(LTP Project)

Joint Research Project on Long-range Transboundary Air Pollutants in North East Asia : Progress and Outcomes

Presented by

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I. Introduction of LTP

Objectives

- Northeast Asia region ;
  - the most rapidly developing region in economy,
  - the highest air pollutants emissions in the world.

Consensus of the necessity for improvement air quality in NEA

Expert Meeting

Joint Research for Present status

Countermeasures for policy-makers

Data sharing and Technical support

I. Introduction of LTP

Coverage

- Participating Countries
  - China, Japan, and Korea
- Target Area
  - Northeast Asia (Lat. 20°~ 50°, Lon. 100°~ 150°)
- Organization
  - Working Group : Govern’tl Official(MOE) and Institute/University,
  - Sub-Working Group : Experts group for Monitoring & Modeling
  - Secretariat : project supporter (expert meeting, publishing)
- Characteristics
  - governmental(non-legal) and scientific project base

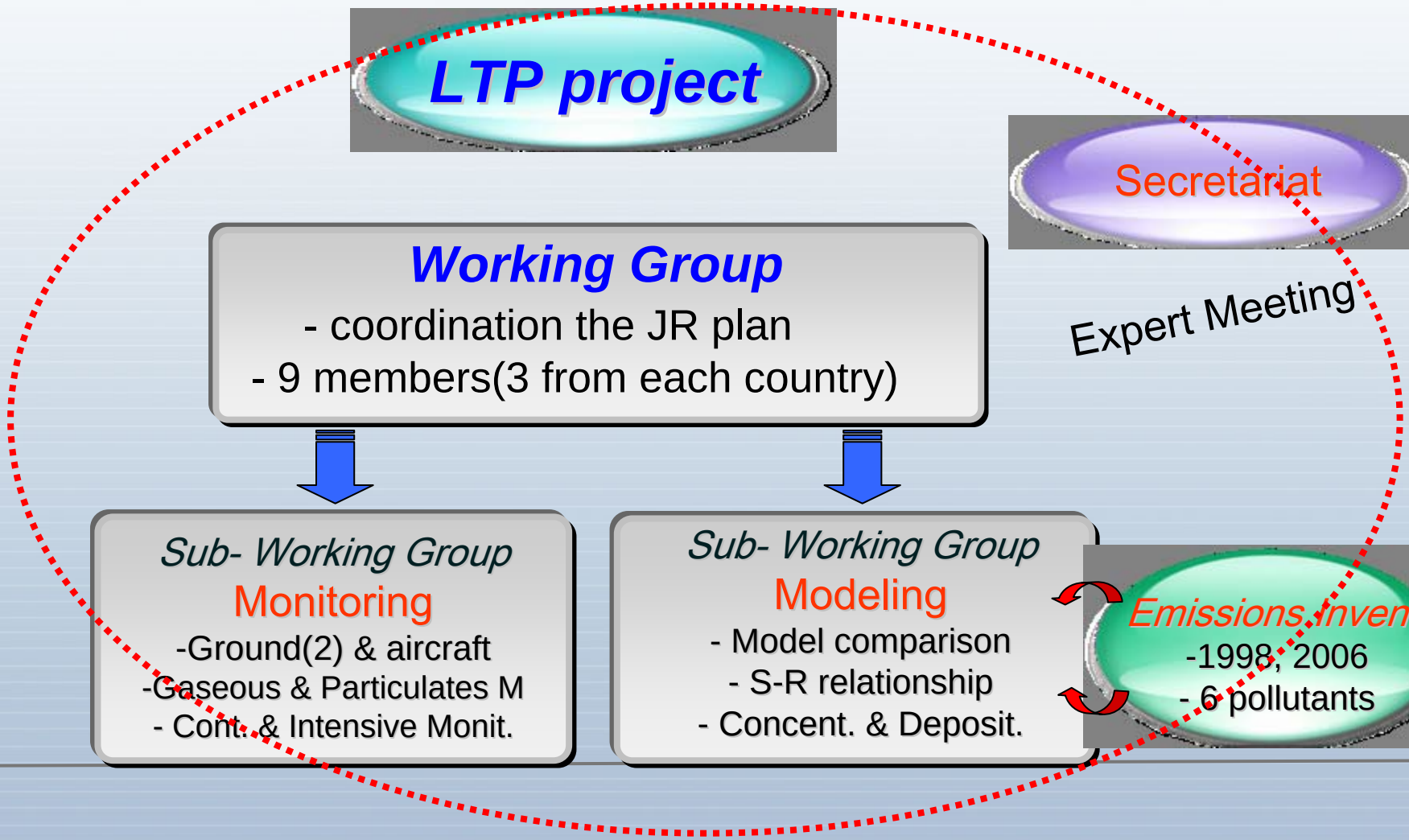
I. Introduction of LTP

Progress

- 1st workshop for “long-range transport air pollutants in Northeast Asia” held in September, 1995 in Seoul, Korea.
  - agreed to start joint research with expert meeting
- 1st Expert meeting was held in Seoul, July 1996.
  - organized the WG and Sub-WGs for Monitoring & Modeling
- The project was started in 1999 and encouraged by ‘Tripartite Environment Ministers Meeting (TEMM)’
- Joint researches had been conducted with 2nd stages (1st stage: 2000~2004, 2nd stage: 2005~2007).
- 3rd stage of Joint research (2008~2012) is on-going

II. Contents and Outcomes

Frame



The stages of LTP project

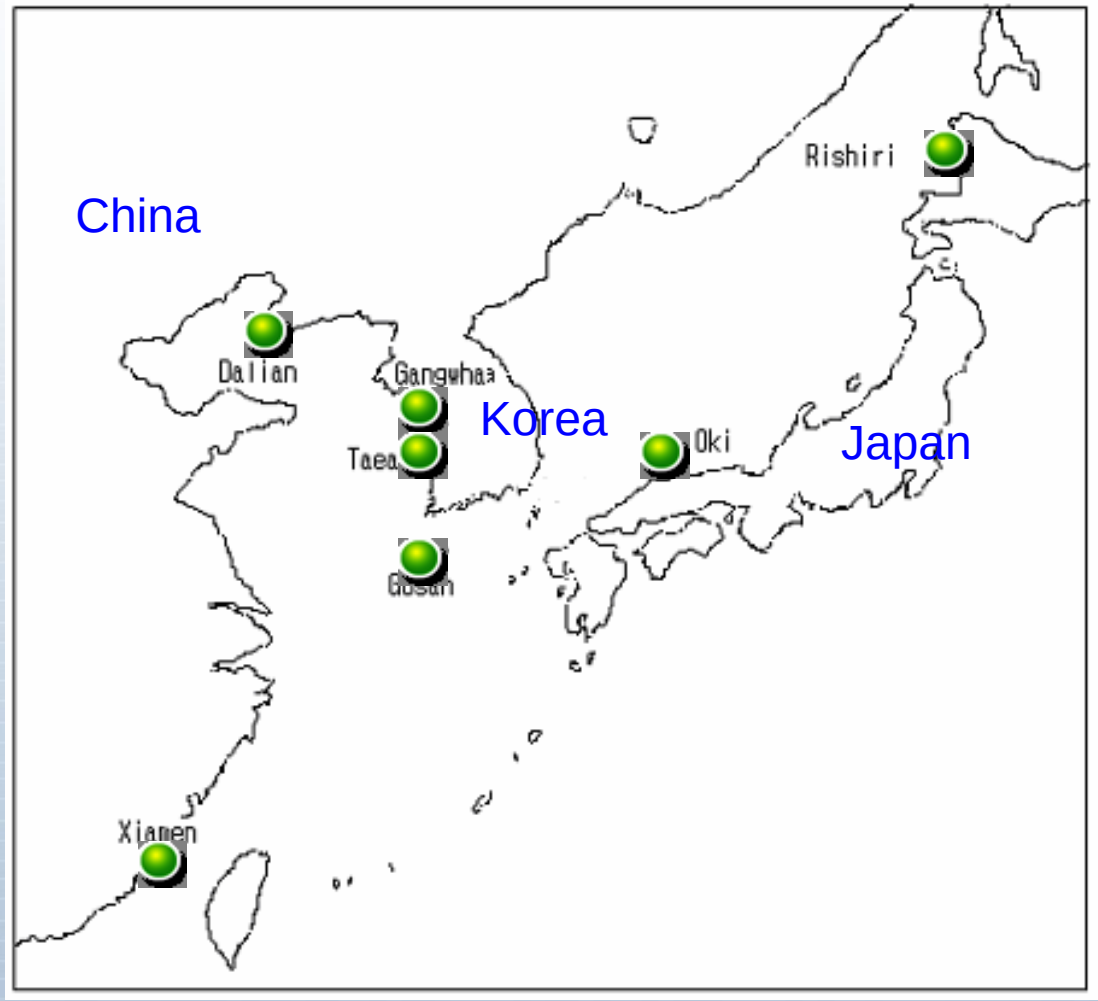
Step	Contents	Period
The 1st Stage	- Launch Joint Research of LTP - Measure the concentrations of air pollutants and emissions - Establish a modeling system - Emission Inventory for 1998(base year)	**2000 ~2004**
The 2nd Stage	- Estimate emissions from Korea, China and Japan - Perform research on Monitoring and modeling - Calculate quantitatively the impacts of the trans-boundary air pollutants in Northeast Asia	**2005 ~ 2007**
The 3rd Stage	- Update the emission data for 2006 (SO2,NOx,NH3,CO,VOCs,PM10) - Calculate S-R Relationship for Sulfur and Nitrate for 2002 - Determine a new methodology to study S-R relationship for total nitrate and sulfur - Prepare and evaluate future emission scenarios	**2008 ~2012**

Sub-Working Group

Monitoring

- **Monitoring Sites ;**
  - China : Dalian, Xiamen
  - Korea : Gangwha, Taean, Gosan
  - Japan : Rishiri, Oki

Monitoring sites



Sub-Working Group - Monitoring

Monitoring

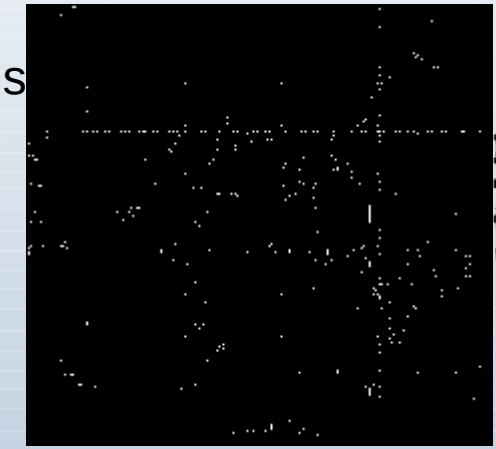
Long-term Monitoring

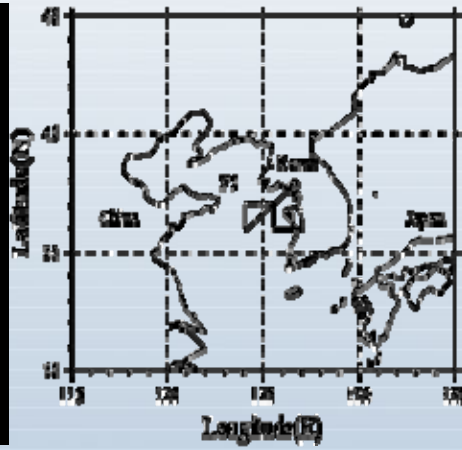
- Existing continuous monitoring station data
- PM(2.5 or 10), SO_2, O_3, NOx, Meteorological data
- Precipitation(pH, EC, anion, cation, rain falls)

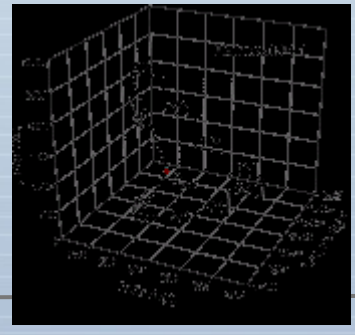
Sub-Working Group - Monitoring

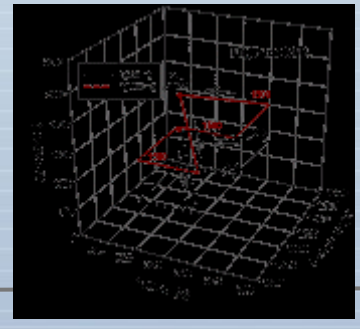
Intensive Monitoring

- Conduct for agreed typical period 2~3 times a year
- PM, SO_2, O_3, NOx, CO, DMS, VOCs, NH_3, HNO_3, HNO_2, HCl, Meteorological data
- Aerosols(EC/OC, anion, cation, metals
- Air craft measurement (optional)







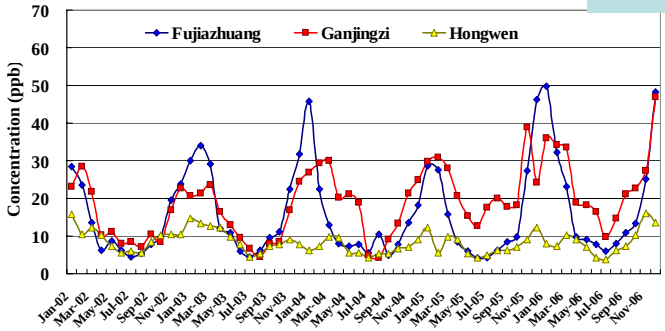


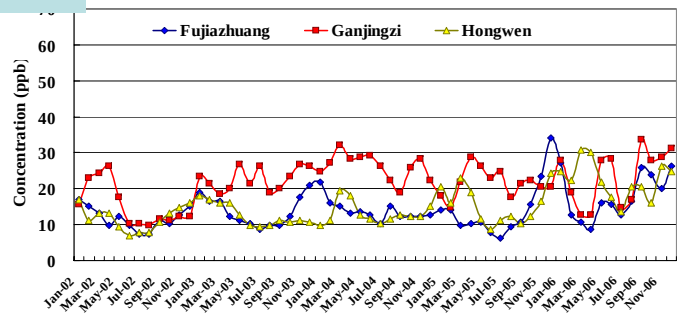
Sub-Working Group - Monitoring

Monitoring Results

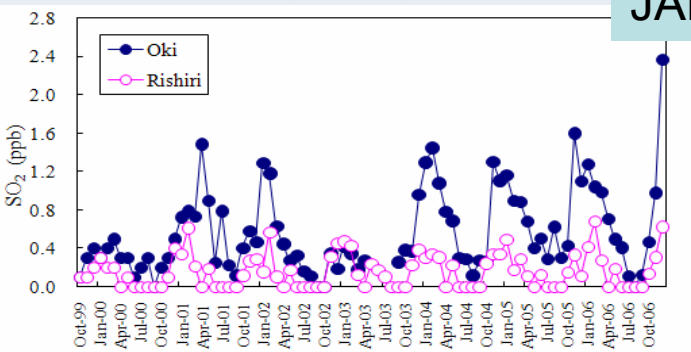
(SO_2, NO_2)

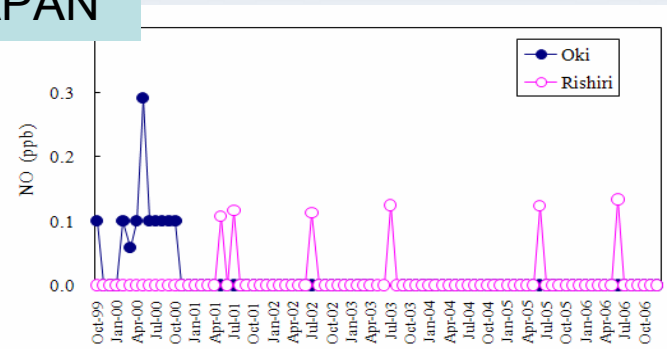
China



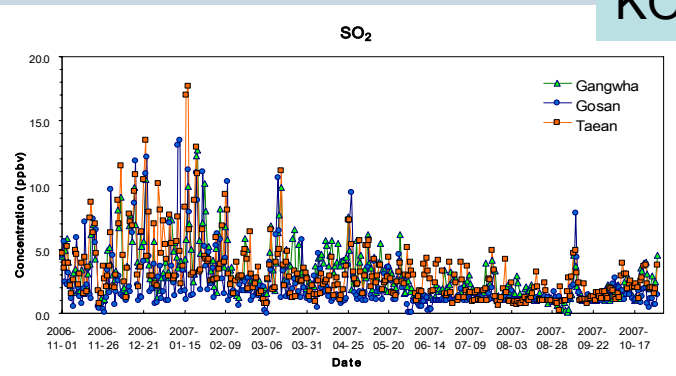


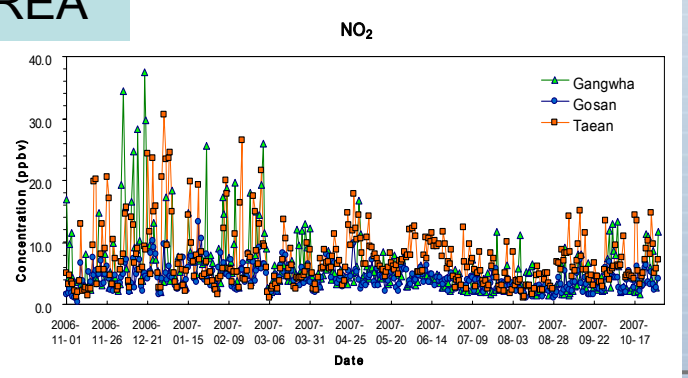
JAPAN





KOREA



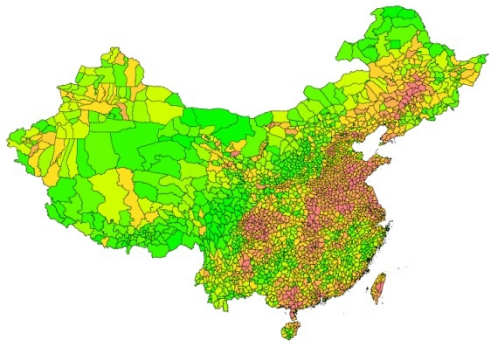


Sub-Working Group – Modeling(Emissions)

Emission Inventory

- **Base year of Emission Data**

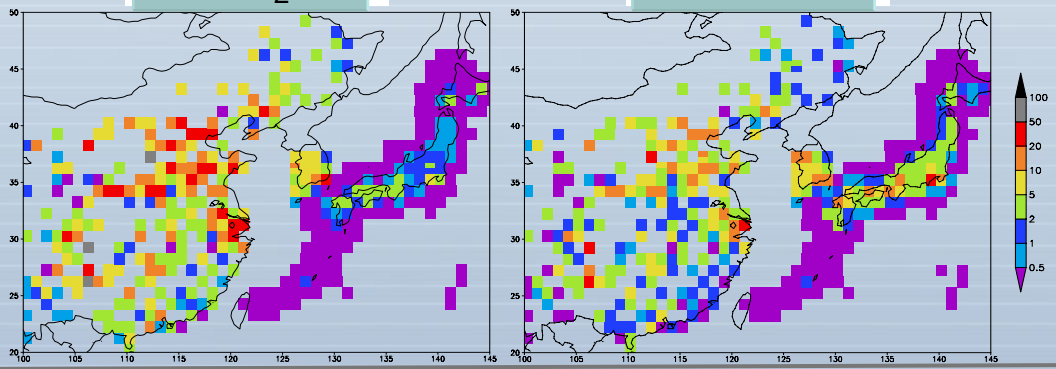
  1998(1st stage) ➡ *2002(2nd stage)* ➡ *2006*(3rd stage)



Ammonia (2002)

Tentatively Academic version (official data from Japan & Korea are available)

SO_2 NOx



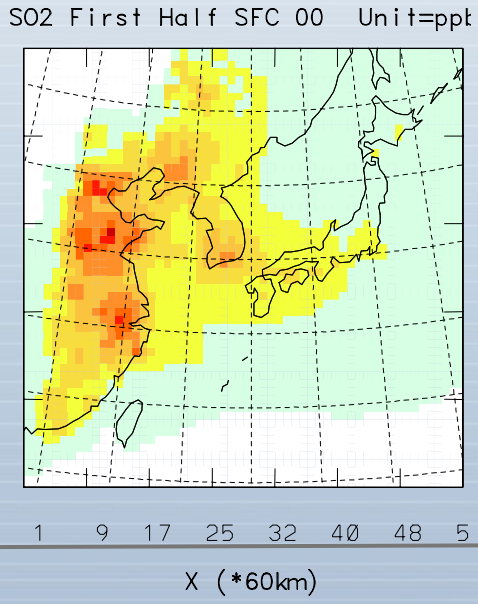
LTP standard emission for SO_2 (left) and NOx (right) prepared by each country (unit: ton year^{-1} grid^{-1})

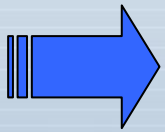
Sub-Working Group – Modeling

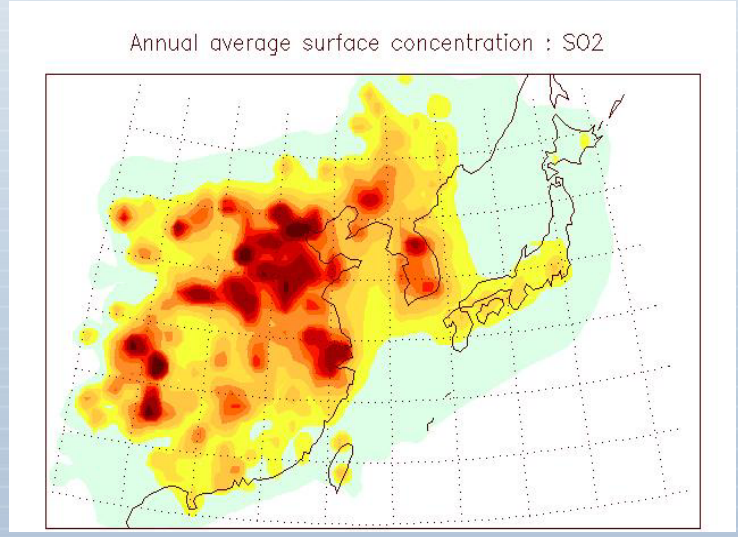
Modeling Domain (Inventory)

Lat. 17°- 55°N, Lon. 115°– 136°E (1st stage)

Lat. 20°- 55°N, Lon. 100°– 145°E (2nd stage)







Sub-Working Group – Modeling

Prediction Contents

- Meteorological fields (wind, precipitation)

- Spatial distribution of Concentration and Wet / Dry Deposition

  * SO_2, NOx, O_3, SO_4^{2-}, NO_3^-

- Source-Receptor relationship for S & nitrate

Sub-Working Group – Modeling

Selected Models for LTP

- Community Multiscale Air Quality(CMAQ) : China

* 3-dimensional Eulerian Model with **MM5**

- Regional Air Quality Model(RAQM) : Japan

* 3-dimensional Eulerian Model with **MM5**

- Comprehensive Acid Deposition Model(CADM) : Korea

* 3-dimensional Eulerian Model with **RAMS**
* planning to upgrade by coupling with CMAQ

Simulate with the same ;

- Period, Domain, and Emission data

Model inter-comparison study,
Validation with monitoring data

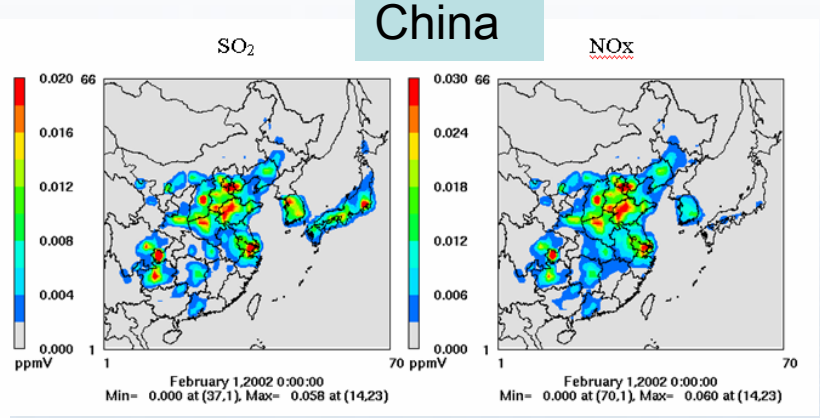
Sub-Working Group – Modeling('05-'07)

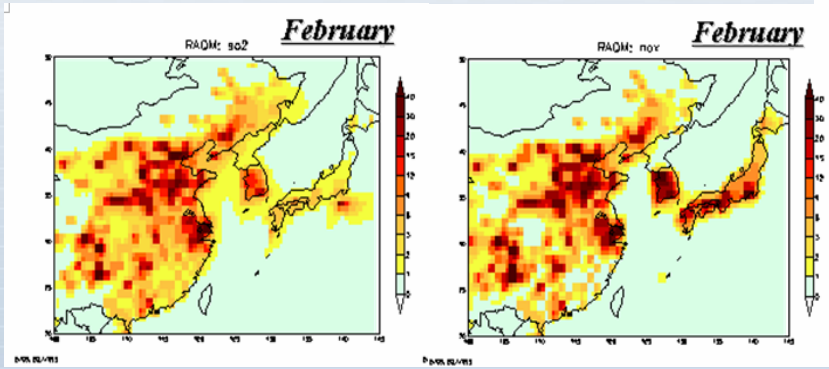
Modeling Results

Concentration

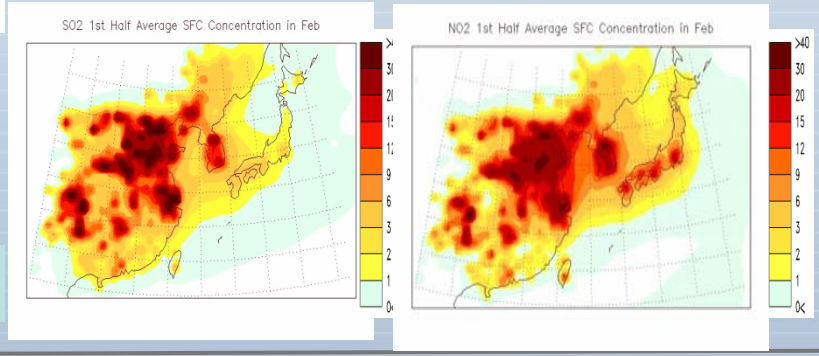
Spatial distribution of monthly average of SO2 and NOx concent. (Feb. 2002)

China





Japan



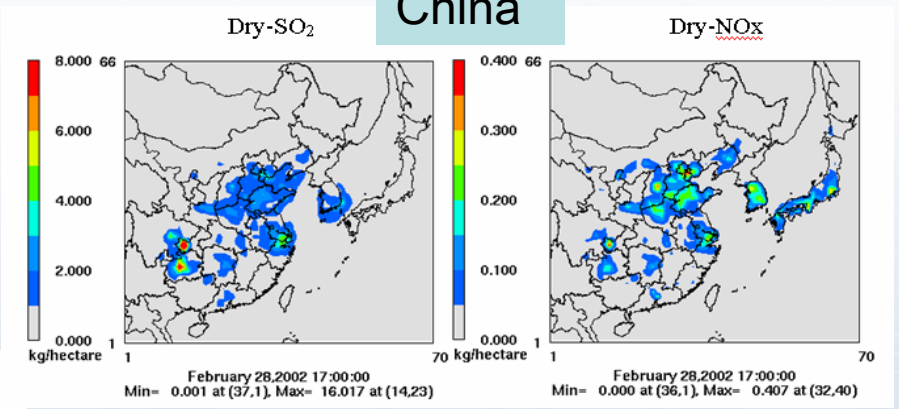
Korea

Sub-Working Group – Modeling('05-'07)

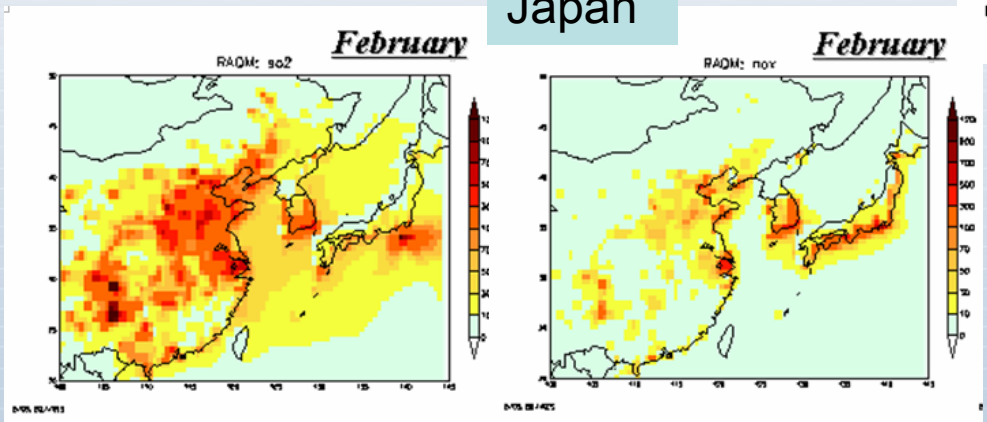
Wet/Dry Depositions

Dry deposition amount of
SO2, NOx (Feb. 2002)

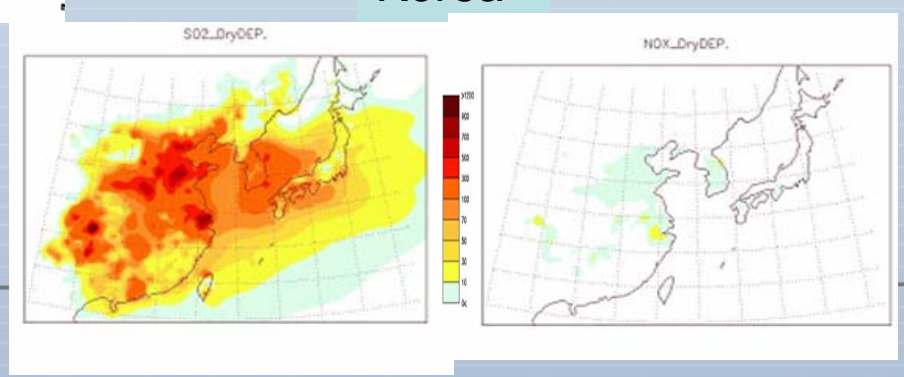
China



Japan



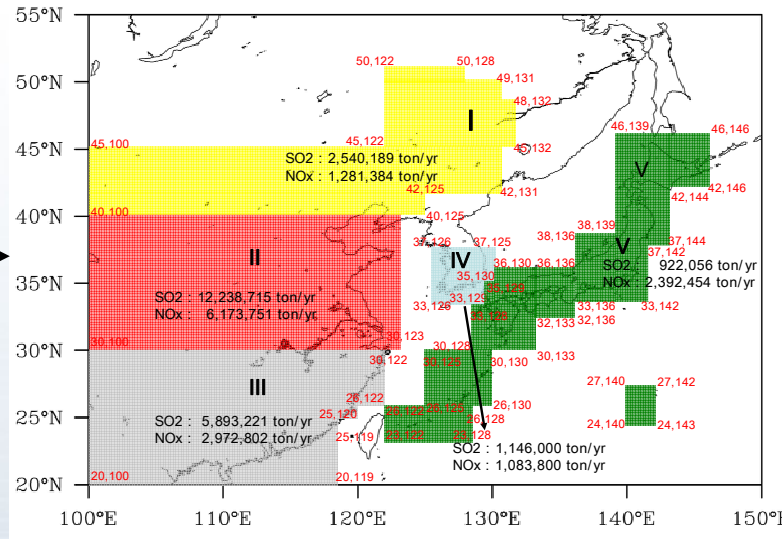
Korea



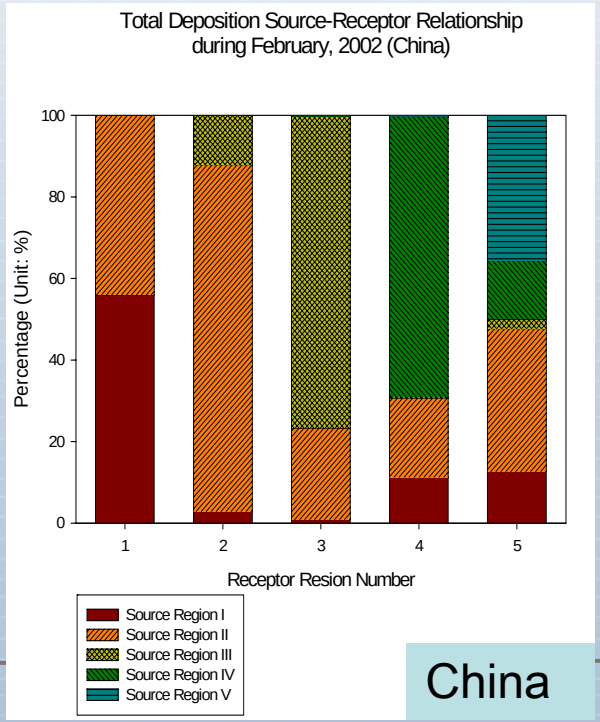
Sub-Working Group – Modeling('05-'07)

Source-Receptor relationship

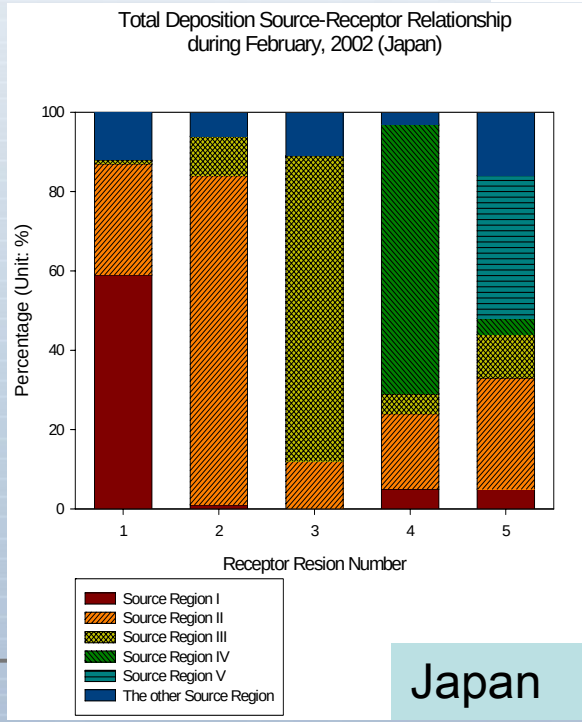
Regions for S-R relationship calculation →



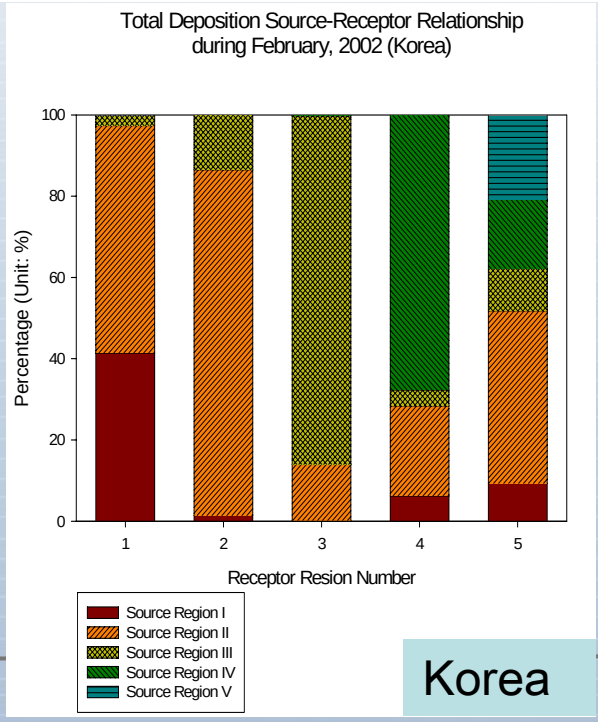
Fractional contribution of each receptor region to the total de position of sulfur (Feb. 2002)



China



Japan

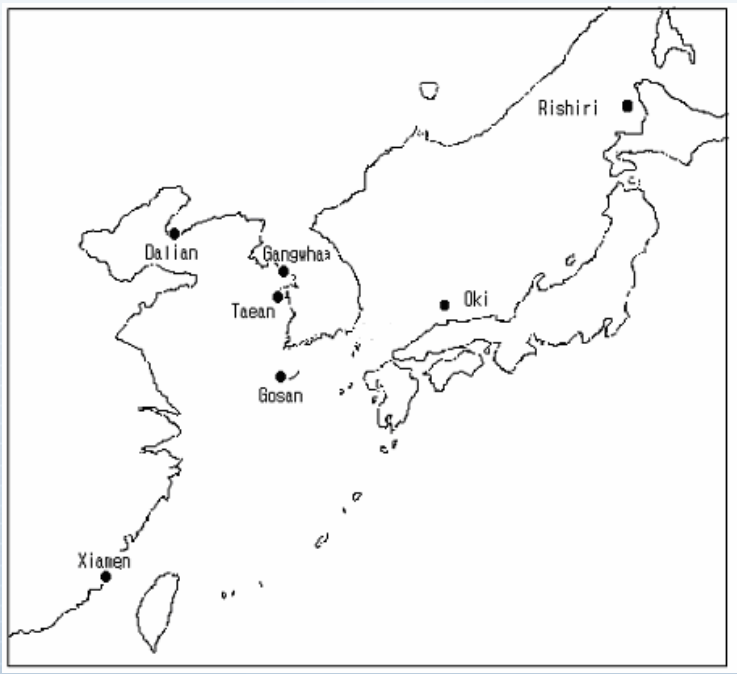


Korea

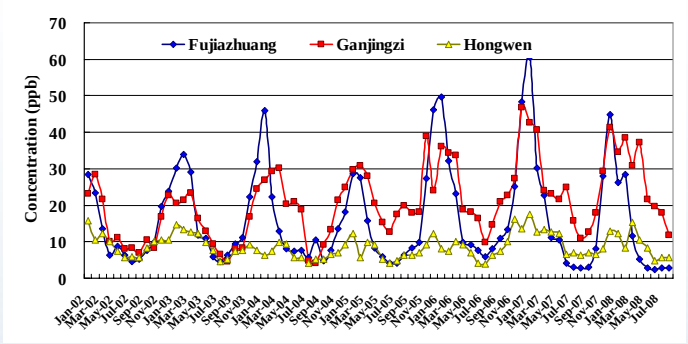
The 3rd stage (2008 ~ 2012)

Monitoring Part

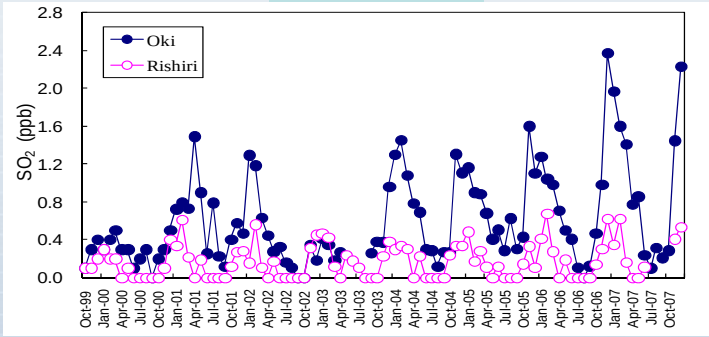
Monitoring sites



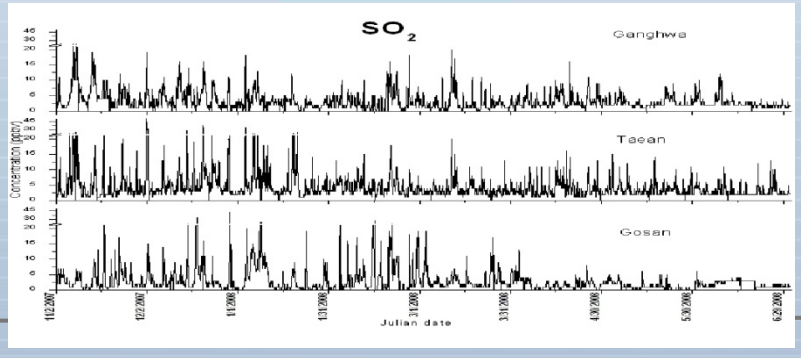
CHINA



JAPAN



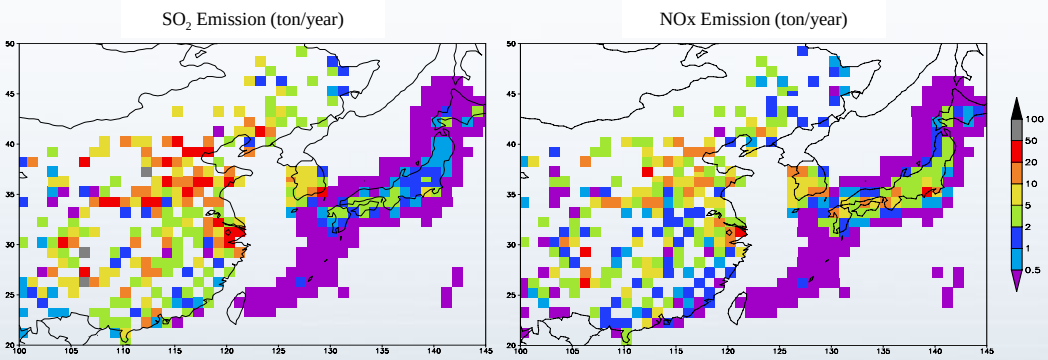
KOREA



The 3rd stage (2008 ~ 2012)

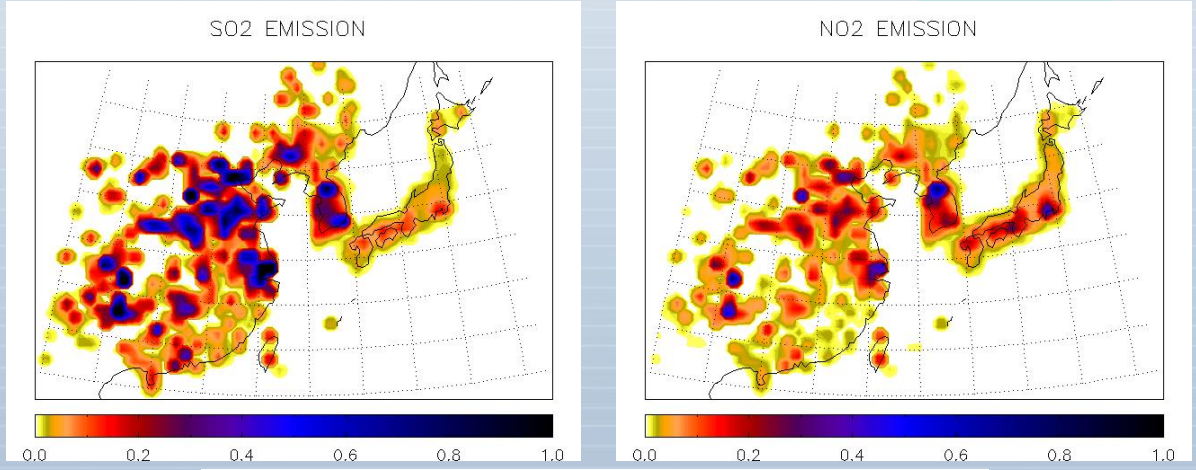
Emission

Japan



LTP standard emission for SO_2 (left) and NOx (right) prepared by each country (unit: ton $year^{-1}$ $grid^{-1}$)

Korea

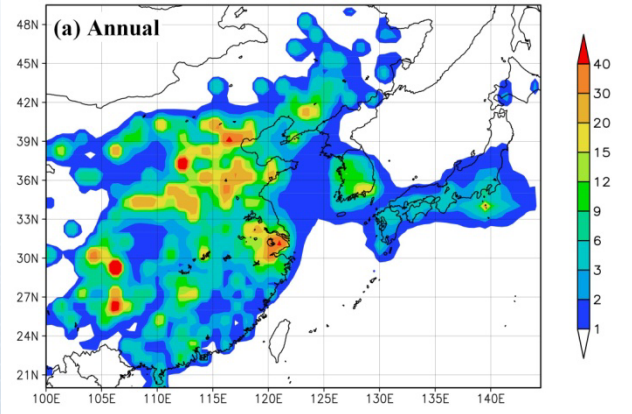


Emission rates (unit : $mgm^{-2}s^{-1}$)

The 3rd stage (2008 ~ 2012)

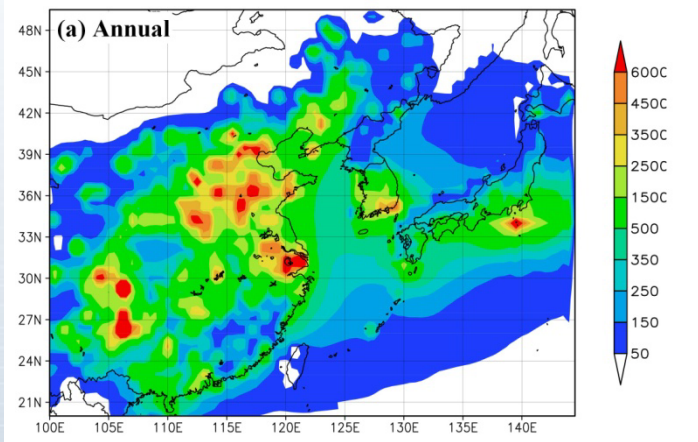
Simulated Concentration and deposition

Spatial distribution of annual average of SO2 concentrati on (2002)

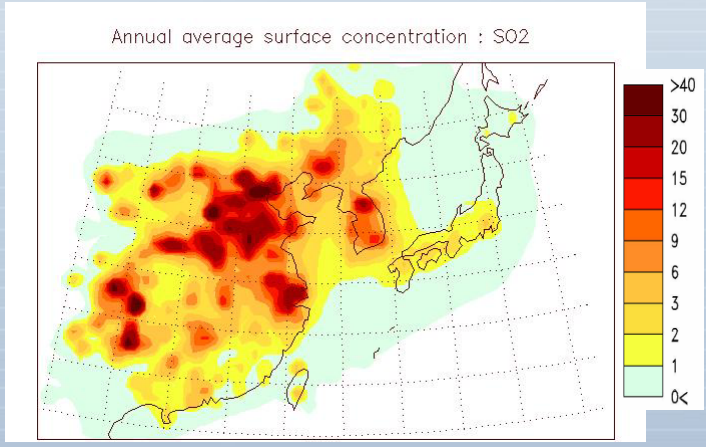


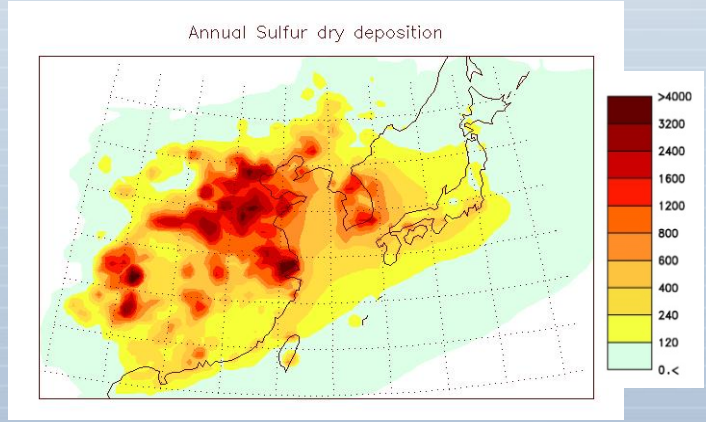
Japan

Spatial distribution of annually accumulated dry deposit ion of SO2 (μg/m²)



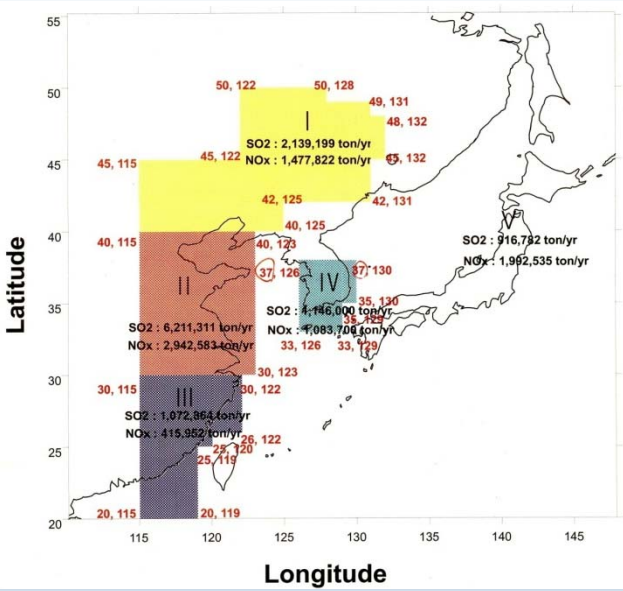
Korea





3rd stage – 2008 ~ 2012

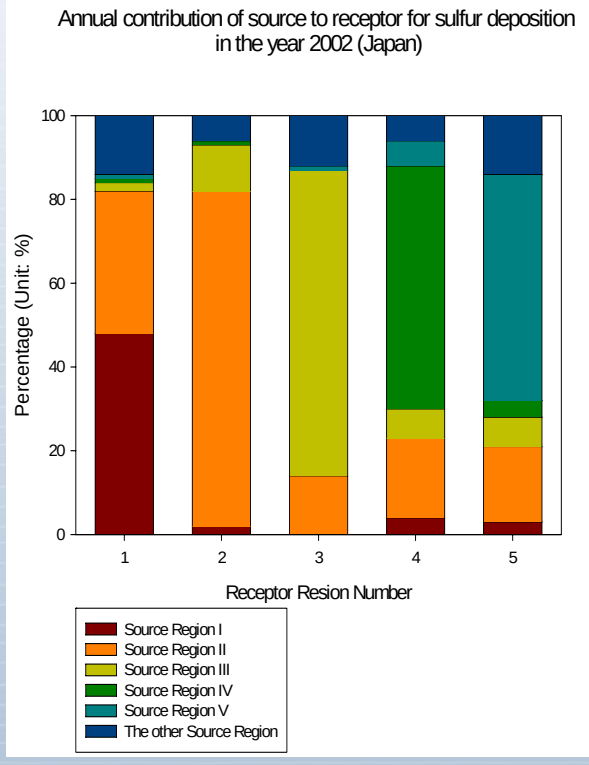
Source-Receptor relationship for sulfur



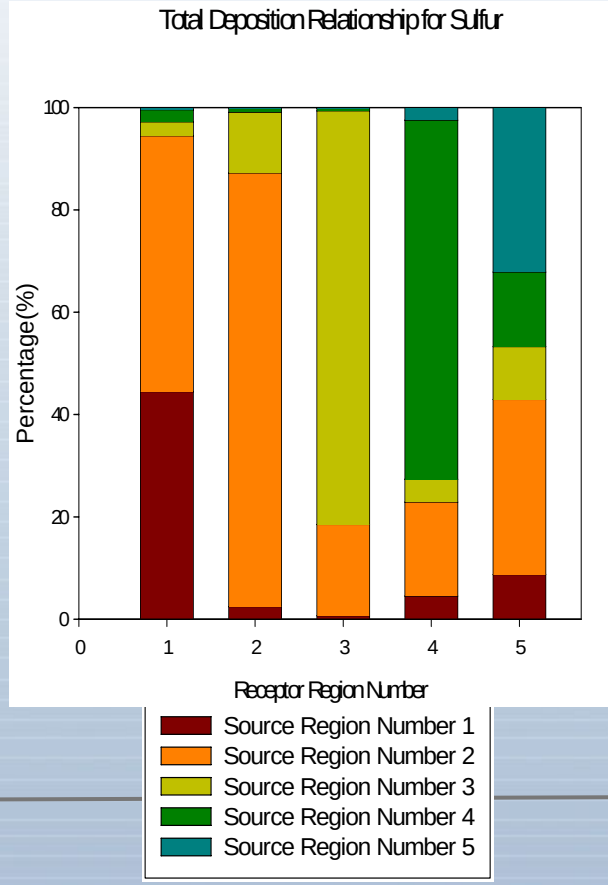
Total emission in each area

S-R relationship for deposition of sulfur in 2002

Japan



Korea



Expert Meeting

- 12 times of Expert Meeting for LTP project since 1996.
  - 7th meeting was held in Xiamen, China.
- the 11th meeting was held on Nov. 11~13, 2008 in Incheon, Korea
- Encourage the joint research activity by secretariat of LTP Project
- Published 8 annual reports

III. Future Plan

All plans need to discuss with member countries

- Strengthen the Monitoring Activity
  - Increase the monitoring site.
- Develop the Modeling capacity
  - Model upgrade by each country
  - Model Inter-comparison and Opening to the Modeling society
- Lead out the Useful results
  - Consensus for the result for policy-makers
  - Activation the research on academic societies
- Contribute the Regional Activities for Air Quality in NEA
  - Strengthen the Mutual Cooperation with Other Program, i.e. EANET

Thank you !!!

Presented by
Secretariat for LTP Project

History of LTP expert meetings

Period	Place	Title
Sep. 14~15, 1995	Seoul, Korea	1st Northeast Asian Workshop on LTP
July 4~5, 1996	Seoul, Korea	1st Expert Meeting
Nov. 18~20, 1997	Seoul, Korea	2nd Expert Meeting
1998	-	< Postponed >
Aug. 16~18, 1999	Seoul, Korea	1st Sub-Working Group Meeting
Aug. 22~24, 2000	Seoul, Korea	3rd Working Group and the 2nd Sub-Working Group Meeting
Aug. 22~24, 2001	Seoul, Korea	4th Expert Meeting
Aug. 27~29, 2002	Gyeongju, Korea	5th Expert Meeting
Nov. 4~6, 2003	Jeju, Korea	6th Expert Meeting
Oct. 28~30, 2004	Xiamen, China	7th Expert Meeting
Nov. 8~10, 2005	Jeju, Korea	8th Expert Meeting
Nov. 7~9, 2006	Daegu, Korea	9th Expert Meeting
Nov. 6~8, 2007	Busan, Korea	10th Expert Meeting
Nov. 11~13, 2008	Incheon, Korea	11th Expert Meeting

Activities

◆ Chairperson's Summary in 1995

- To launch a working group composed of government officials and experts from each of the three countries to support joint research of LTP
- To establish an Interim Secretariat at the National Institute of Environmental Research in Korea for supporting the organization and affairs of the working group

Activities

◆ Chairperson's Summary in 1996

- Organization
  - Working Group
    1. The total number of members 9, elected from either government officials, researchers, or professors
    2. To coordinate issues related to the researches on LTP over the Northeast Asian region
    3. To review specific joint research proposals submitted by each country
  - Sub-Working Group : necessary to discuss the specific joint research proposals in detail
  - Secretariat : To prepare and facilitate the expert meeting

- Research fields
  - field observations of the long-range transboundary air pollutants (LTP), including aircraft and ground-base observation
  - modeling and modeling validation of LTP
  - reports or papers on LTP

Activities

◆ Chairperson's Summary in 1997

- Presented national reports
  - ✓ China
    - the current status of Long-range Transboundary Air Pollutants and the progress of acid rain pollution control in China
  - ✓ Japan
    - studies on acid deposition under the Global Environmental Research Program and the characteristics of the air quality in Northeast Asia
  - ✓ Korea
    - the status, scope and plans of research projects on Long-range Transboundary Air Pollutants in Korea

- Agreed to organize two Sub-working Groups
  - ✓ Monitoring: to be led by Japan
  - ✓ Modeling: to be led by China and Korea

Activities

Chairperson's Summary in 1999

- To discuss the research plans and methods for 3 stages and to adopt the Terms of Reference (TOR) for Joint Research
- To exchange the national monitoring plans and present state of air quality, and to carry out ground monitoring and/or aircraft observations
- To review the gridded emission data for SO2, NOx, and VOC from 3 countries, and to perform numerical simulations for the selected meteorological conditions on modeling

Activities

◆ Chairperson's Summary in 2000

- Presented national reports
  - China: Introduced a current situation of monitoring, the research progress and mitigation on acid deposition, estimation of SO2, NOx emission in the eastern China, and China air quality model
  - Japan: Presented a current monitoring situation, the plan on modeling research, and NOx and SOx emission inventories
  - Korea: Presented current status and plans on the Korean monitoring research, long-range transport and deposition modeling of air pollutants, and SO2 and NOx emissions in Korea

    ※ Emission inventory was prepared for the year of 1998

- Agreements in Sub-Working Groups
  - Monitoring
    1. To supplement national reports including a detail description of measuring equipments
    2. To submit detailed measurement data, possibly hourly data, for data exchange
  - Modeling
    1. To supplement national reports, including fuel consumption, by sector following the UNDP methodology
    2. To prepare the emission inventory for SO2, NOx, and VOC

Activities

◆ Chairperson's Summary in 2001

- Presented national reports
  - China: Introduced monthly trends of major air pollutants and precipitation data in the selected sites, and development and application of the air quality model
  - Japan: Presented long-term monitoring at Rishiri and Oki, and intensive monitoring at Oki, with aircraft measurements over the East China Sea, activity data and emission factors for estimating NMVOC emissions in Japan, and development of regional air quality model
  - Korea: Presented continuous monitoring results at 4 remote sites and intensive monitoring results performed on Nov. of 2000 and Apr. of 2001 using aircraft, and the preliminary results for emissions for NMVOC in Korea

- Agreements in Sub-Working Groups
  - Monitoring: EANET QA/QC program (e.g. round robin test) can be utilized
  - Modeling : model simulation and validation cases will be decided after the review

Activities

◆ Chairperson's Summary in 2002

- Presented national reports
  - China: Introduced emission inventory of VOCs at 3 regions for the year of 1997,
    and monitoring results obtained at Dalian and Xiamen sites, including aircraft observations
    in coastal areas of East China in the spring of 2002
  - Japan: Introduced the supplemented NMVOC emissions in Japan for the year of 1998,
    modeling research conducted by RAQM over Apr., Sep., and Oct. of 2002
    and was compared with the observed SO2, NO2, and O3 at the monitoring stations
    and presented the results of monitoring at Rishiri and Oki
  - Korea: Supplemented emission inventories of NMVOC and compared with the previous emission inventories
    in the 2nd year,
    Modeling results by CADM for 4 typical meteorological cases,
    Continuous monitoring results at 4 remote sties since Sep. 2001 and intensive monitoring results including
    the aircraft observations

- Agreements in Sub-working Groups
  - Monitoring
    1. To include the aircraft observations in China and Korea
    2. To add to the work plan "the assessment of air quality trend" and "Comparison analysis of monitoring results"

  - Modeling
    1. To prepare the preliminary emission inventory of NH3 in an 11 grid format by three countries
    2. To carry out model verification using the observed precipitations, ionic species in precipitation
       and gaseous components during the intensive observation (5~15, Mar. 2002)

Activities

◆ Chairperson's Summary in 2003

- Presented national reports
  - China: Introduced intensive monitoring results
    Modeling results of the 5 cases and comparisons between modeling and intensive measurement results
  - Japan: long-term monitoring data and meteorological variables from Rishiri and Oki, and intensive monitoring data
    Ammonia emissions and model results of the 5 cases
  - Korea: long-term and intensive monitoring data along with the results of modeling and its comparisons with other measurements
    Ammonia emissions from Korea

- Agreements in Sub-working Groups
  - Monitoring: To conduct intensive monitoring in 3 different periods
  - Modeling
    1. To prepare the emission inventory for PM10, and CO in 1°X 1°by three countries
    2. To conduct model simulation for 2 cases (Mar. 2002 and Jul. 2002) and the relationship of S-R for sulfur in 5 regions (S. China, C.E. China, N.E. China, S. Korea, Japan) and model inter-comparisons

- Others
  - Expended the LTP project period to 2007

Activities

◆ Chairperson's Summary in 2004

- Presented national reports
  - China: introduced long-term monitoring and intensive monitoring results
    Modeling results for Mar. 2002 and NH3 emission
  - Japan: long-term monitoring data, meteorological variables, and intensive monitoring data
    CO and PM10 emissions and model results including S-R relationship
  - Korea: introduced long-term and intensive monitoring data
    Results of modeling including S-R relationship
    CO and PM10 emissions

- Agreements in Sub-Working Groups
  - Monitoring
    1. To conduct intensive monitoring in 2 different periods
    2. To continue a long-term and intensive monitoring activity
    3. To expand the optional monitoring items to VOCs, EC/OC, and trace metals of PM10 or PM2.5

  - Modeling
    1. To extend the model domain area to 20°X 50°(latitude), 100°X 150°(longitude)
    2. To conduct modeling with the gridded emission data for SO2, NOx, NH3, VOCs, PM10 and CO for the base year of 1998
    3. EANET and IMPACTS data can be used for the model validation

- Others
  - To prepare scientific papers for publication in international journals

Activities

◆ Chairperson's Summary in 2005

- Presented national reports

  - China: introduced long-term monitoring and intensive monitoring results
    Emission results of VOCs and NH3 based on 2000 and the model results including sulfur S-R relationship for Mar. and Jul. 2002
  - Japan: long-term monitoring data, meteorological variables, intensive monitoring data
    SO2, NOx, VOCs, NH3, CO, and PM10 emissions, and model results including S-R relationship
  - Korea: introduced long-term and intensive monitoring data as well as the results of aircraft measurement during 2004-2005
    Emissions of VOCs, CO and PM10 based on 1998 and the results of modeling including S-R relationship as well as the estimation of critical load for sulfur

- Agreements in Sub-working Groups

  - Monitoring
    1. To continue long-term and intensive monitoring activity
    2. To change the monitoring stations to Gosan and Dukjeok in Korea

  - Modeling
    1. Emissions of SO2 and NOx, LTP data for the base year of 1998 will be used and for VOCs and NH3, the base year may be different among the countries in the work plan for 2006
    2. To calculate concentration and deposition for 4 months of 2002 (Jan. Apr. Aug. and Oct.), and S-R analysis for sulfur for Jan. Oct. 2002 and for nitrate for Mar. 2002 (Japan and Korea)

Activities

◆ Chairperson's Summary in 2006

- Presented national reports
  - China: introduced long-term monitoring and intensive monitoring results
    Results of NH3 emission and model results including sulfur S-R relationship for Jan. and Oct. 2002
  - Japan: long-term monitoring data, surface meteorological variables, and intensive monitoring data
    Model results for deposition of S-R relationship for sulfur in Jan. and Oct. 2002 and for nitrate in Mar. 2002
  - Korea: introduced long-term and intensive monitoring data as well as the results of aircraft measurement during 2005-2006
    Results of modeling, including S-R relationship, for deposition of sulfur in Jan., Mar., Jul., Oct. 2002 and for deposition of nitrate in Mar. 2002

- Agreements in Sub-working Groups
  - Monitoring
    1. To continue long-term and intensive monitoring activity
    2. To make an overall map of intensive monitoring data for Oct. 15~25, 2005 and analyze the long-term trend of air pollutants (SO2, NOx or NO2, PM10) from Jan. 2002 to Dec. 2005
  - Modeling
    1. To calculate concentrations and depositions for 6 months of 2002 (Feb., May, Jun., Sep., Nov., and Dec.)
    2. S-R analysis for sulfur for Feb., May, Aug., Nov. 2002 and for nitrate only for July 2002

- Others
  - Expanded the joint research period to the 3rd stage (2008~2012)

Activities

◆ Chairperson's Summary in 2007

- Presented national reports
  - Monitoring: introduced long-term monitoring and intensive monitoring results
    introduced the results of aircraft measurements during 2006~2007(Korea)
  - Modeling: model results including sulfur S-R relationship for Feb., May, Aug., and Nov. 2002
    and for nitrate in July 2002

- Agreements in Sub-working Groups
  - Monitoring
    1. To continue long-term and intensive monitoring activity
    2. To study research methodology for utilization of satellite data and other alternative tools (Korea)

  - Modeling
    1. To calculate S-R relationship for sulfur for additional 4 months (Apr., Jun., Sep., and Dec.)
    2. To compile the entire results of simulation in 2002, and perform model inter-comparison
    3. To prepare the first draft for publishing model results of concentration and deposition for 2002 in peer-reviewed journals, excluding the S-R relationship part
    4. To use new methodology to study S-R relationship for total nitrate (NO3- and HNO3) and sulfur
    5. To update the emission data (SO2, Nox, NH3, CO, VOCs and PM10) for the target year
    6. To conduct research of O3 and PM

- Others
  - Adopted the revised goals of the 3rd stage and specific research contents

Activities

◆ Chairperson's Summary in 2008

- Presented national reports

✓ Monitoring
- introduced long-term monitoring and intensive monitoring results
- results of satellite retrieval and aircraft measurement for the intensive monitoring period (Korea)

✓ Modeling
- each model result of S-R relationship for sulfur for remaining 4 months in 2002
- a draft version of model inter-comparison study,
- introduced the methodology for future S-R relationship for total nitrate (Korea)

- Agreements in Sub-working Groups

✓ Monitoring
- to continue the research activities during the 3rd stage
- intensive monitoring periods for 2010 and 2011 should include summer and winter

✓ Modeling
- to continue the model inter-comparison study
- to publish the model results of concentration and deposition for 2002 in peer-reviewed journals excluding the S-R relationship part
- to conduct sensitivity study of O3 using emissions for July in 2006
- to investigate S-R relationship for total nitrate with Method III of EMEP for Mar., Jul., Oct., and Dec. in 2006
- to hold a technical meeting in early 2009
- to use an academic version of an emissions inventory for the base year of 2006 for a model inter-comparison study