to acid deposition in respective climatic zones. However, in (sub-) arid zone, sensitivity and/or physiological response of plants to acid deposition have not been enough studied.

In Bogdkhan Mountain around Ulaanbaatar, Mongolia, decline of larch trees (*Larix sibirica*) has been reported, and it might be due to air pollution from the thermal power plants. A number of useful plant (grass) species also grows in the mountainous area, and effect of the air pollution on plant species should be studied.

Based on the above background, Joint Research Project on plant sensitivity to acid deposition in Mongolia started in 2001. From 2001 to 2002, basic information on air concentration and physiological response of these plants to acid deposition has been obtained.

In 2003, Network Center for EANET obtained research budget from non-profit organization, "Sumitomo Foundation", and the Joint Research Project is being carried out in order to obtain information on implication between emission from a thermal power plant and chemical/ (eco-) physiological properties on plant and soil, and basic information on Mongolian plant sensitivities.

2. Research team

The Central Laboratory of Environmental Monitoring, National Agency of Meteorology, Hydrology and Environmental Monitoring of Mongolia (hereinafter referred to as the "CLEM") and the Acid Deposition and Oxidant Research Center (hereinafter referred to as the "ADORC") are jointly carrying out the Joint Research Project. For implementation of the project, both parties are supported by relevant organizations such as National University of Mongolia (NUM) and National Institute for Environmental Studies of Japan (NIES).

3. Surveys implemented in the previous years

1) Monitoring sites (Figure 3.1)

Two monitoring sites in the city area of Ulaanbaatar, and four sites were in the Bogdkhan Mountain were selected; site A1 and A2 were at the Ulaanbaatar Monitoring Site and the CLEM compound in the city area, respectively; sites B and C were at the lower part (grassland) and upper part (open forest) on the Chandmani slope facing the Thermal Power Plant No.3 in the mountain; sites RF1 and RF2 were at certain distance from the power plant as reference forest areas. Sites A1, RF1 and RF2 were newly added in 2003 while the site D was surveyed near the site C only in 2001.

2) Observation of trees

Measurement of tree size and observation of tree decline were carried out at the sites B, C, RF1 and RF2 in the mountain. One round plot of 400 m^2 (radius 11.28 m) was established for measurement of tree size (species name, diameter at breast height (DBH) and height of trees) in the respective sites. Twenty trees were selected for observation of tree decline in the plots. The decline scale of the EANET Technical Manual was used for the observation (SECOND ISAG MEETING OF EANET, 2000).

3) Air concentration

Air concentration of gaseous pollutants, such as SO_2, NO_X (only in 2001) and O_3, was measured using the passive sampler (Ogawa & Co., USA, Inc.) with basically two-week interval from the late July through the end of November in 2001 and 2003. Three samplers for each pollutant were prepared in the respective sites. The samplers were set on metal fences in city areas and on tree trunks at heights of upper than 2 m under canopies in forest areas.

4) Soil and leaf analysis

Soil samples (0-10 cm depths) were collected at the sites A2, B, C, and D in 2001 and also at the sites A1, A2, B, C, RF1 and RF2 in 2003. The soils were air-dried and sieved. Exchangeable cations were analyzed for the soils collected in 2001, and Concentrations of heavy metals such as Cd, Cr, Cu, Ni, Pb, and Zn in the soil were analyzed using Atomic Absorption Spectrometer (AAS) for the soils collected in 2003. Larch needles were collected around the sites A1, A2, B, C, RF1, and RF2 before change of needle color in early autumn in 2003. The needles were collected from three trees in each site. Concentrations of heavy metals and sulfur in the powdered needles were analyzed using ICP-AES (SII SP6000) and elemental analyzer (EA2500, CE Instruments), respectively.

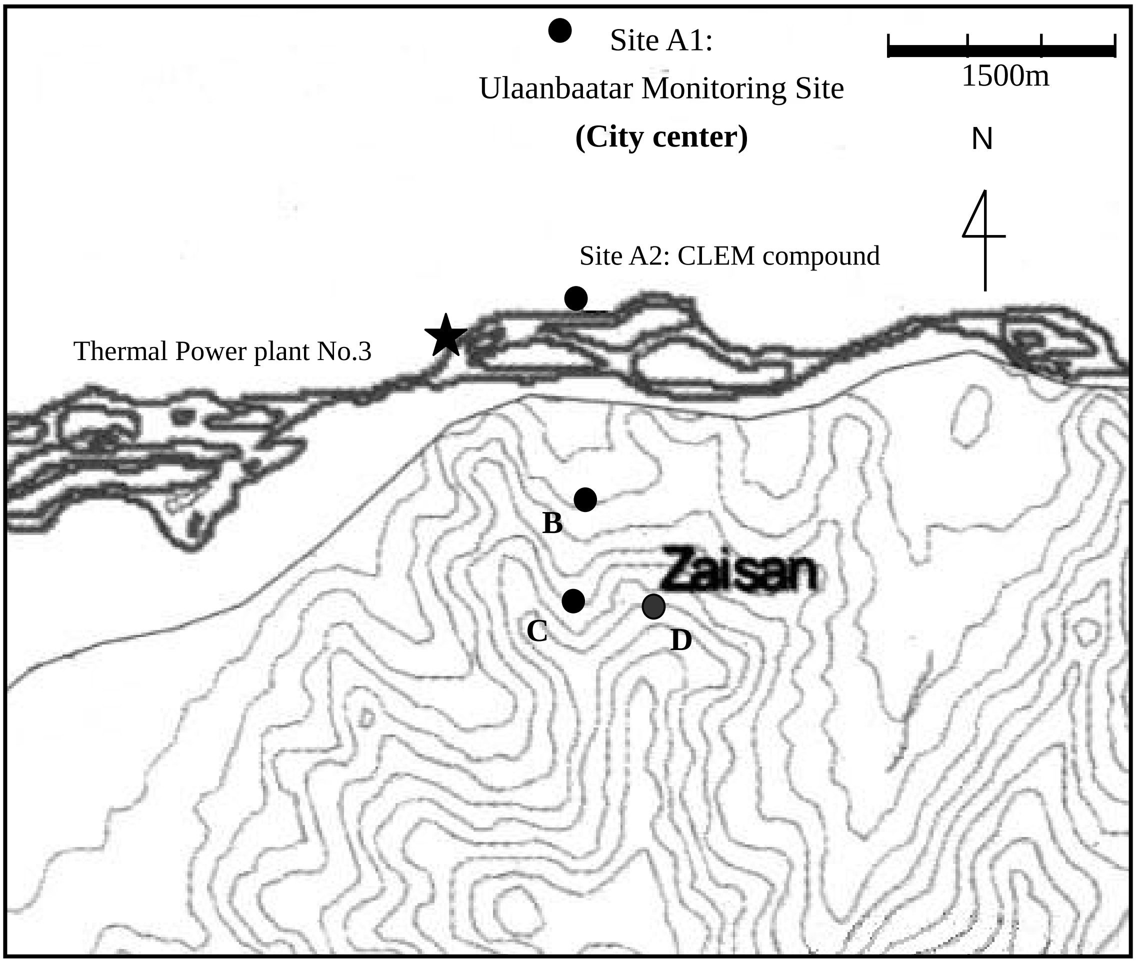


Figure 3.1. Monitoring sites in the Bogdkhan Mountain.
Sites RF1 and RF2 were located in west part of the mountain (outside the map).

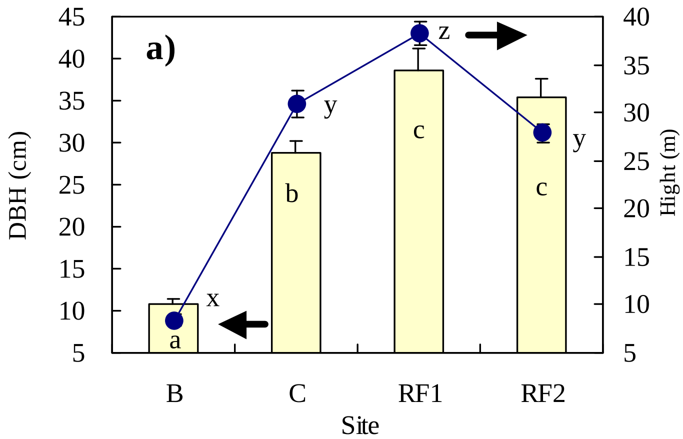
4. Results and discussions

1) Observation of trees

Tree sizes of *Larix sibirica* were shown in Figure 3.2 a). At the site B in the bottom of the slope facing the plant, only young trees were observed and the sizes were three times smaller than ones in the other sites. Trees at the site C were significantly smaller than ones at the site RF1 and RF2 in DBH although they were not different from trees at RF2 in height.

Decline classes by the representative observation parameters were shown in Figure 3.2 b). The young trees at the site B were healthier than ones at the other sites. Trees at the sites C and RF1 were worse than ones RF2 in vitality of trees. Even in the reference area far from the thermal power plant, older trees were declined probably due to other environmental factors. Severe tree damage by insect attack has been reported in the Bogdkhan Mountain since a few years in addition to possible impact of air pollution.

It seems that forests of Mongolia have been established in limited slopes under appropriate water and sunlight conditions because of limited annual precipitation (less than 300 mm). Changes in natural environmental factors might cause severe effects on such forests. Both effects of natural and anthropogenic environmental factors should be discussed as well as synergistic effects of them.



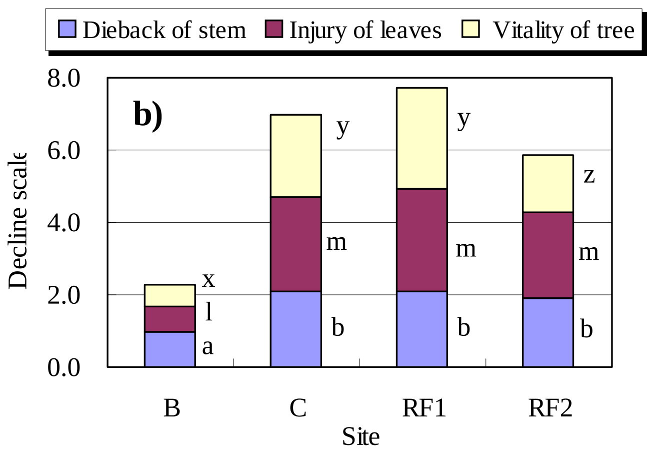


Figure 3.2. Tree size (a) and decline condition (b) of *Larix sibirica* in Mt. Bogdkhan
Site B and RF1 consist of not only *Larix* but also other species such as *Picea* and *Betula*. Numbers of Larix trees are 19, 20, 11 and 20, in site B, C, RF1 and RF2, respectively. Different letters beside the plots indicate siginificant ($P < 0.05$) diffrences by Tukey's HSD test.

2) Air concentration of acidic pollutants

In mid summer, concentrations of SO_2 and NO_X were not high, lower than 5 ppb and 1 ppb respectively (average concentration of two weeks), but concentrations of NO_X increased up to ca. 15 ppb in the city area and ca. 10 ppb in the mountainous area from autumn to winter. This seasonal trend may be due to increasing of coal/wood combustion and use of automobile in winter. Seasonal change of SO_2 concentration was not very clear.

Concentrations of O_3 were relatively high (ca. 40 ppb) in mid summer and gradually decreased from autumn to winter, especially in the city area. In the mountainous area, relatively high concentration (more than 30 ppb) was recorded even in late autumn in 2003. Concentrations of O_3 were usually higher in the mountain slope facing to the power plant than in the city area through the survey periods.

Mean concentrations during the sampling period of 2003 were shown in Figure 3.3. Concentrations of both SO_2 and O_3 were higher in the site B and C than the other sites although SO_2 concentration was relatively low. It was suggested that the slope facing the thermal power plant have stronger effects than the other areas.

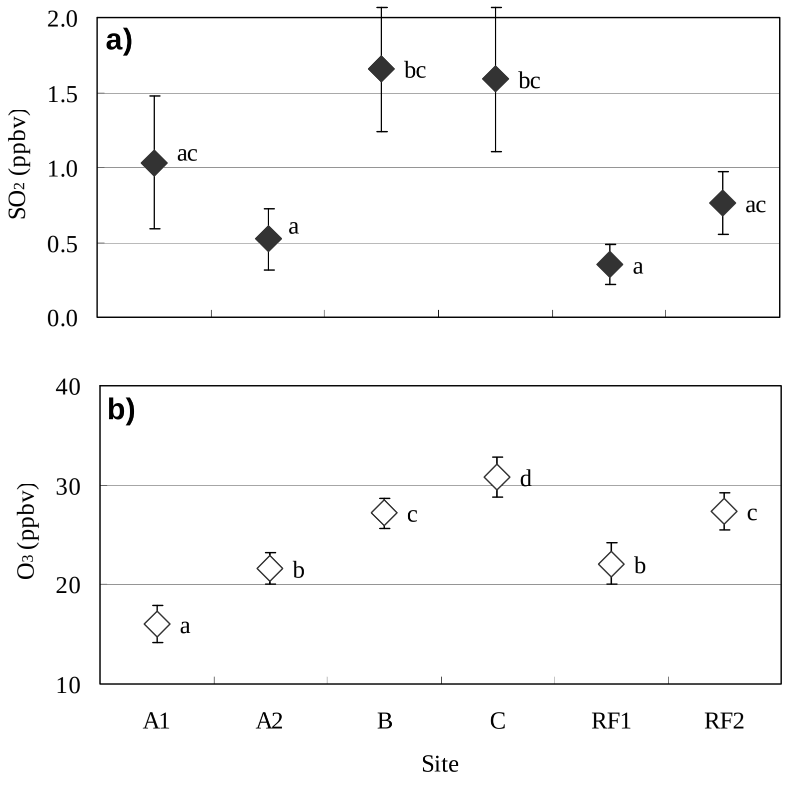


Figure 3.3. Mean concentration of a) SO_2 and b) O_3 from summer to late autumn of 2003 in the Bogdkhan Mountain.

Different letters beside the plots indicate significant (*P* < 0.05) differences by Tukey's HSD test.

AOT40 is used as a threshold value to evaluate risk of O_3 in Europe. Air concentration at the height of canopy top or open space is generally used for the calculation of AOT40. In this study, mean O_3 concentration was ca. 30 ppb at the site C under the canopy and the maximum data was 46 ppb. Generally O_3 concentration is lower in canopy than above canopy height. Probably O_3 concentration is higher at the canopy height (30m), and further study should be implemented for O_3 concentration and deposition in the mountain.

3) Soil and leaf analysis

Soil pH and contents of exchangeable base cations were relatively high; e.g. pH (H_2O): 5.9, exchangeable Ca: 22.6 cmol(+)/kg in sites on the slope. It was suggested that soil acidification due to acidic deposition would hardly occur because of the high concentration of base cations.

There was no special trend of heavy metal concentrations in soil and larch needles. However, sulfur content of the needles was higher in the slope (at B and C) facing the thermal power plant than in the reference forest area (at RF1 and RF2): 1.8 mg-S/g-dry needles at B, 2.2mg/g at C, 1.2 mg/g at RF1 and 1.1 mg/g at RF2. It was suggested that trees on the slope had larger effects of air pollution from the thermal plant/city area.

5. Conclusion and perspective

It was clarified that air pollutions such as SO_2 and O_3 were transported to the Bogdkhan Mountain, and the slope where the sites B and C were located had larger effects of the pollution than the reference forest area. Concentration of SO_2 was very low but one of O_3 was relatively high. Effects of air pollution, especially the effect of O_3, should be considered as one of possible causes for tree decline although effect of insect attack might be the major cause as observed in large extent of the Bogdkhan Mountain.

It was speculated that O_3 concentration at the canopy height might be higher than the data obtained in this study. In the future study, O_3 concentration at the canopy height or open space and also deposition amount of O_3 should be clarified for evaluating possible risk of O_3 more clearly in the Bogdkhan Mountain.

IV. Collaboration with Existing Initiatives on Developing Emission Inventory and Numerical Modeling

1. Introduction

The Second Session of the Intergovernmental Meeting (IG2) for the Acid Deposition Monitoring Network in East Asia (EANET), held in October 2000, issued the "Joint Announcement on the Implementation of EANET" (EANET/IG 2/5/2rev.) in order to start the EANET activities on a regular basis. Operational paragraph 6 of the Joint Announcement indicates that "the participating countries will discuss future EANET activities in order to contribute to development of international cooperative efforts for preventing or reducing adverse environmental impacts of acid deposition." In this connection, it is described in the "Tentative Design of the Acid Deposition Monitoring Network in East Asia (EANET)" (EANET/IG 2/5/3) that the "participating countries will promote studies of other scientific issues in order to improve understanding of the risks of acid deposition." And according to the "Work Program and Budget in 2001 for the Acid Deposition Monitoring Network in East Asia (EANET)"(EANET/IG 2/7/2), the EANET activities include "starting consideration of further scientific issues such as emission inventory studies and numerical modeling."

At IG3 held in November 2001, the Interim Secretariat presented the document on "Future Development of EANET" (EANET/IG 3/9). With regard to "efforts for preventing and reducing adverse environmental impacts", one of the topics about future development indicated in the document, some countries pointed out the importance of such activities as emphasized the usefulness to learn experiences from existing initiatives on emission inventories and modeling as the first step of such activities. The research activities of the Network Center (NC), which are described in the "Work Program and Budget in 2002 for the Acid Deposition Monitoring Network in East Asia (EANET)"(EANET/IG 3/10/1rev.) adopted at IG3, include "Review of existing initiatives on developing emission inventories and numerical modeling." In this context, NC carried out the review of the existing initiatives such as (1) Long-range Transboundary Air Pollutants in Northeast Asia (LTP project), (2) RAINS-Asia, (3) Model Intercomparison Study in Asia (MICS-Asia), (4) the Study on the Acid Deposition Control Strategy in the Kingdom of Thailand (TAciDES) and (5) Cooperative research program between the Malaysian Meteorological Service and the Swedish Meteorological and Hydrological Institute.

"Work Program and Budget in 2003 for the Acid Deposition Monitoring Network in East Asia (EANET)"(EANET/IG 4/8/1), which was adopted at IG4 held in November 2002, include "Collaboration with existing initiatives on developing emission inventories and numerical modeling.” as one of the research activities of NC. Moreover, continuation activity for the collaboration is included in the “Work Program and Budget in 2004 for the Acid Deposition Monitoring Network in East Asia (EANET)”(EANET/IG 5/8/1), which was adopted at IG5 held in November 2003.

According to the Work Program and Budget in 2003 and 2004, NC has been making collaboration with existing initiatives on developing emission inventories and numerical modeling so far. This document summarizes major activities of NC regarding collaboration with existing initiatives on developing emission inventories and numerical modeling in 2004.

2. Collaboration with existing initiatives on developing emission inventory and numerical modeling

2.1. Model Intercomparison Study in Asia (MICS-Asia)

[Project]

In order to have a common understanding of model performance and uncertainties in Asia, a model intercomparison study on long-range transport and deposition of sulfur, called MICS-Asia Phase I, was carried out among simulation results from eight models during the period from 1998 to 2000.

The Fourth Workshop on the Transport of Air Pollutants in Asia held at IIASA, Austria in October 2001 recognized that a wider perspective in Phase II activities could yield important insights including nitrogen compounds, ozone and aerosols to be critical for effective control of various environmental problems.

At the Fifth workshop held at IIASA, Austria in January 2003, plans of MICS-Asia Phase II were discussed. Common data sets for the model intercomparison were distributed in 2003.

At the sixth workshop, preliminary model results were reported from some participants and analytical framework for the model intercomparison was developed. The model simulations are expected to be run under the conditions described in Table 1. According to the analytical framework, this comparison study will be summarized by the Seventh workshop may be held in February 2005. As an example, Figure 1 shows the study domain for MICS-Asia, and Figure 2 shows one of simulation results for horizontal distribution of precipitation amount in March 2002. Precipitation is an important factor for the estimation of wet deposition in simulation.

Table 1 Conditions for the simulation in MICS-Asia Phase II

	Conditions for simulation
Domain	15S-60N, 75E-160E
Grid size	0.5 by 0.5 degree
Emission	SO_2, NOx, CO, CO_2, PM10, PM2.5, BC, OC, NH_3, CH_4, isoprene, terpene, VOCs (anthropogenic, biomass, natural and volcano sources)
Boundary	Calculated by MOZART-2 (1)
Meteorological fields	Calculated by MM5 (2)
Period	March, July and December 2001 and March 2002

(1) Model for OZone And Related chemical Tracers version 2

(2) the fifth-generation Mesoscale Model of non-hydrostatic version

(See MICS-Asia website for more information; http://www.adorc.gr.jp/adorc/mics.html)

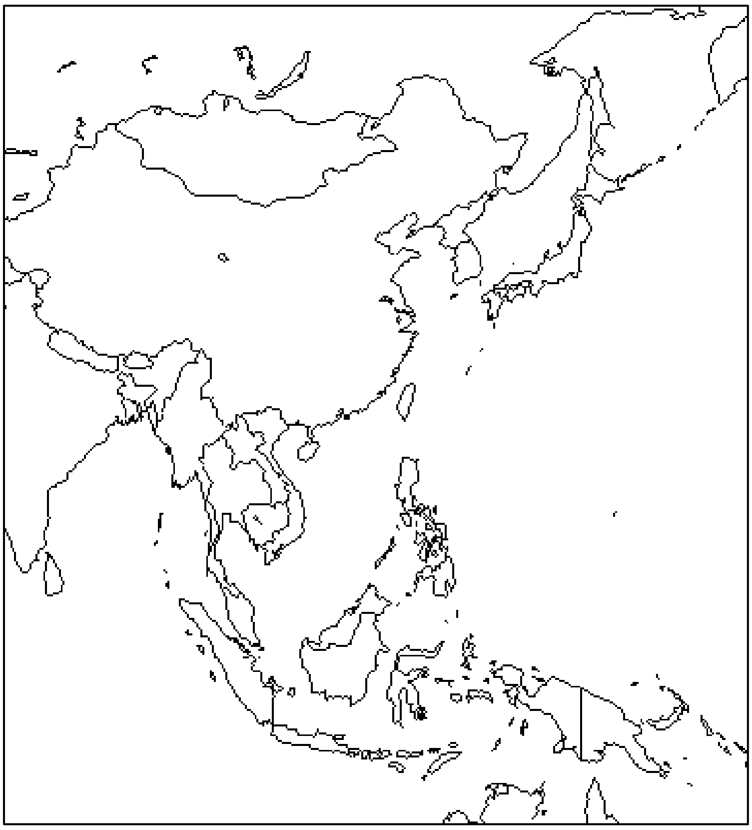


Figure 1 The study domain for MICS-Asia.

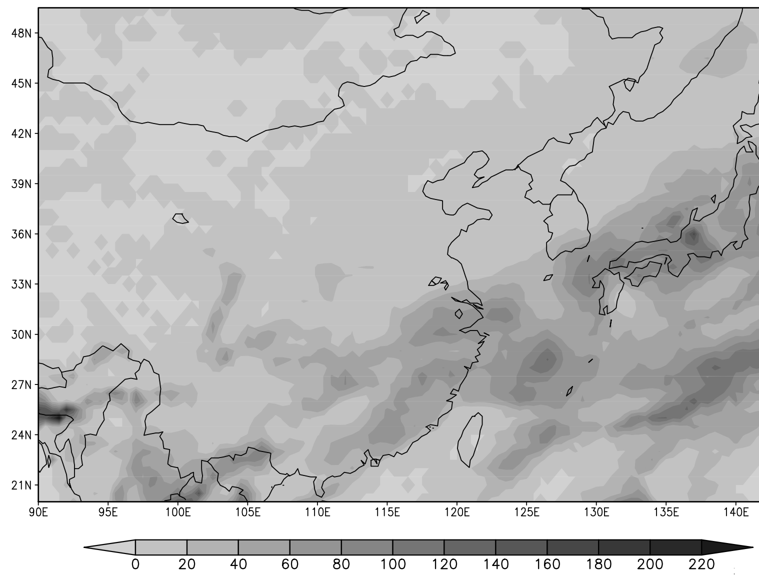


Figure 2 Horizontal distribution of simulated precipitation amount in March 2002 (mm/month).

[Relationship with EANET]

NC has cooperated with the project by announcing the latest information of the activities in its website.

In response to participants' expectations, NC provides EANET monitoring data for the model validations following the agreement of the "Procedures on Data and Information Disclosure for EANET" adopted at IG3 and the "Detailed Mechanism of Article 4 of the Procedures on Data and Information Disclosure for EANET endorsed by IG5.

Models developed in EANET participating countries join the project. They include ATMOS II model [*1] in Thailand and MATCH model [*2] in Malaysia.

*1 The Japan International Cooperation Agency (JICA) undertook the study on the acid deposition control strategy in the Kingdom of Thailand. Pollution Control Department acted as the counterpart agency to the JICA study team. The study began in January 2002 and completed in March 2003. In the study, the emission inventories of SO_2 for whole Thailand and NO_x for Bangkok metropolitan region were developed and the simulation analysis using the ATMOS II model were carried out.

*2 Following an initiative of the Sweden International Development Cooperation Agency (Sida) and a request from the Environmental Studies Division of Malaysian Meteorological Service, a collaborative research project has recently started between MMS and SMHI. The study focuses on the use of a regional transport model (Multiple-scale Atmospheric Transport and Chemical modeling system; MATCH) in Southeast Asia.

[Relationship with LTP project]

LTP project also provided their monitoring data to evaluate the performance of each model. The provided data consisted of the monitoring data at Fujiazhuang, Ganjingzi, Gangwha, Taean, Geoje and aircraft observation data. Moreover, all of LTP modeling teams from Korea, China and Japan, join the model intercomparison study.

2.2. RAINS (Regional Air Pollution INformation and Simulation)-Asia

[Project]

The RAINS-Asia model has been developed as an analytical tool to help decision-makers analyze future trends in emissions, estimate regional impacts of resulting acid deposition levels, and to evaluate costs and effectiveness of alternative mitigation options.

For the first time a model has been specifically developed and applied for integrated assessment of future SO_2 emissions in Asia. The RAINS-Asia model offers the opportunity to assess sulfur deposition and ecosystems protection levels resulting from different energy pathways and different emission control strategies. The costs of various control options are also provided.

[Relationship with EANET]

NC has been maintaining the mirror site of RAINS-Asia according to a request from World Bank (Mirror site: http://www.eanet.cc/mirror/docs/index.html).