Hokkaido Institute of Environ Sciences

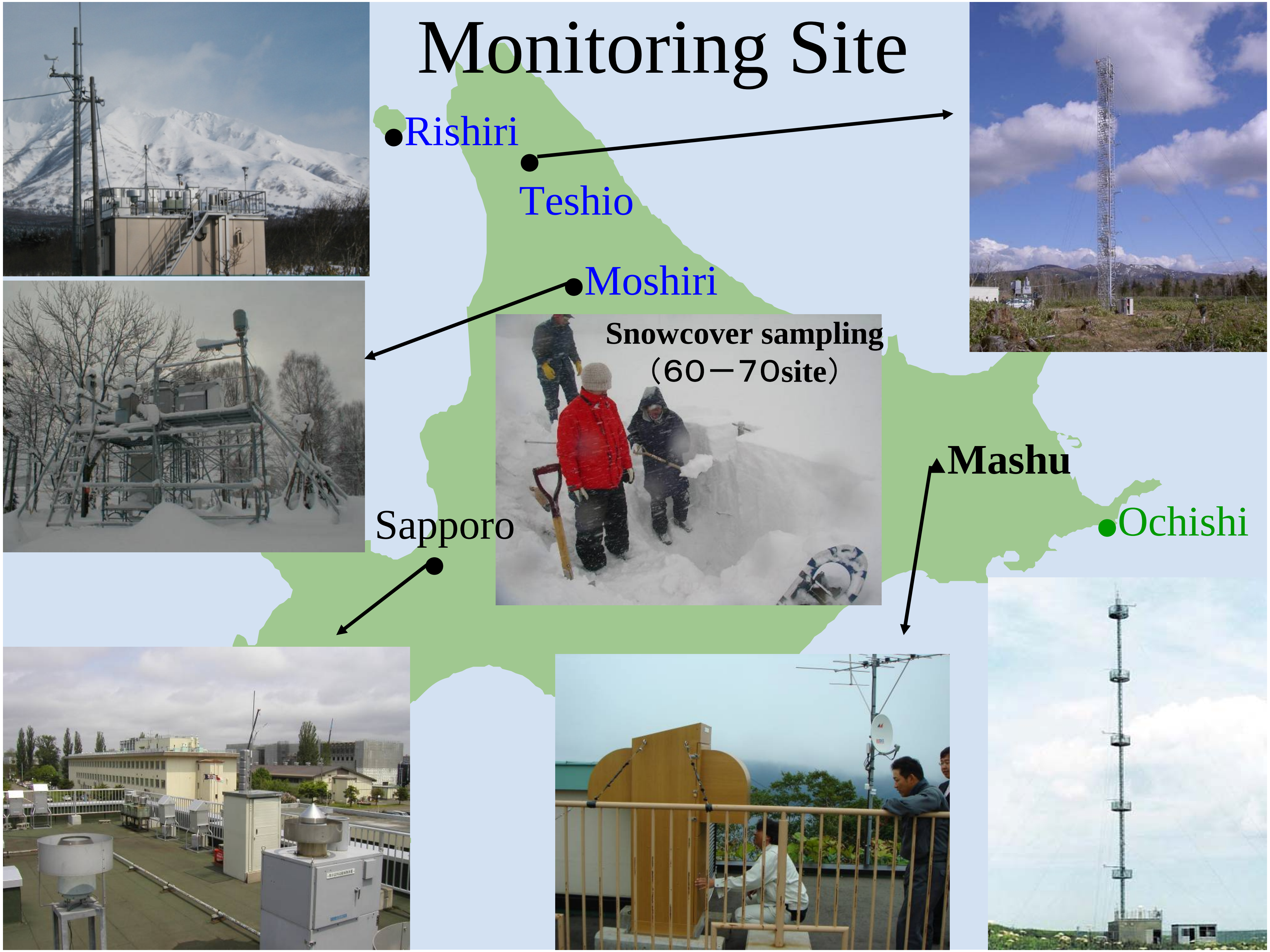
Organization

Director ---Vice Director

- General Affairs Department
  - General Affairs Section
  - Planning and Coordination Section
- Environmental Protection Department
  - Air Environment Section
  - Water Environment Section
  - Pollution Control Section
  - Chemical Pollution Section I
  - Chemical Pollution Section II
- Environmental Studies Department
  - Materials Cycle Section
  - Regional Environmental Section
  - Environmental Engineering Section
- Nature Conservation Department
  - Natural Environments Conservation Section
  - Vegetation Section
  - Wildlife Section
  - Eastern Hokkaido Wildlife Research Station
  - Southern Hokkaido Wildlife Research Station

Materials Cycle Section

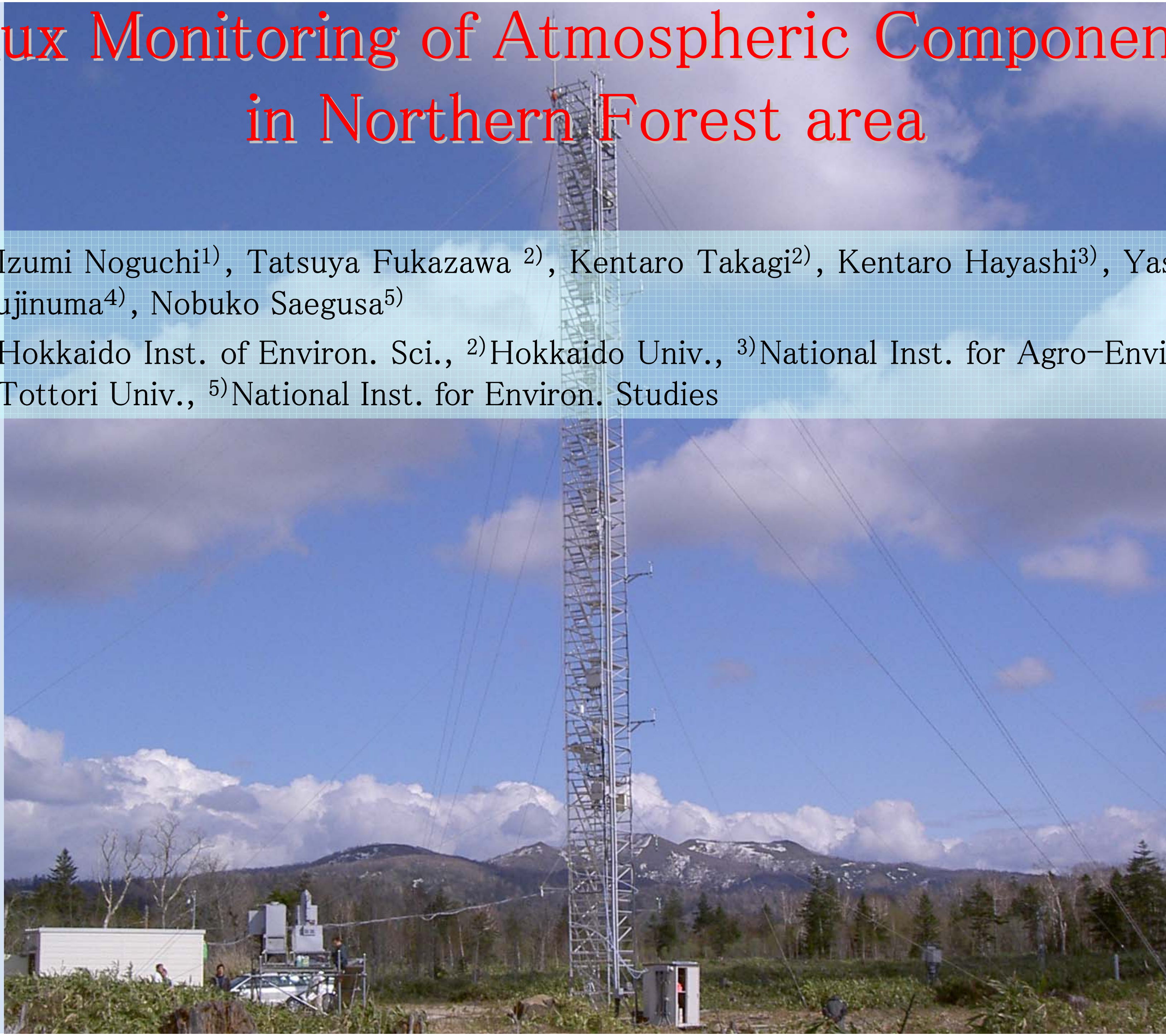
Research on the material cycle (N or C cycle and so on), acid rain and environmental control concerning waste management.


Monitoring Site
Rishiri
Teshio
Moshiri
Snowcover sampling
（60－70site）
Mashu
Sapporo
Ochishi

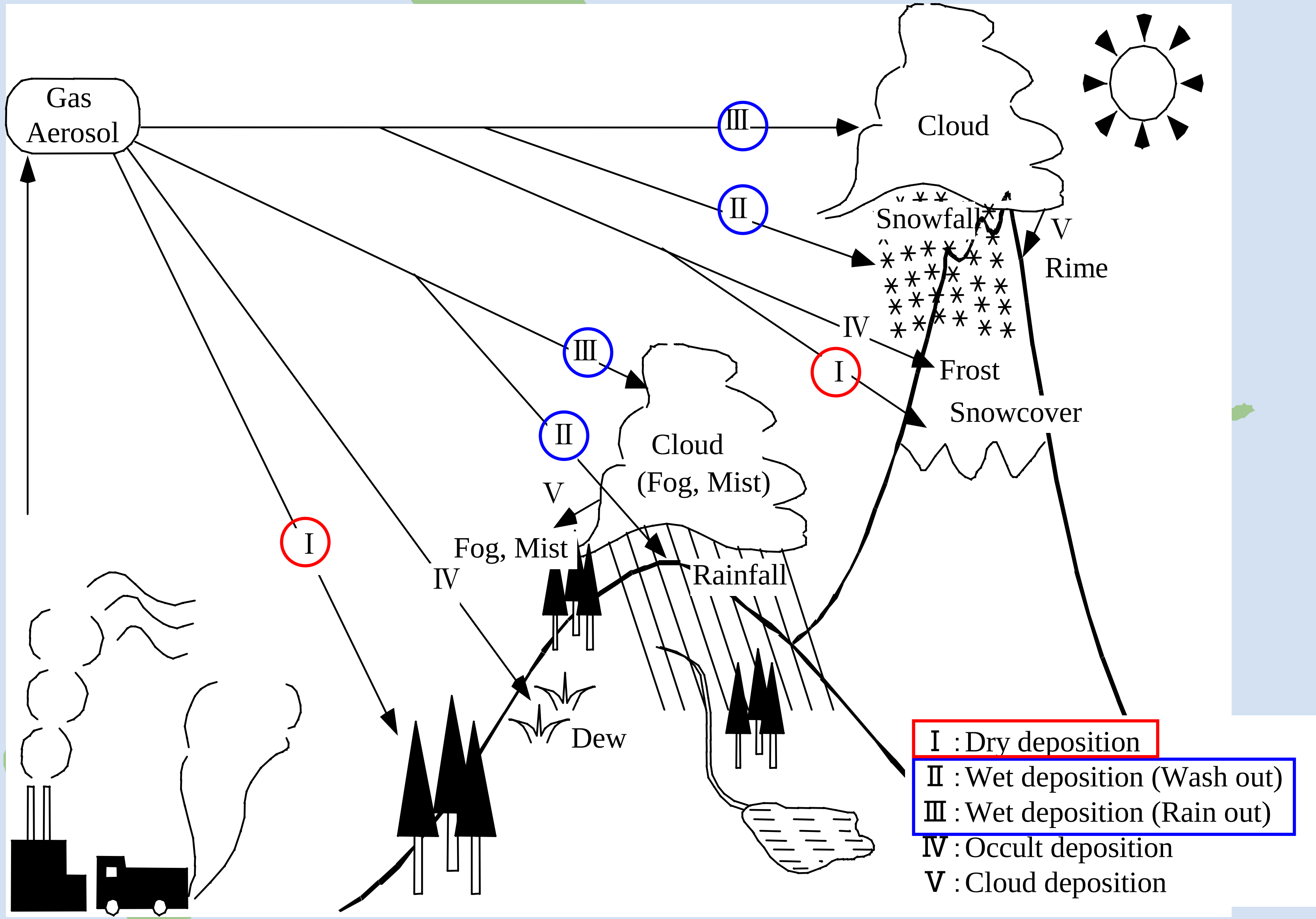
Flux Monitoring of Atmospheric Components in Northern Forest area

Izumi Noguchi[1)], Tatsuya Fukazawa [2)], Kentaro Takagi[2)], Kentaro Hayashi[3)], Yasumi Fujinuma[4)], Nobuko Saegusa[5)]

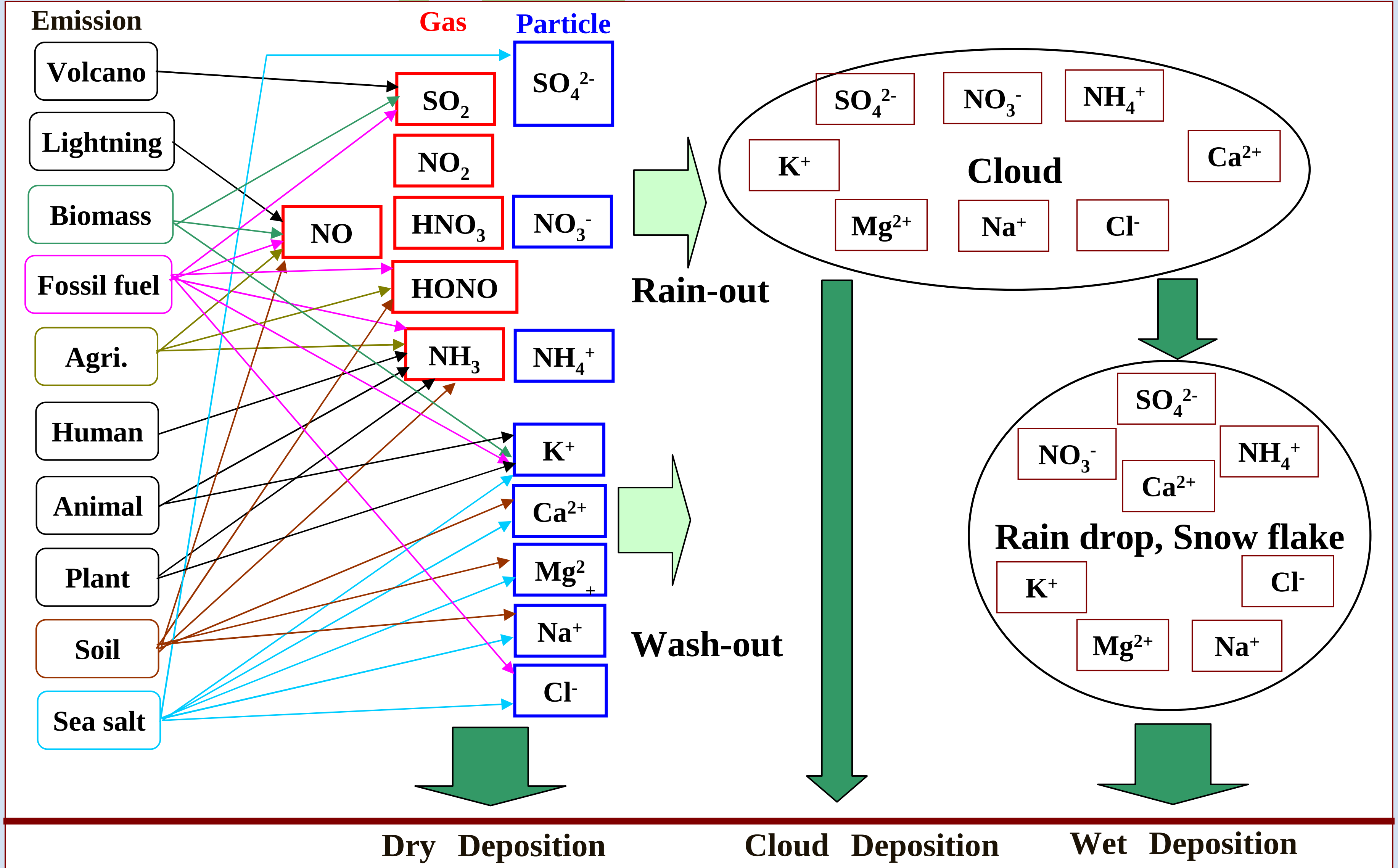
[1)]Hokkaido Inst. of Environ. Sci., [2)]Hokkaido Univ., [3)]National Inst. for Agro-Environ., [4)]Tottori Univ., [5)]National Inst. for Environ. Studies



Deposition process

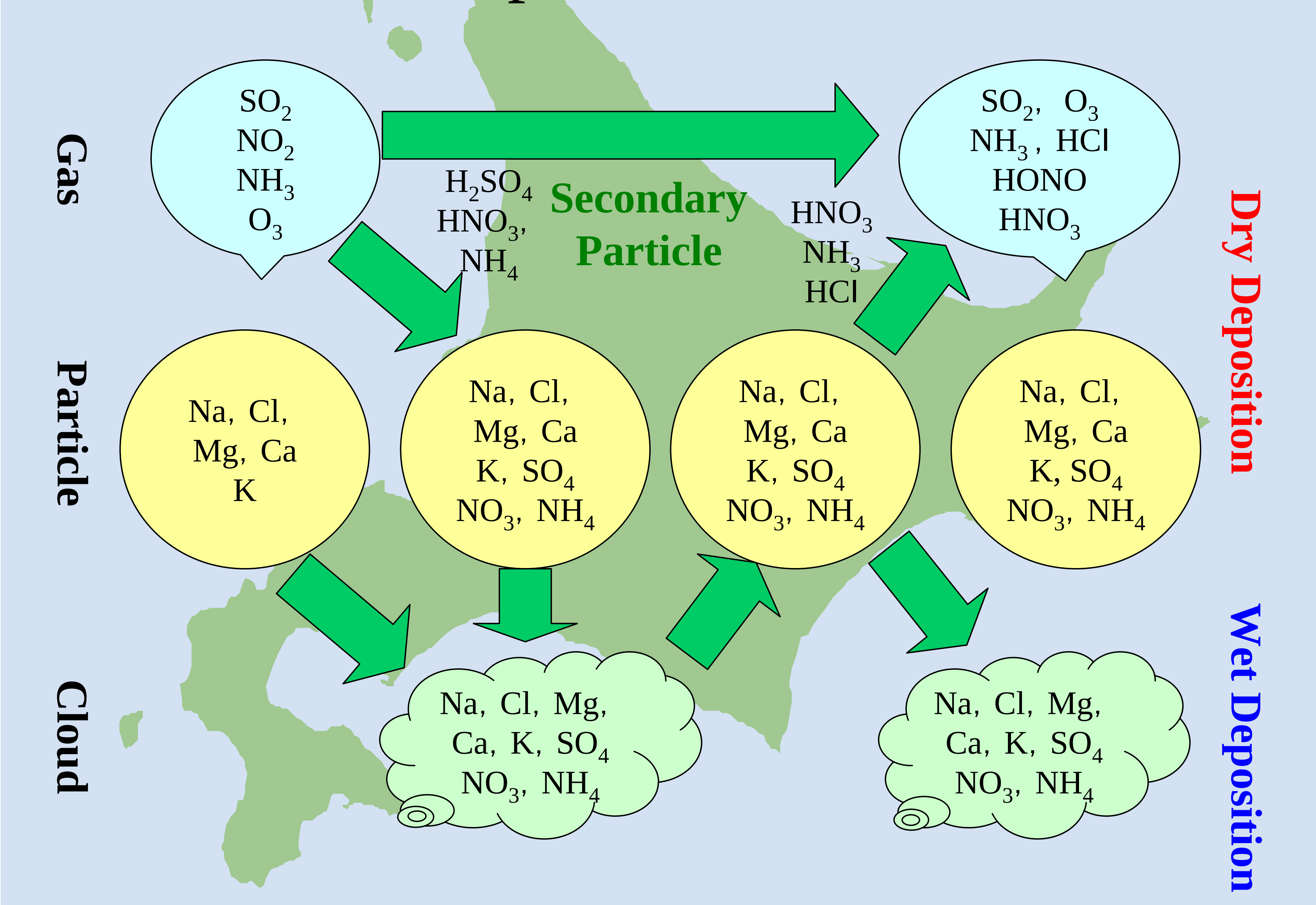


Gas and particle ion components

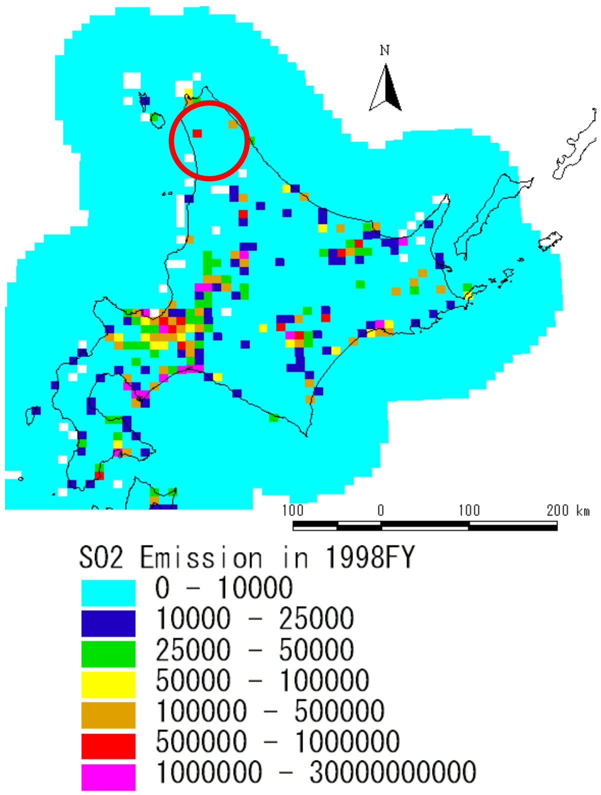


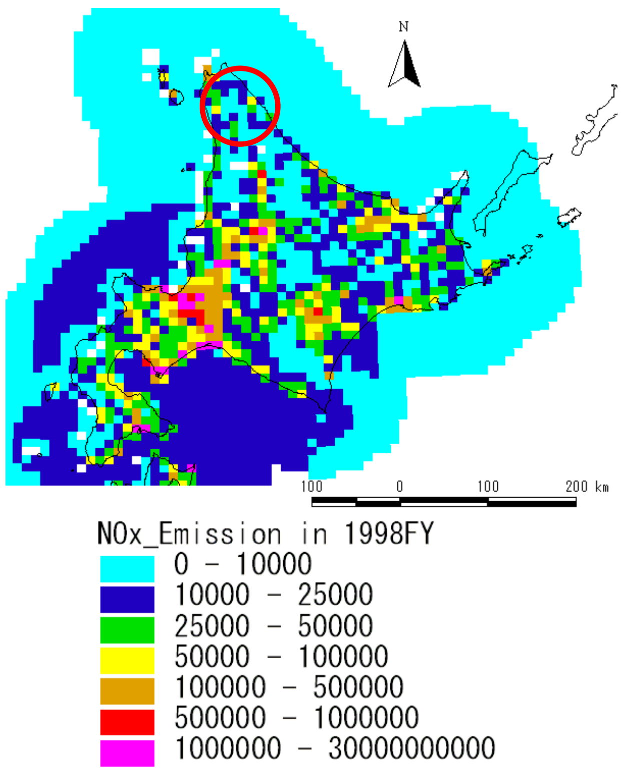
Agri.: Agriculture (fertilizer, livestock, and so on.)

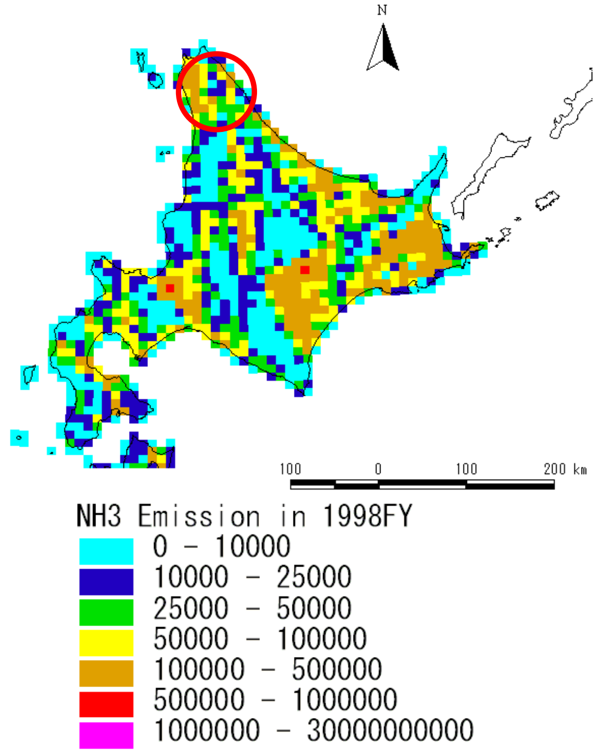
Transport & Reaction



Emission of Hokkaido







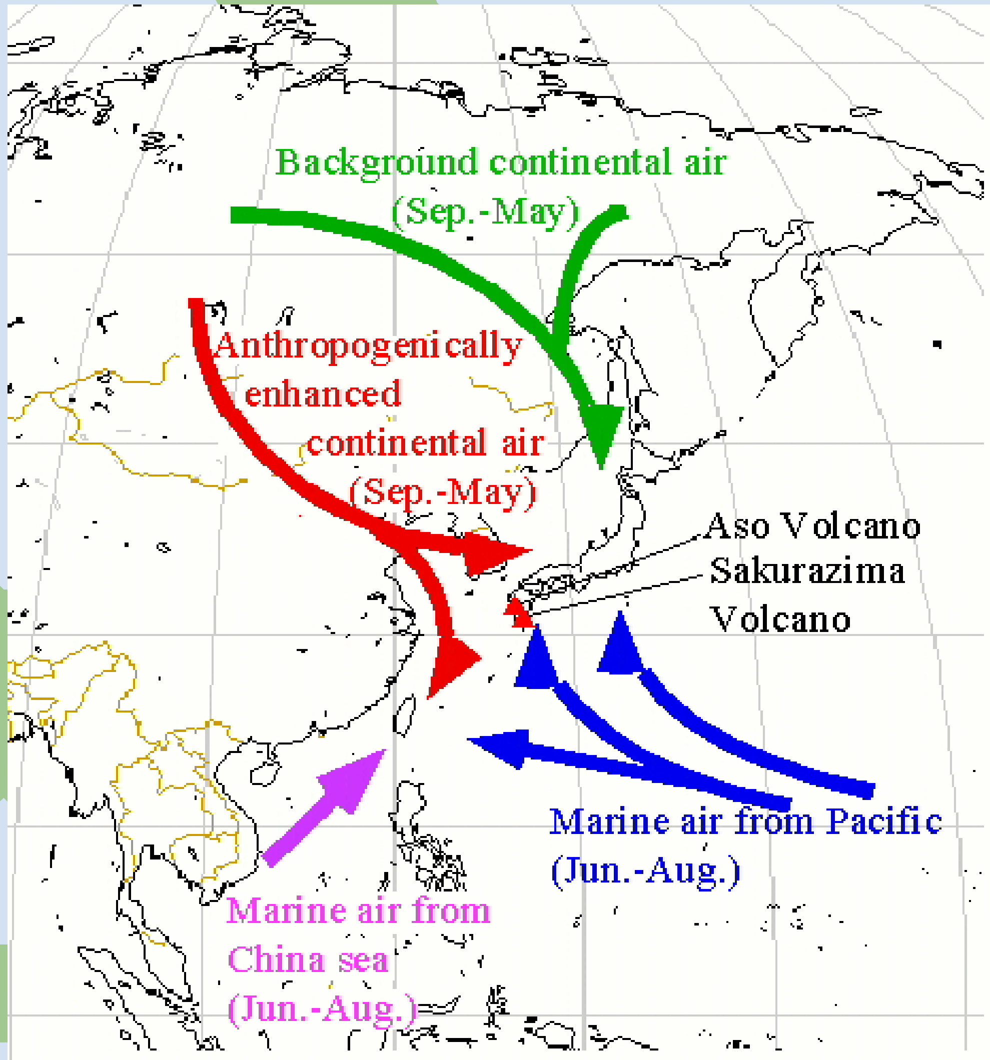
Normal
Black color

Kosa
Yellow color

To Sapporo

In March 2002, large Kosa phenomenon.
First observation in Eastern Hokkaido.

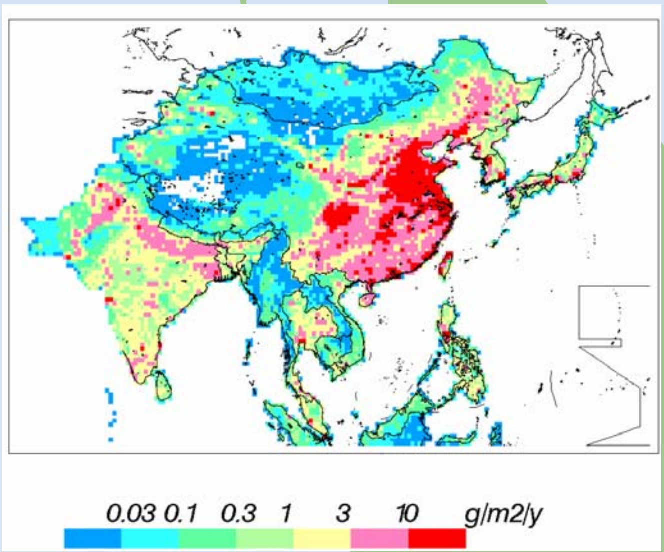
Air mass Flow



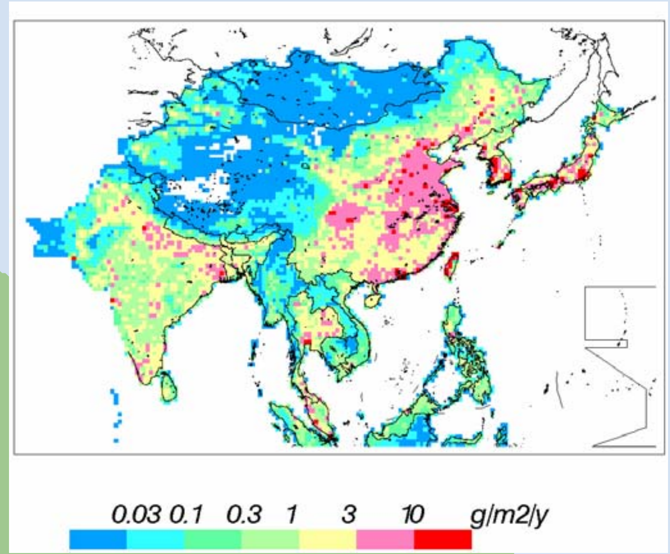
by Akimoto et al., (1998)

Emission Inventories

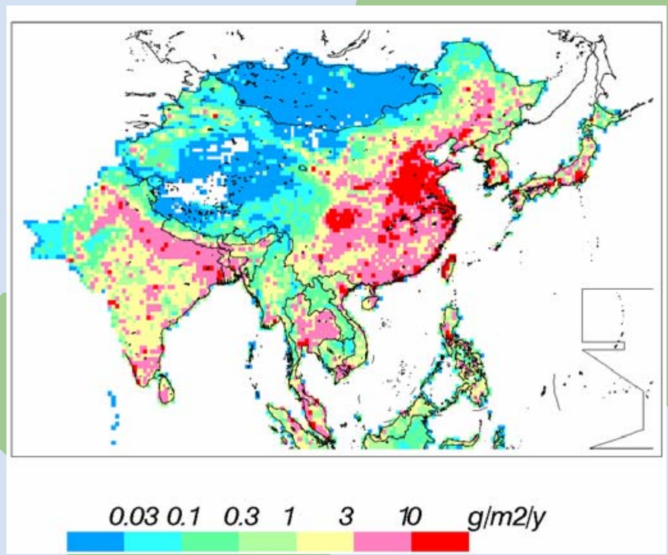
SO_2



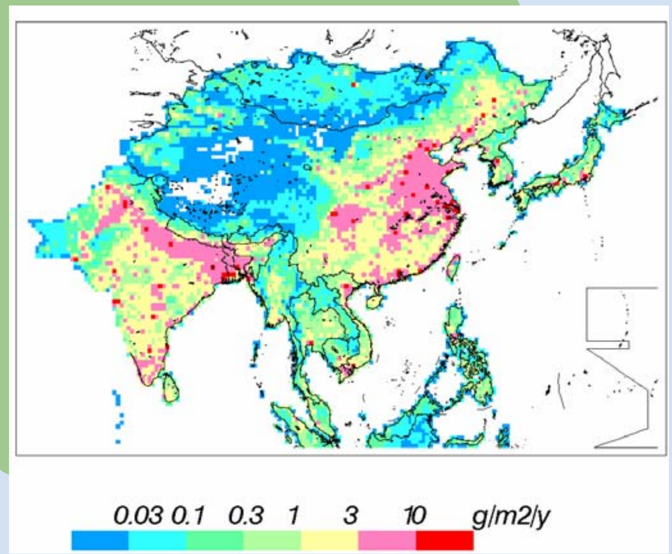
NO_x



NMVOC



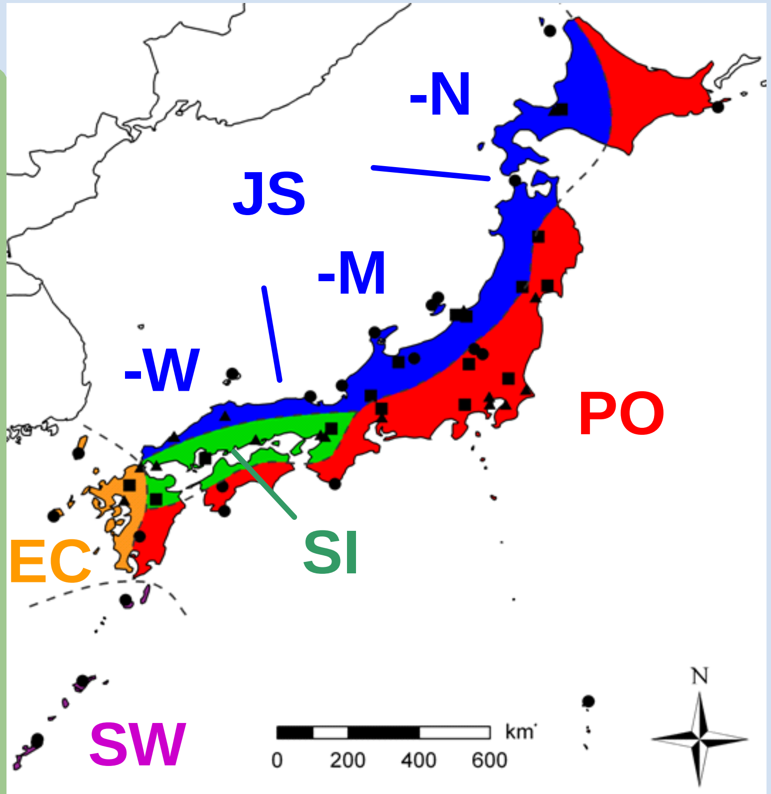
NH_3



http://www.iiasa.ac.at/rains/meetings/ACCENT_GEIA/presentations/old/EMISSIONChinaTonooka.ppt

Wet deposition in Japan

Region	C.	Prc. (mm yr^{-1})	Annual deposition (mmol m^{-2} yr^{-1}) nss-SO_4^{2-}	NO_3^-	NH_4^+	Sites *n*
JS-N	Re	761	10.1	8.8	13.7	1
	Ru	931	16.6	12.0	16.8	3
	U	974	20.3	11.8	20.6	1
JS-M	Re	1778	26.3	27.8	28.5	7
	Ru	1938	41.0	29.9	37.8	10
	U	1494	51.4	27.3	54.4	3
JS-W	Re	1348	19.0	21.6	22.4	1
	Ru	1806	30.6	22.3	28.1	1
	U	1576	23.0	25.6	23.9	3
PO	Re	2083	23.1	18.1	18.3	6
	Ru	1838	25.9	26.2	31.6	9
	U	1247	27.5	29.3	35.0	12
SI	Ru	1449	23.8	19.7	30.5	4
	U	1346	27.0	20.7	26.2	7
EC	Re	1791	25.5	23.9	31.3	2
	Ru	1857	33.7	18.8	34.0	2
	U	1676	36.1	24.2	36.1	3
SW	Re	3370	37.5	28.4	32.2	6
Japan	Re	2211	27.3	24.0	26.1	23
	Ru	1725	30.6	24.4	32.1	29
	U	1365	30.0	25.5	33.4	29



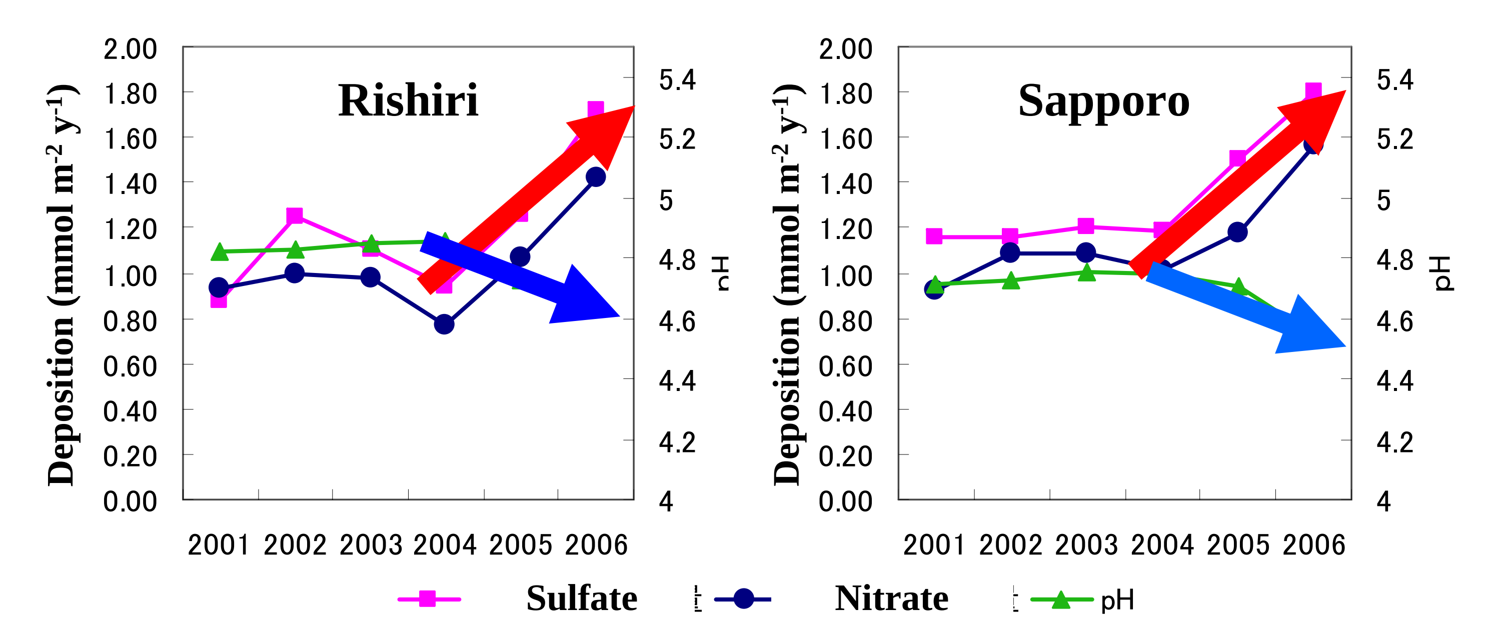
Region: JS-N: Northern part of the Japan Sea area, JS-M: Central part of the Japan Sea area, JS-W: Western part of the Japan Sea area, PO: The Pacific Ocean area, SI: The Seto Inland Sea area, EC: The East China Sea area, and SW: Southwestern Islands Sea area. C.; Re: Remote site, Ru: Rural site, and U: Urban site.

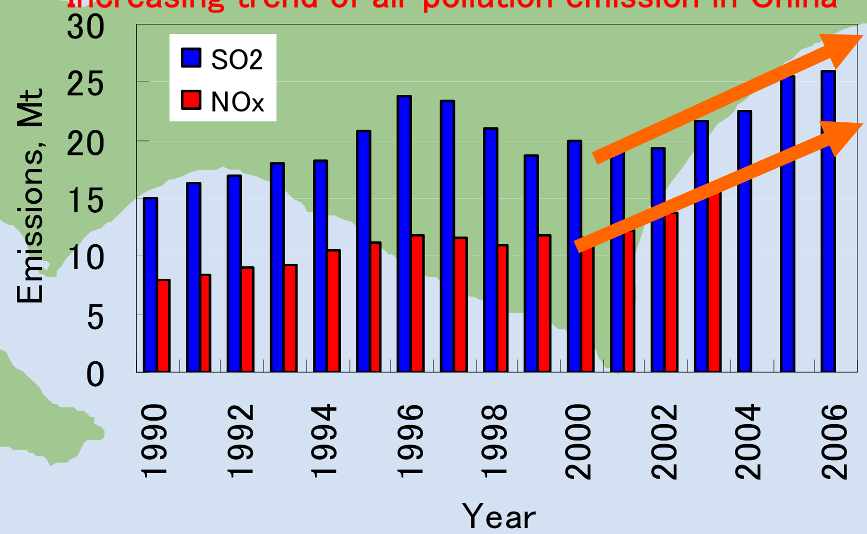
Contributions of emission on precipitation components in Hokkaido

		Object year	China	SE Asia	S Korea	N Korea	Taiwan	Japan	Volcano	Other
										%
SOx										
Hokkaido	Inoue et al.(2005)	1995	63	1	10		0.2	15	9	3
	Ikeda et al.(1997)	1990	25		9	1.3	0.9	19	**45**	
		Spring	26		9	1.6	1.0	16	**47**	
		Summer	1		3	0.1	0.3	20	**76**	
		Autumn	27		11	1.6	0.2	23	**37**	
		Winter	48		16	1.9	2.0	17	**15**	
	Arndt et al. (1998)	1990	13		6	3.0		13	**65**	
	Noguchi et al. (2007)	2002	39		6	4.0	2.0	39	10	
Other area	Inoue et al.(2005)	1995	41-56	1-3	6-17		0.4-1.2	13-36	8-21	1-3
	Ikeda et al.(1997)	1990	17-37		4-11	1.3-3.7	0.1-0.3	33-57	**15-24**	
NOx										
Hokkaido	Ikeda et al.(1997)	1990	20		17	1.9	1.6	60		
		Spring	20		15	1.8	3.0	60		
		Summer	1		8	0.3	1.0	90		
		Autumn	24		17	2.4	0.5	56		
		Winter	32		26	2.9	2.3	37		
	Noguchi et al. (2007)	2002	21		14	3.0		62		
Other area	Ikeda et al.(1997)	1990	7-21		3-11	0.9-2.7	0.2-0.4	69-89		

Blue Bold: Over estimation for Volcano in Hokkaido

Increasing of Sulfate & Nitrate, decreasing pH

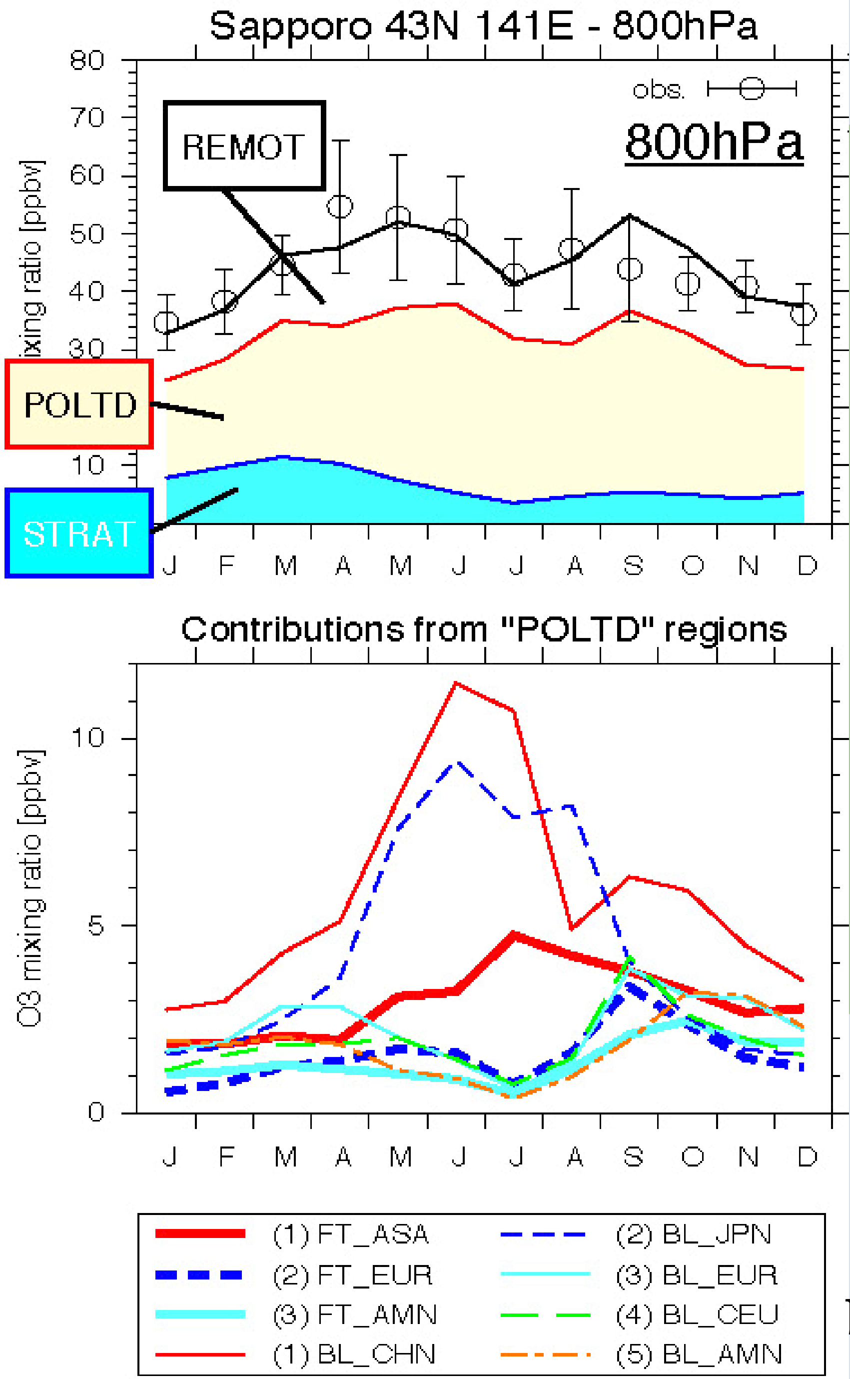


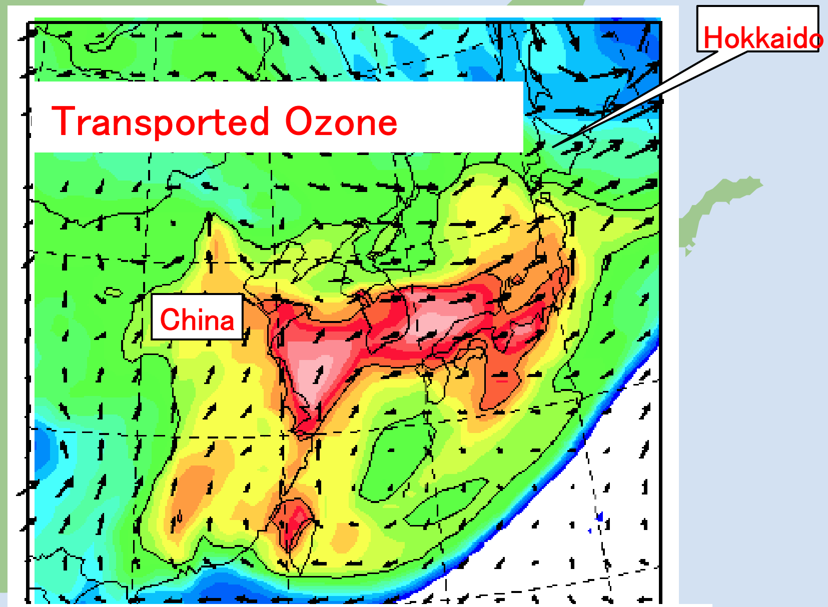


（国家环境保护总局, 2007；Tian *et al.*, 2005）

Transported Ozone

**Contributions of China and Japan are large.
However, contributions of Europe and North America cannot be ignored.**



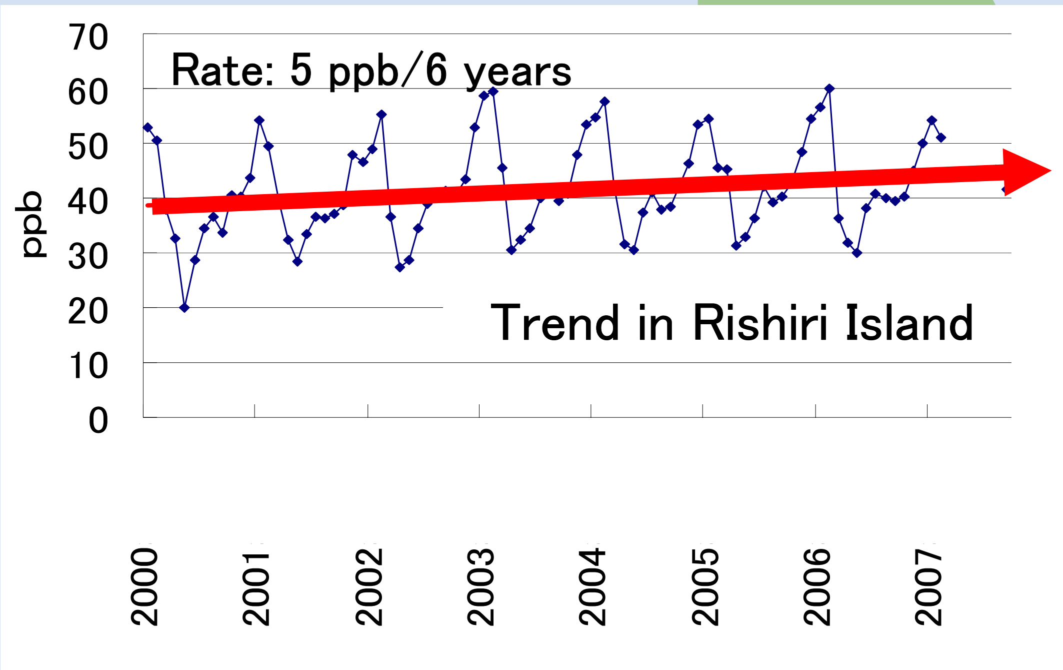


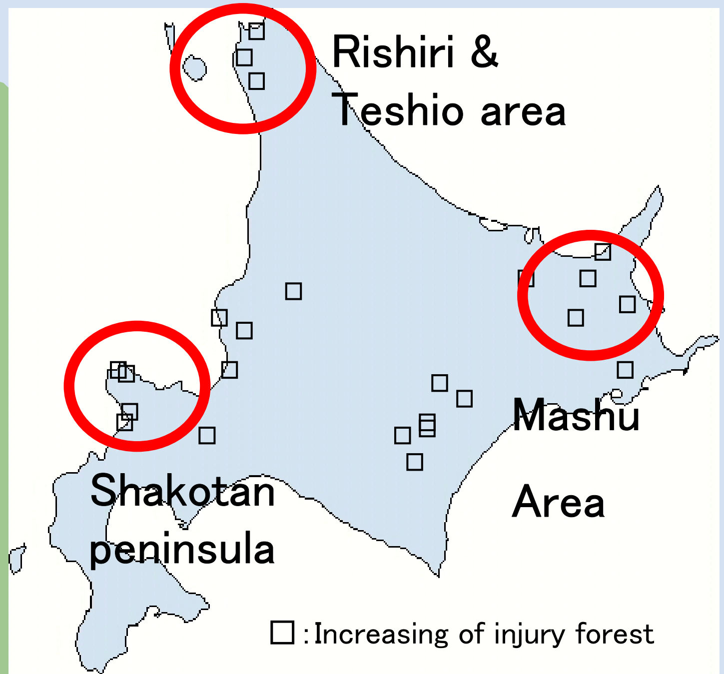
Simulation results (5/8/2007)
(by NIES/Kyushu Univ.)

by Akimoto et al. (2007)

Surface Ozone

Effect on Vegitation（>40ppb）
Effect on Human Health（>60ppb）



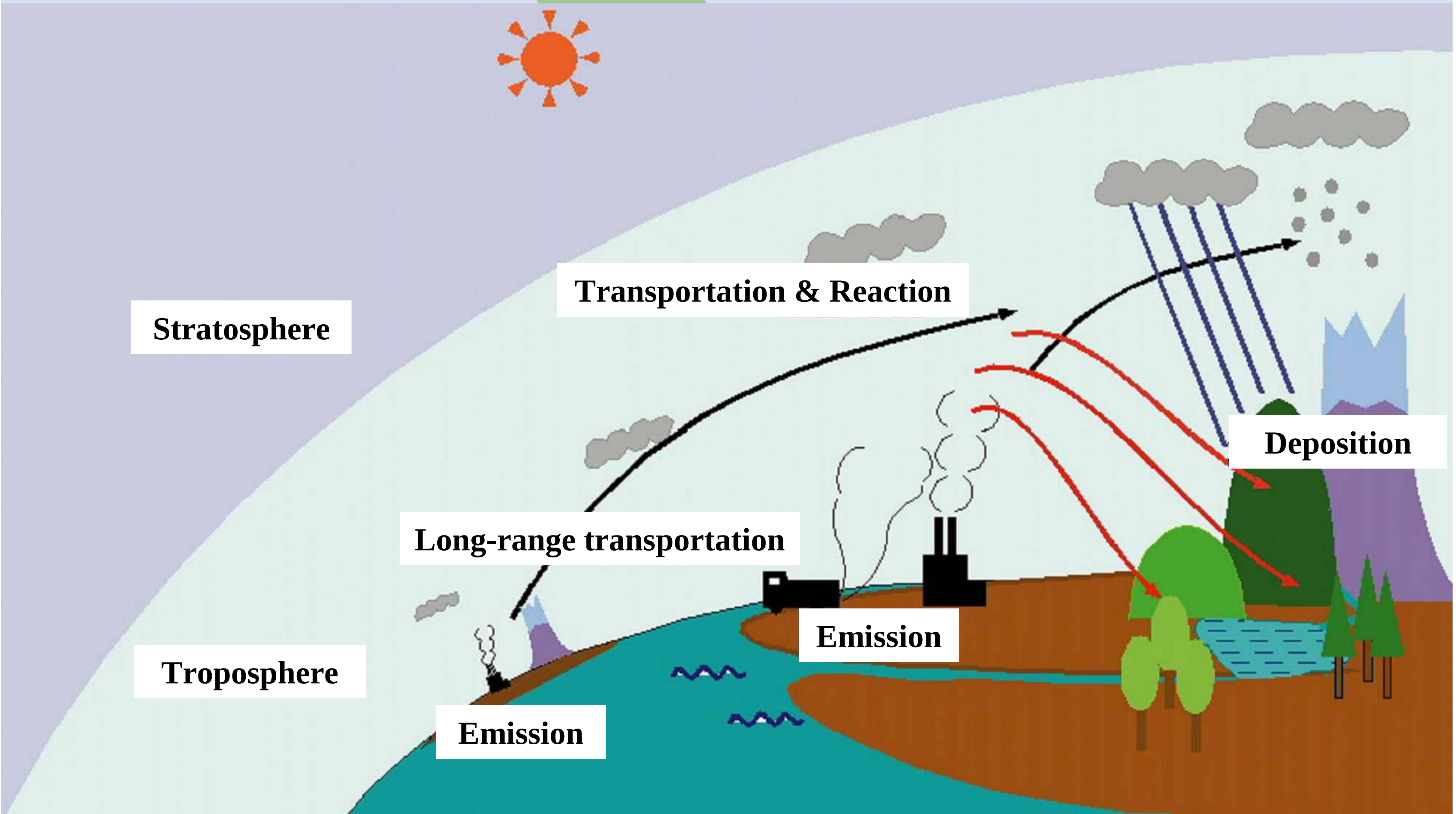


Ishii et al.(2005)

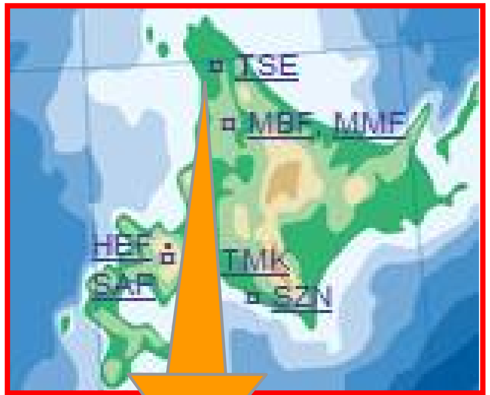
Surface ozone is shown increase trend.

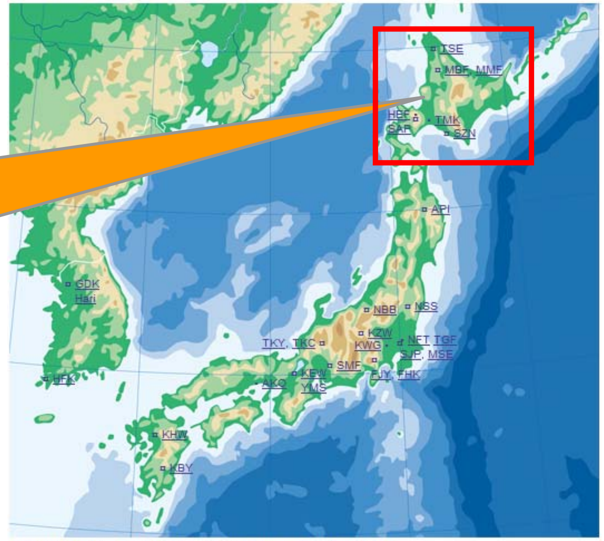
Injury of Larix forest was increase in ozone high concentration area.

Overview of LRTAP



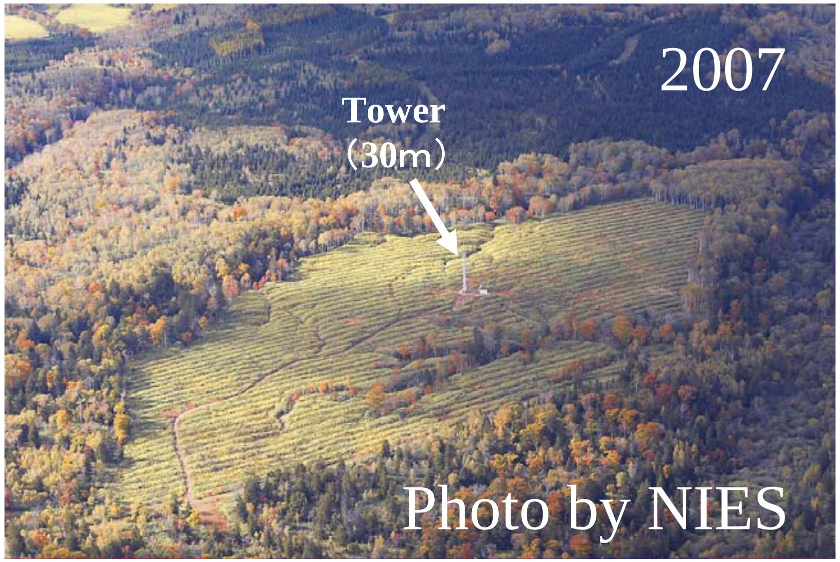
Teshio Site





CC-LaG:Carbon Cycle and Larch Growth experiment

Site: Teshio Experimental Forest, Horonobe, Hokkaido, Japan
Location: 45deg 03' N, 142deg 06' E



Elevation: ca.70m, a.s.l.

Area:13.7 ha (Young larch plantation)

Mean annual precipitation: 1000mm

Monitoring system

Subject	Components	Height	Method	Sampling cycle
Gas	SO_2, HNO_3, HONO, HCl, NH_3	30m & 10m	Annular Denuder	Weekly
Aerosol	SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Mg^{2+}, Ca^{2+}			
Gas	NO_2, NO, O_3		Auto	Half-hourly
Precipiotation	pH, EC, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Mg^{2+}, Ca^{2+}	Ground	Wet-only	Weekly
	pH, EC, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Mg^{2+}, Ca^{2+}		Bulk	Monthly

D1: annual denuder coated by NaF
D2: annual denuder coated by Na_2CO_3
D3: annual denuder coated by Na_2CO_3
D4: annual denuder coated by citric acid

F1: Teflon filter for aerosol (>2.5μ m)
F2: Teflon filter for aerosol (PM2.5)
F3: Cellulose filter impregnated K_2CO_3
F4: Cellulose filter impregnated H_3PO_4

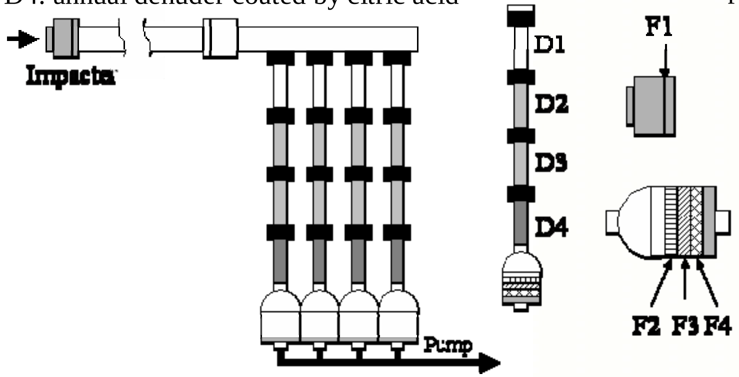
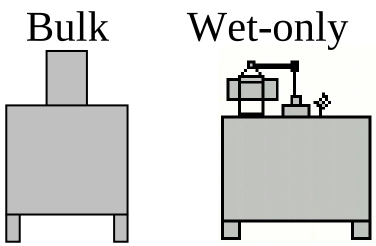
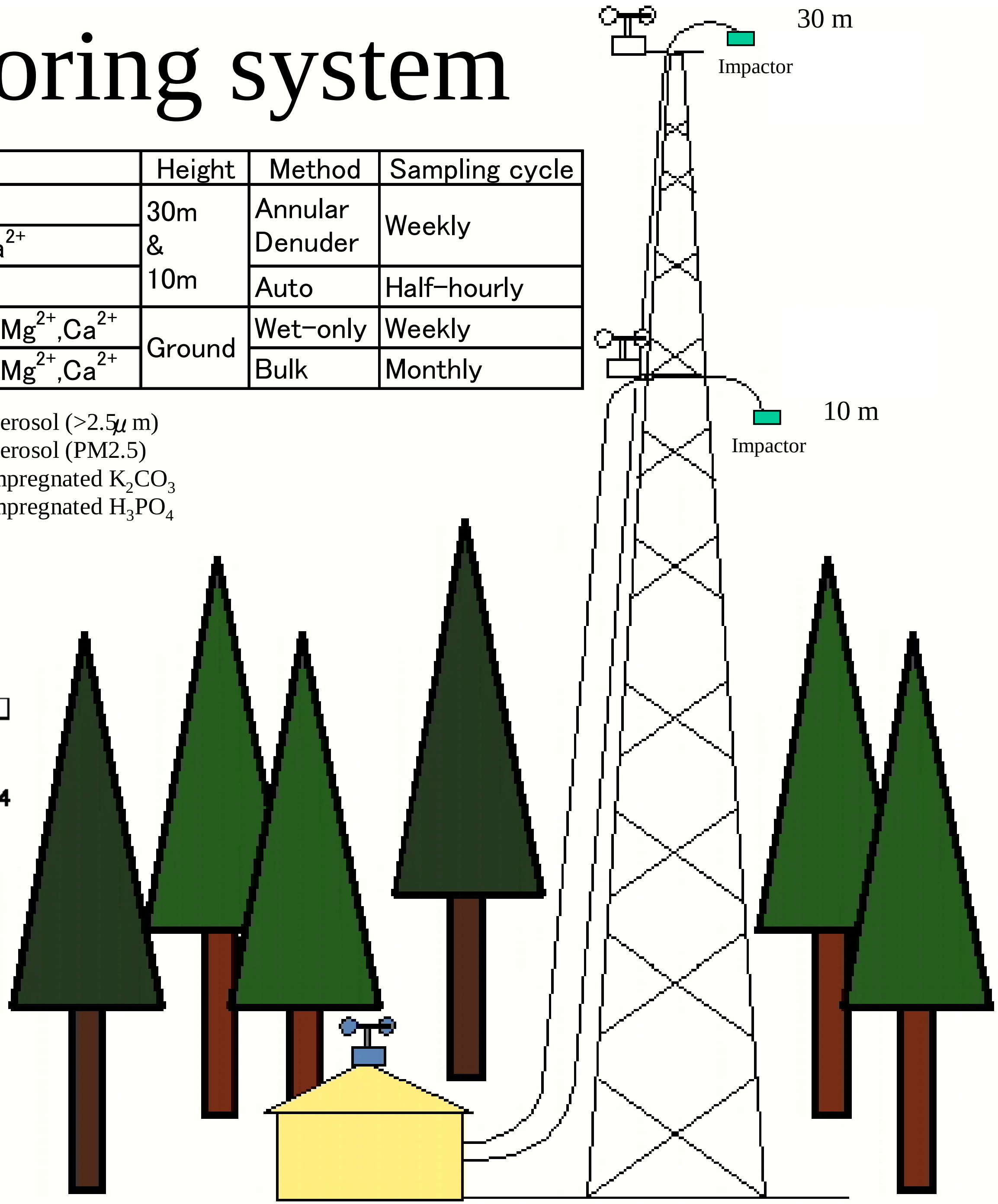


Fig. Annular Denuder system





Objective and Subject

Objective

The site aims at measurements of CO_2 flux of woodland ecosystem in deciduous larch forest. Simultaneously, the effects on carbon flux of air pollutants was observed by Hokkaido Institute of Environ Sciences.

Therefore, we have carried out the following researches;

（1）Establishment of Monitoring Method for Air pollutants

（2）Estimation Dry and Wet deposition

（3）Interaction with Atmosphere- Forest, Atmosphere- Soil and Atmosphere- Snowcover.

Main Subject of Monitoring

1. SOx : SO_2 (g), SO_4^{2-}(p), SO_4^{2-}(w)
2. NOy : NO, NO_2, HNO_3, HONO, NO_3^-, NO_3^-
3. NHx : NH_3, NH_4^+, NH_4^+
4. O_3

Research Themes

1. **Development of HONO Measuring Method**
2. **Establishment of simple and low cost measuring method**
3. **Deposition components and Efflux components**
4. **Interaction of HONO with Atmosphere - Forest**
5. **Application of the Dry deposition Measurements**
6. **NHx Flux**
7. **Seasonal variation of O_3 concentration and AOT 40**

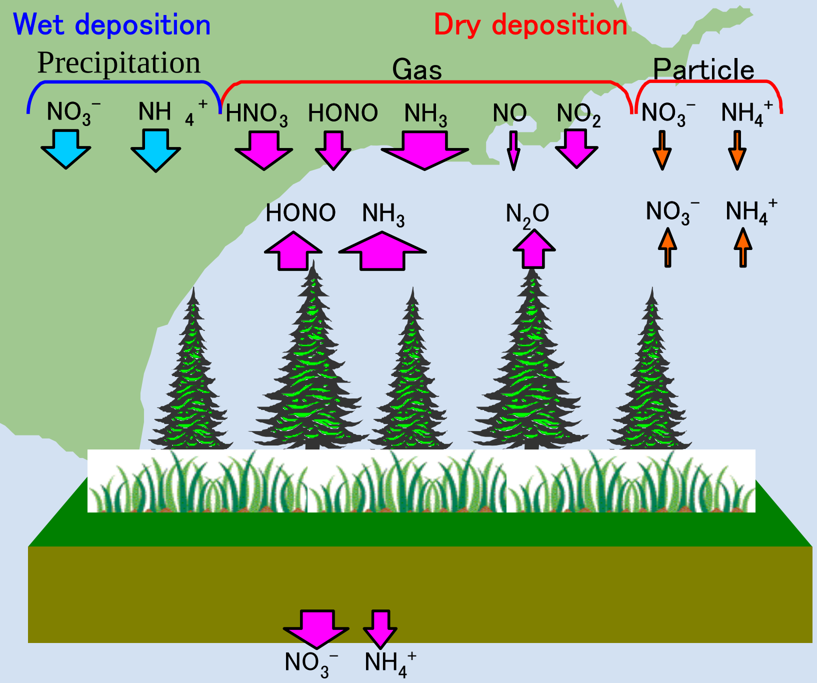
The flux measurement method in this site was used the gradient method. Therefore, the flux values are shown as net values. It means differences between influx and efflux.

$$\text{Flux} = K \times \triangle C / \triangle Z$$

K: Diffusion coefficient

⊿C: Difference of concentration

⊿Z: Difference of height



Result 1

Development of HONO Measuring Method

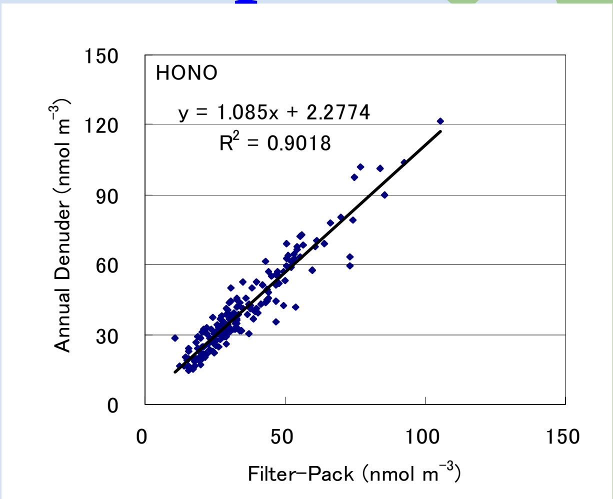


Figure1 Comparison of developing method (Filter pack) and Annular denuder method for HONO measurement.

A parallel survey results showed that HONO concentrations obtained using the annular denuder method, which is generally used for the measurement of HONO, and the filter-pack method were in good agreement. Thus, the filter-pack method is useful for the monitoring of air pollutants including HONO.

In addition, HONO concentrations are high in winter in urban area. However, HONO concentrations are high in summer in rural area.

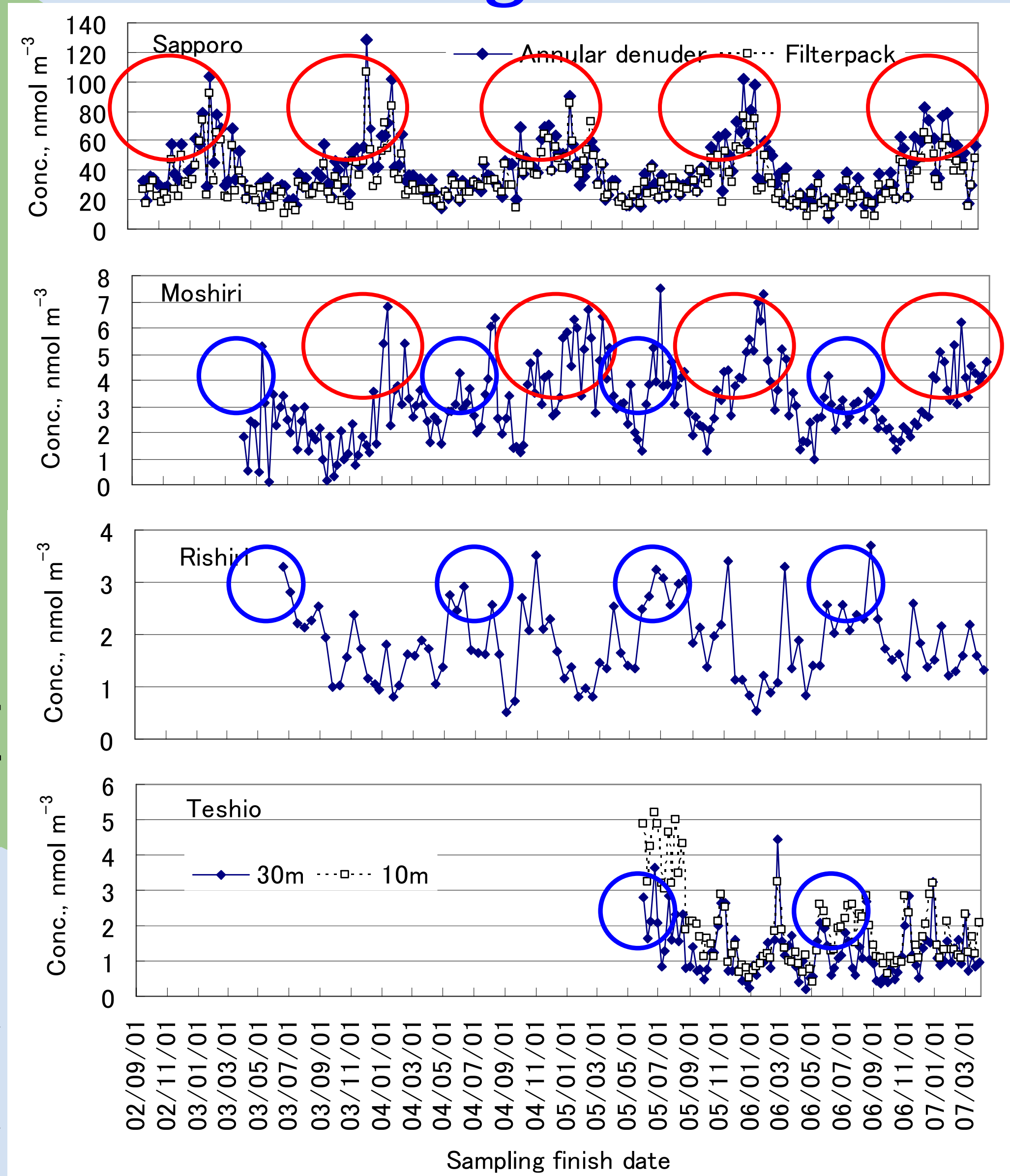


Fig. 2 Variation of HONO concentrations.

Result 2

Simple and low cost method

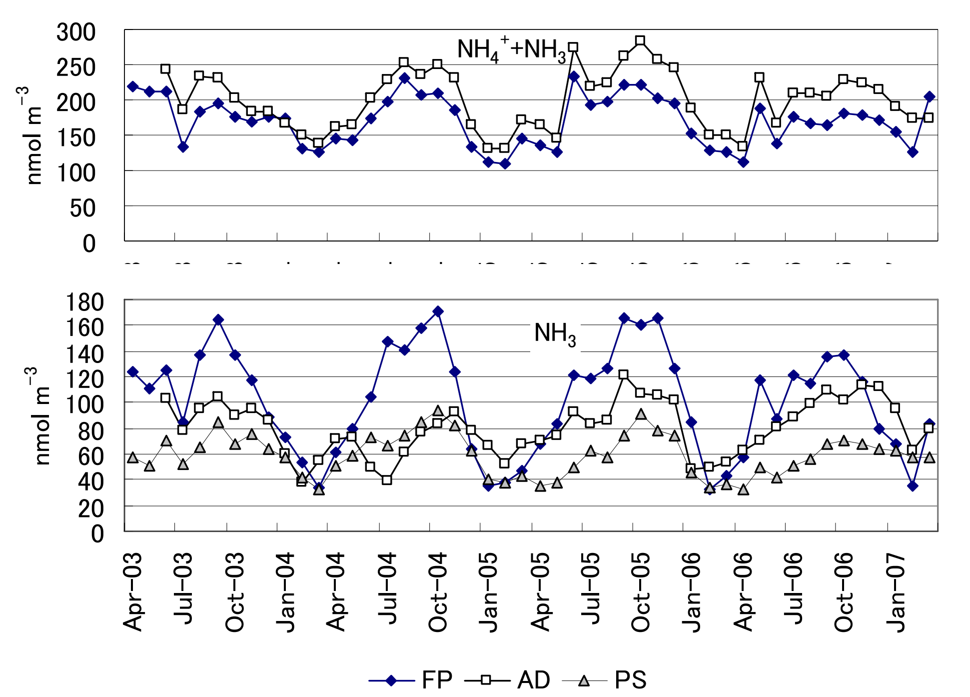


Fig. 1 Concentration of NH_3 and NHx (NH_4^++ NH_3).

・Concentrations of NHx (NH_4^++NH_3) by Filter-pack method (FP) are agree with by Annular Denuder method (AD).

・Concentrations of NH_3 by FP are higher than by AD.

→effects of artifact

→Concentrations of NH_3 should be measured with more accuracy.

→using by Passive sampler (PS).

I0: Teflon doughnut filter (Coarse particle)
F0:Teflon filter (PM-10)
F1: Nylon filter (HNO_3, HONO, SO_2, NH_3)
F2: K_2CO_3 impregnated filter (SO_2, HONO, HCl)
F2': K_2CO_3 impregnated filter (interference of HONO from NO_2)
F3: H_3PO_4 impregnated filter (NH_3)

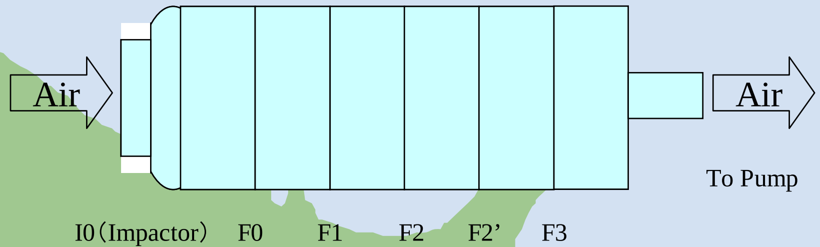


Fig. 2 Filter pack method.

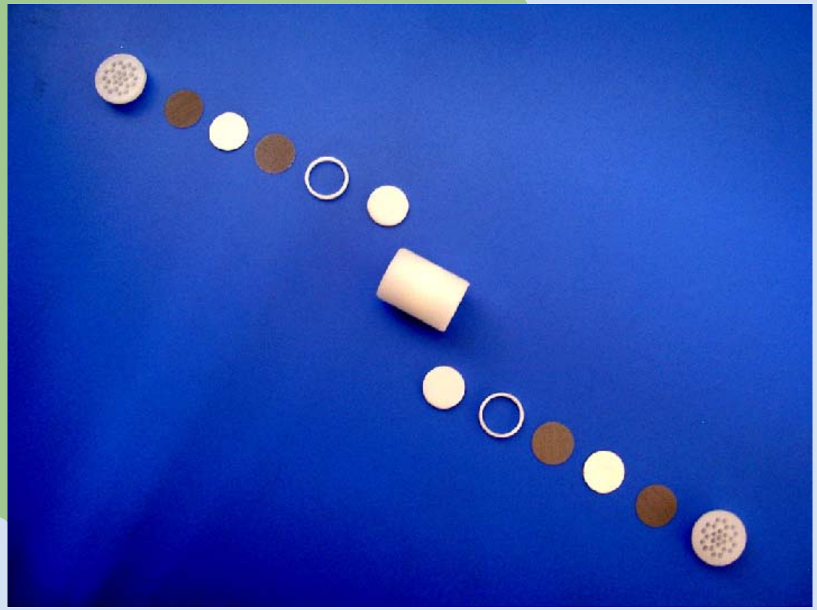


Fig. 3 The Ogawa Passive sampler.

Result 3

Deposition components and Efflux components

- NH_3, HONO and particulate components have a trend of efflux (Noguchi et al., 2006a; 2007b).
- Particulate components would be affected by “Gas to Particle conversion”.
- Wet +Dry depositions have influx trends except NHx components.
- The flux of NHx should be consider with organic nitrogen compounds.

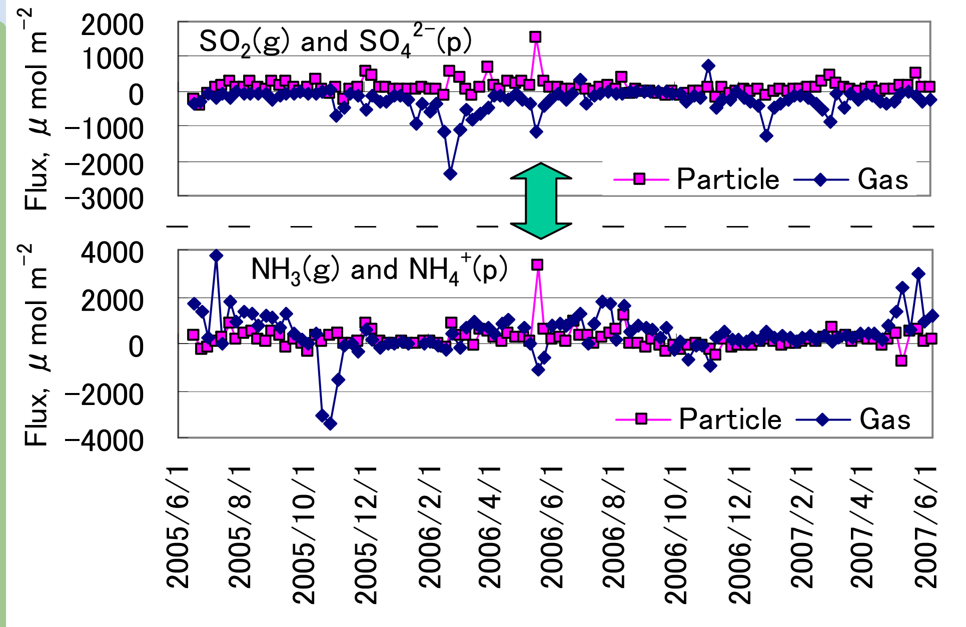
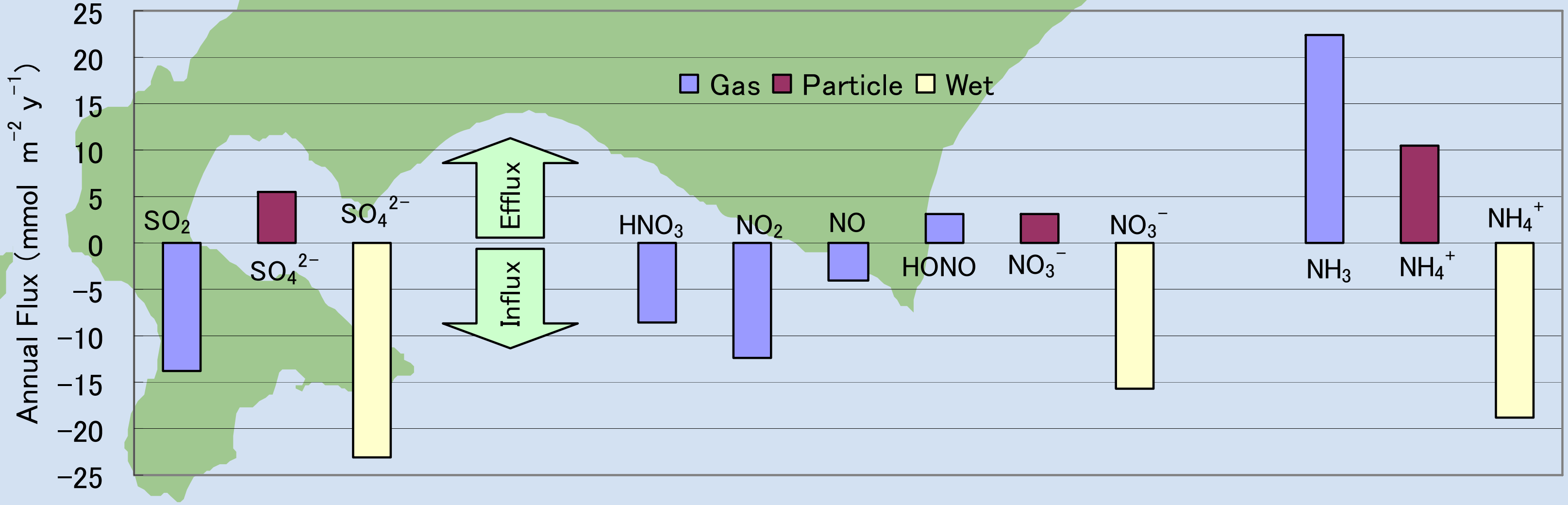
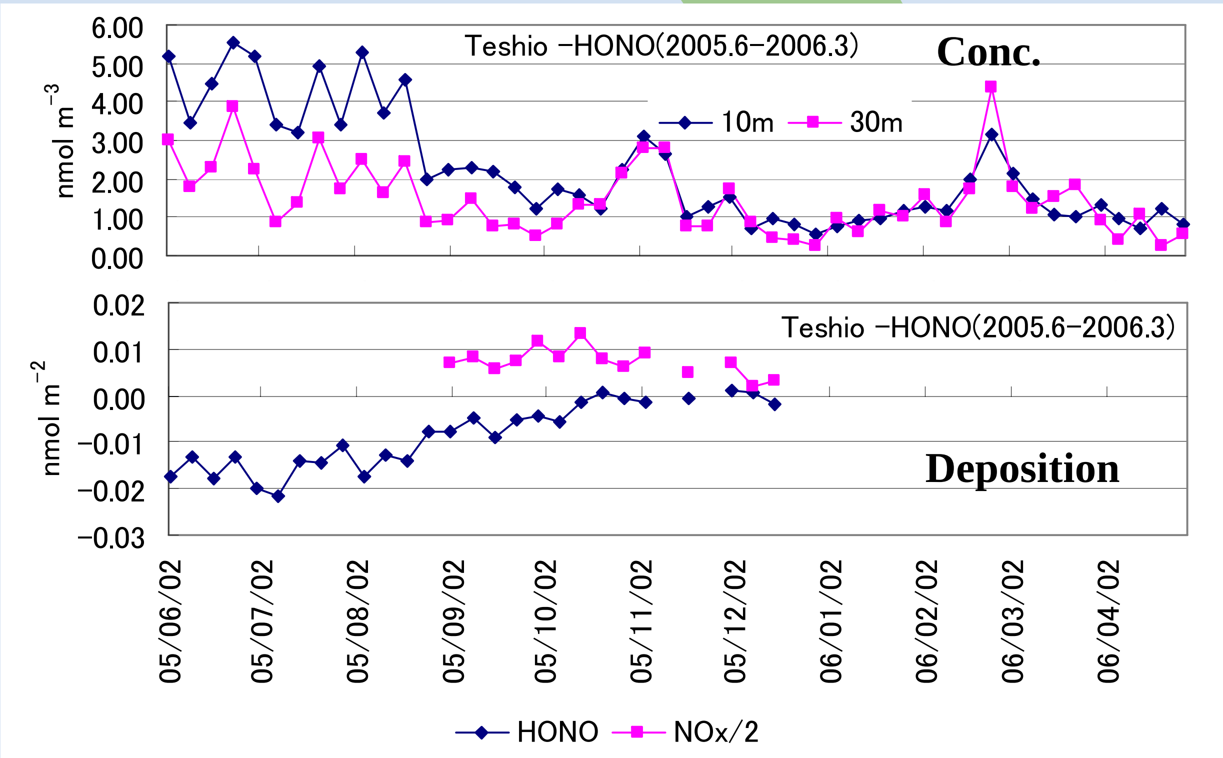


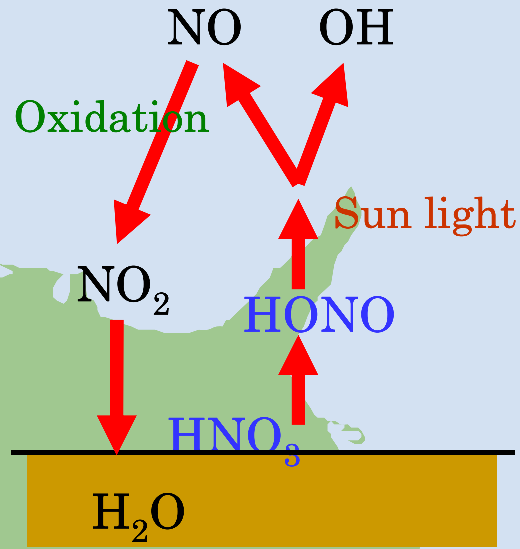
Fig. Effects of “Gas to particle conversion”



Result 4

Interaction of HONO with Atmosphere - Forest





$2NO_2+H_2O \rightarrow HNO_3+HONO$

Concentrations of HONO in night time are higher than in daytime.

Efflux of HONO is under 50% of NO_2 deposition

- This results are agree with Hayashi and Noguchi (2006), Stemmler et al. (2006).
- Diurnal variations of O_3, NO, NO_2, HNO_3 should be analyzed not only HONO.

Stemmler et al. (2006) *Nature* **440**, 195 – 198.

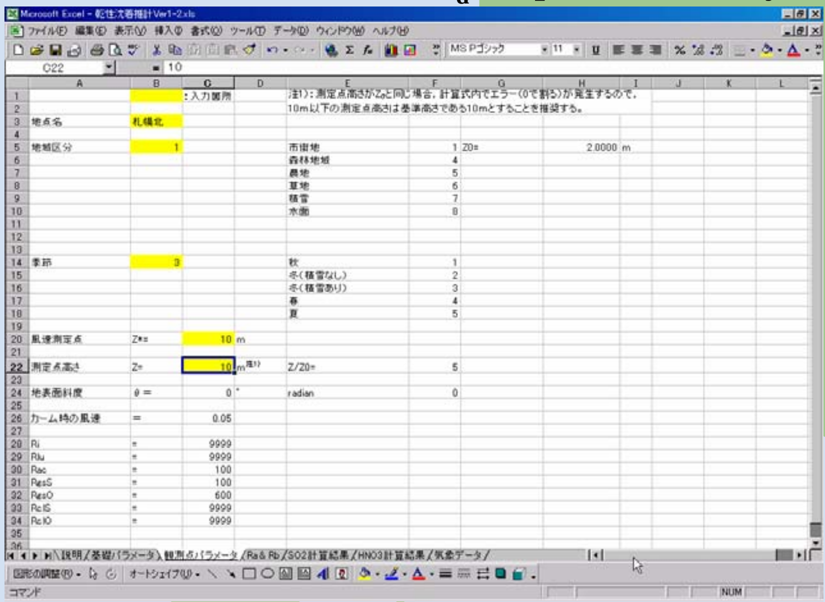
Result 5
Application of the Dry deposition Measurements

- Developing the calculation program for dry deposition velocity using Inferential method..
- Inferential method is useful for many species of land use not only for forest area.
- However, this model should be improved for accuracy (ex. Application of Diurnal Model of concentrations).
- Thus, the calculation result is verified by the results of gradient method in Teshio site (net flux).

Inferential method

Deposition = C × V_d

C: Concentration in the air, V_d: Depositionvelocity



Calculation File for Dry deposition velocity Ver. 3

http://www.hokkaido-ies.go.jp/seisakuka/acid_rain/kanseichinchaku/kanseichinchaku.htm

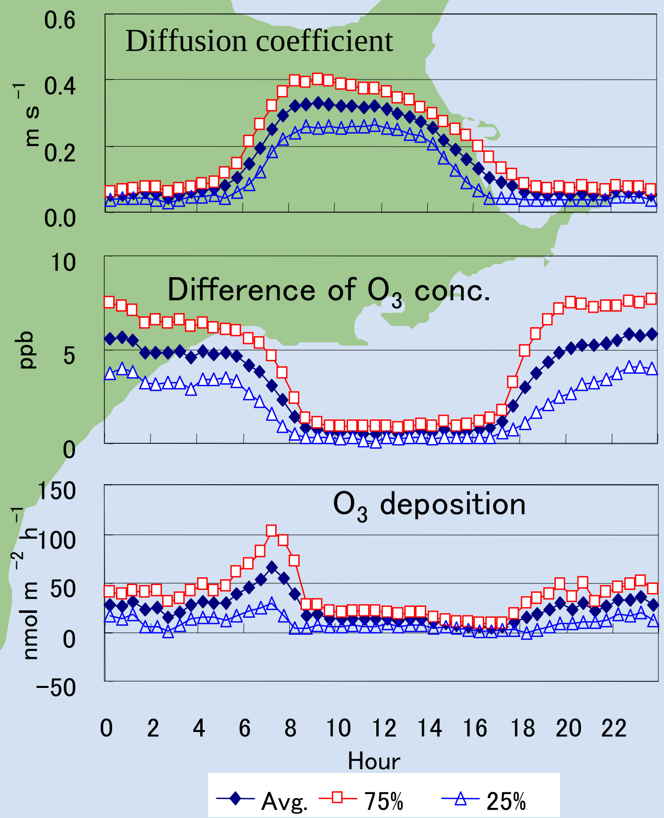
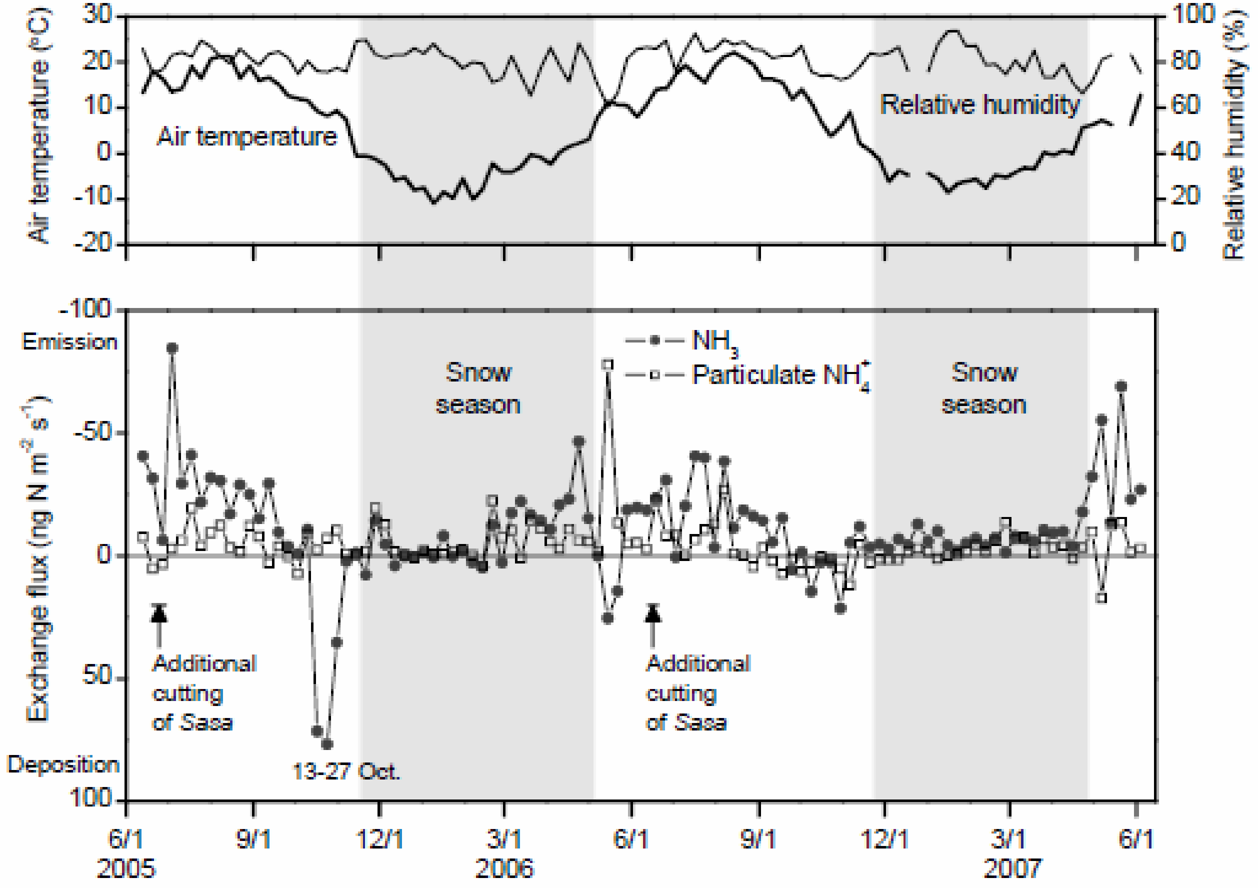


Fig. Diurnal variation

Result 6

NHx Flux



Emissions of NH_3

Snowless season: the stomata of the larches and *Sasa*, the decomposition of the cut *Sasa* materials and soil.

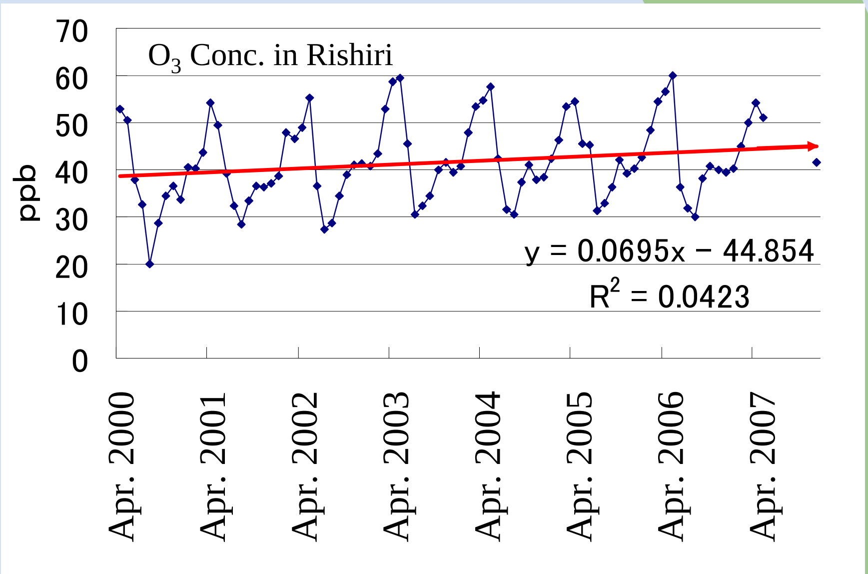
Snow season: Soil and Snowpack.

Annual emission of 4.8 ± 0.1 kg N ha^{-1} yr^{-1}, exceeded the annual wet deposition of NH_X-N .

by Hayashi et al. (2008) in prep.

Result 7

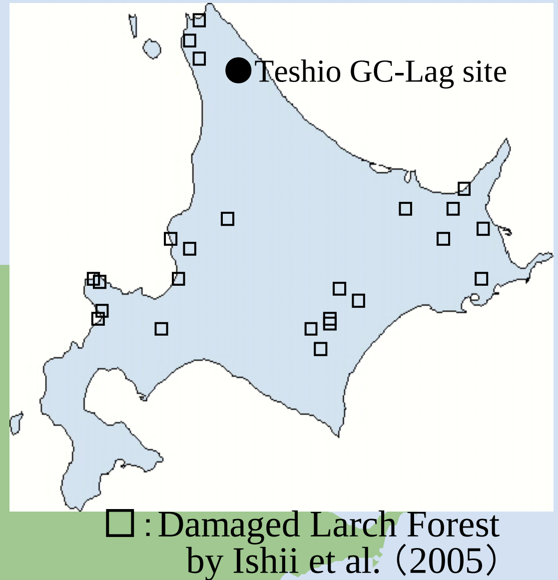
Variation of O_3 concentration and AOT 40

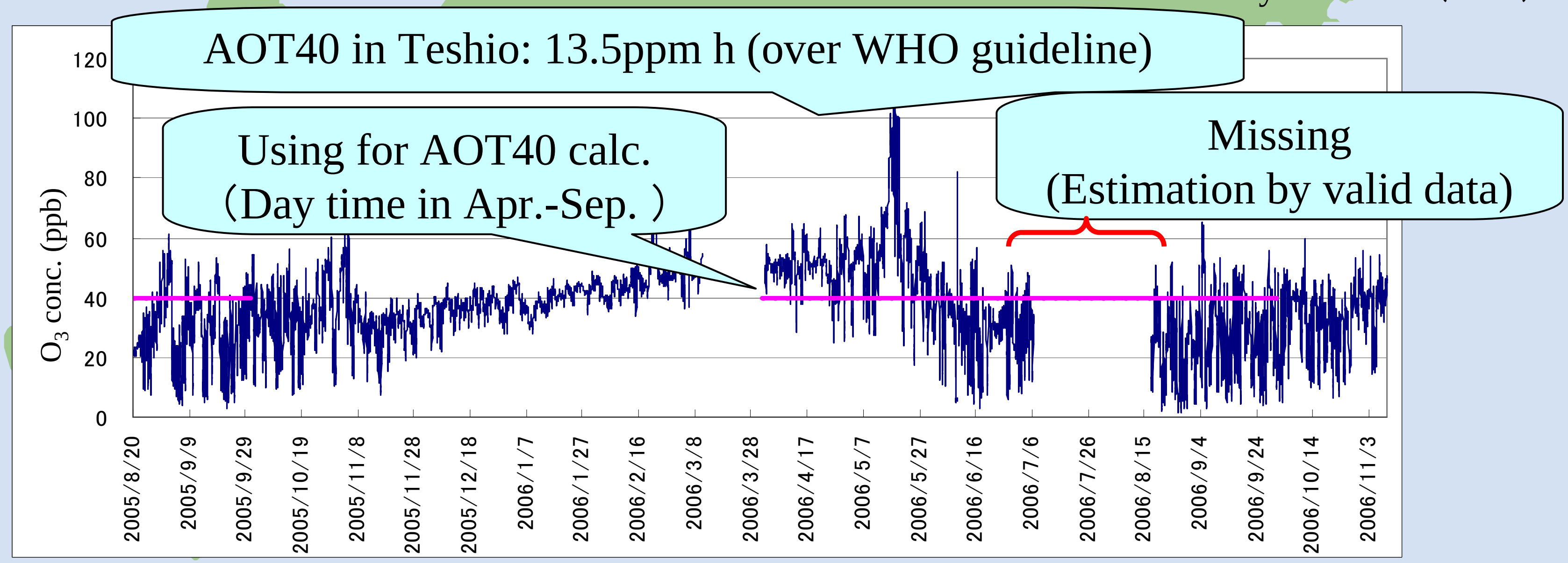


WHO guideline:

10 ppm h

(for protection forest)





Science Bulletin

（Only related to Hokkaido Institute of Environmental Sciences）

- K. Hayashi, K. Takagi, I. Noguchi, T. Fukazawa *et al.*（2008）Ammoniacal nitrogen emission from a young larch ecosystem afforested after clear-cutting of a pristine forest in northernmost Japan. *Water, Air and Soil pollution*, in print.
- I. Noguchi *et al.*(2008) Effects of time resolution on the dry deposition estimating of air pollutants. Proceeding of 49th Annual Meeting of Japan Society for Atmospheric Environment, 515.
- I. Noguchi *et al.*(2007c) Measuring Concentrations of Nitrous Acid Gas by the Filter-Pack Sampling Method. Journal of Japan Society for Atmospheric Environment, **42**, 162-174.
- I. Noguchi *et al*. (2007b) Deposition and efflux of nitrogen components in Northern forest site. Proceeding of 48th Annual Meeting of Japan Society for Atmospheric Environment, 568.
- I. Noguchi *et al.*(2007a) Sampling methods for atmospheric ammonia and particulate ammonium (Annular denuder system, Filter pack and Passive sampler. Proceeding of 48th Annual Meeting of Japan Society for Atmospheric Environment, 244-245.
- I. Noguchi *et al.*(2006b) Concentrations of nitrous acid gas and its relationships with other pollution components at urban and background site in Hokkaido. Proceeding of 48th Annual Meeting of Japan Society for Atmospheric Environment, 2C1024.
- I. Noguchi *et al.*(2006a) Ammonia gas flux including efflux from ground surface and its seasonal variation. Proceeding of 48th Annual Meeting of Japan Society for Atmospheric Environment, 2C1036.
- K. Hayashi and I. Noguchi (2006)Indirect emission of nitrous acid from grasslands indirected by concentration gradients. Journal of Japan Society for Atmospheric Environment, **41**, 279-287.
- I. Noguchi, K. Matsuda (2006) Program File Development for the Estimation of Dry Deposition Velocity. Regional Scientific Workshop on Air Pollution and Acid Deposition.

Recent study (1)

Improvement of accuracy for the estimation of flux

Development of estimation method of flux

①Measurement method

Expensive & complication

→low cost & simple

(AD→FP+PS)

②Estimation method

For the low time resolution components (ex. weekly), its flux can be estimated with accuracy using diurnal variation model of the diffusion coefficient and the difference of concentration.

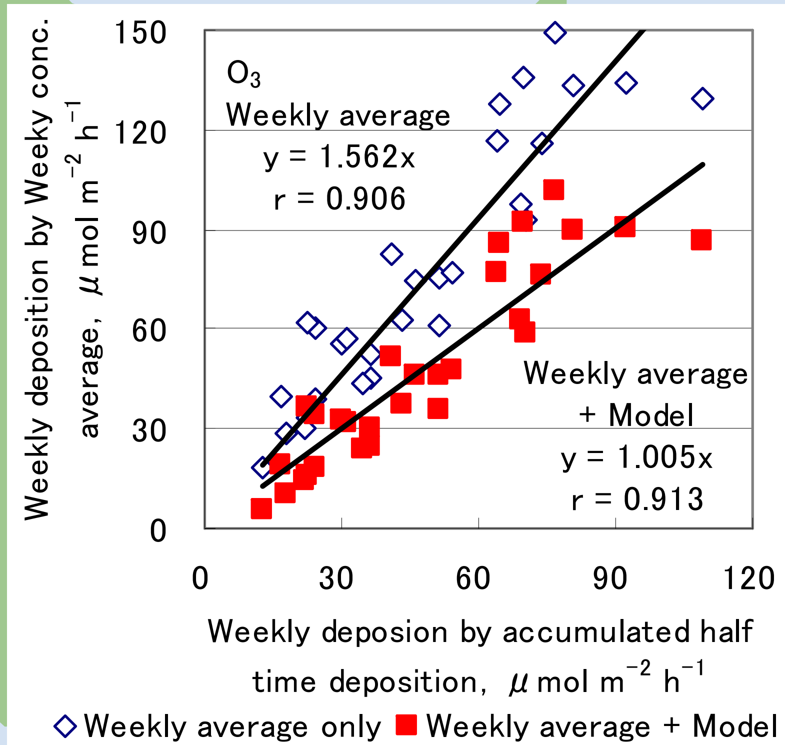


Fig. Effect on weekly deposition of diurnal Model.

Recent study (2)

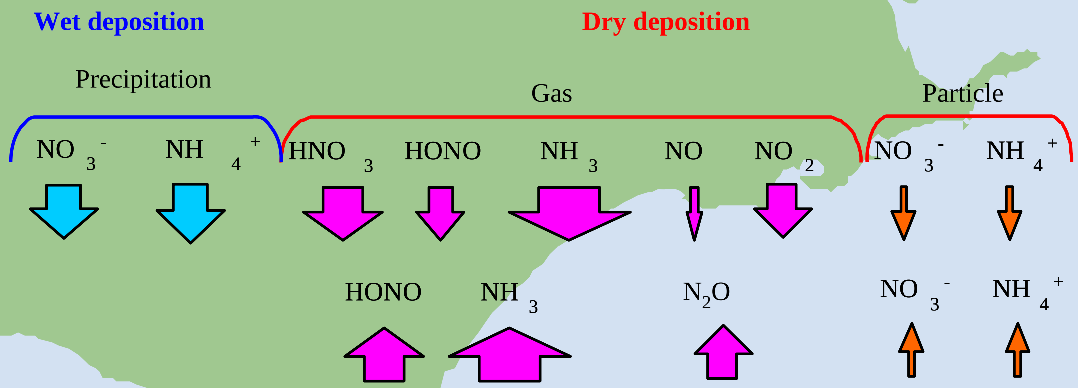
Estimation of nitrogen cycle and of material balance

Recent theme

Behavior of O_3 and NO_y related to the deposition and efflux of HONO

Elucidating of the NH_3 emission system（during the preliminary survey）

Estimation of effects of “Gas to Particle conversion”



Significant references concerning the nitrogen cycle in Teshio site

High sensitive of Larch forest to O_3 due to lack of nitrogen. (Watanabe et al., 2006)

Nitrogen saturation by the effect of bamboo grass cutting in Teshio site (Fukuzawa et al.,2006)

Nitrogen cycle affects on carbon cycle（Oren et al., 2001）

Nitrogen flux between atmosphere and forest or soil (Noguchi et al., 2007；Hayashi et al., 2008)

Future study (1)

Influence of high concentration O_3 on forest

Plan of study

(1) Measurement of Chlorophyll in leaf of bamboo grass and Lurch.

(2) Distribution of O_3 concentration (Effect of season, altitude, location and so on)

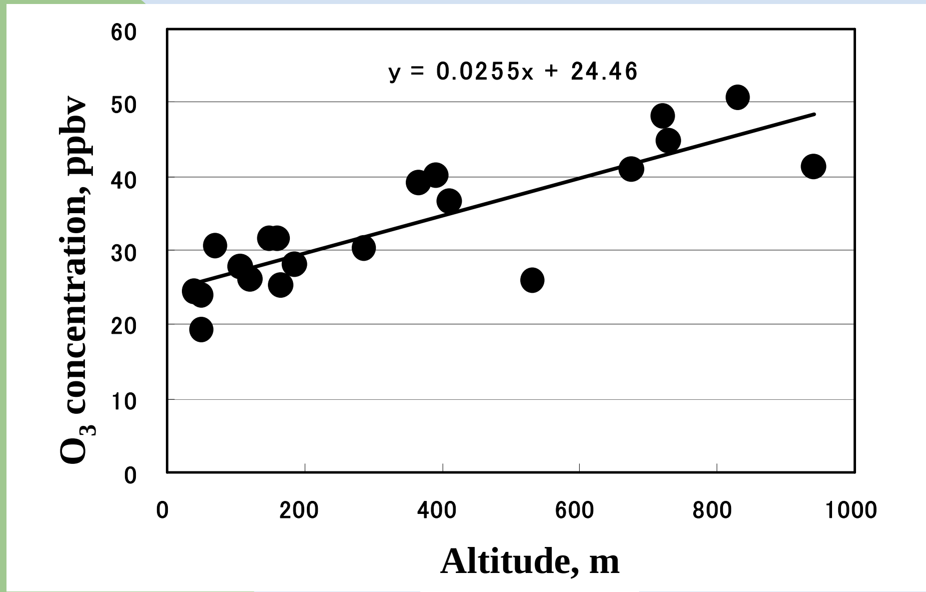


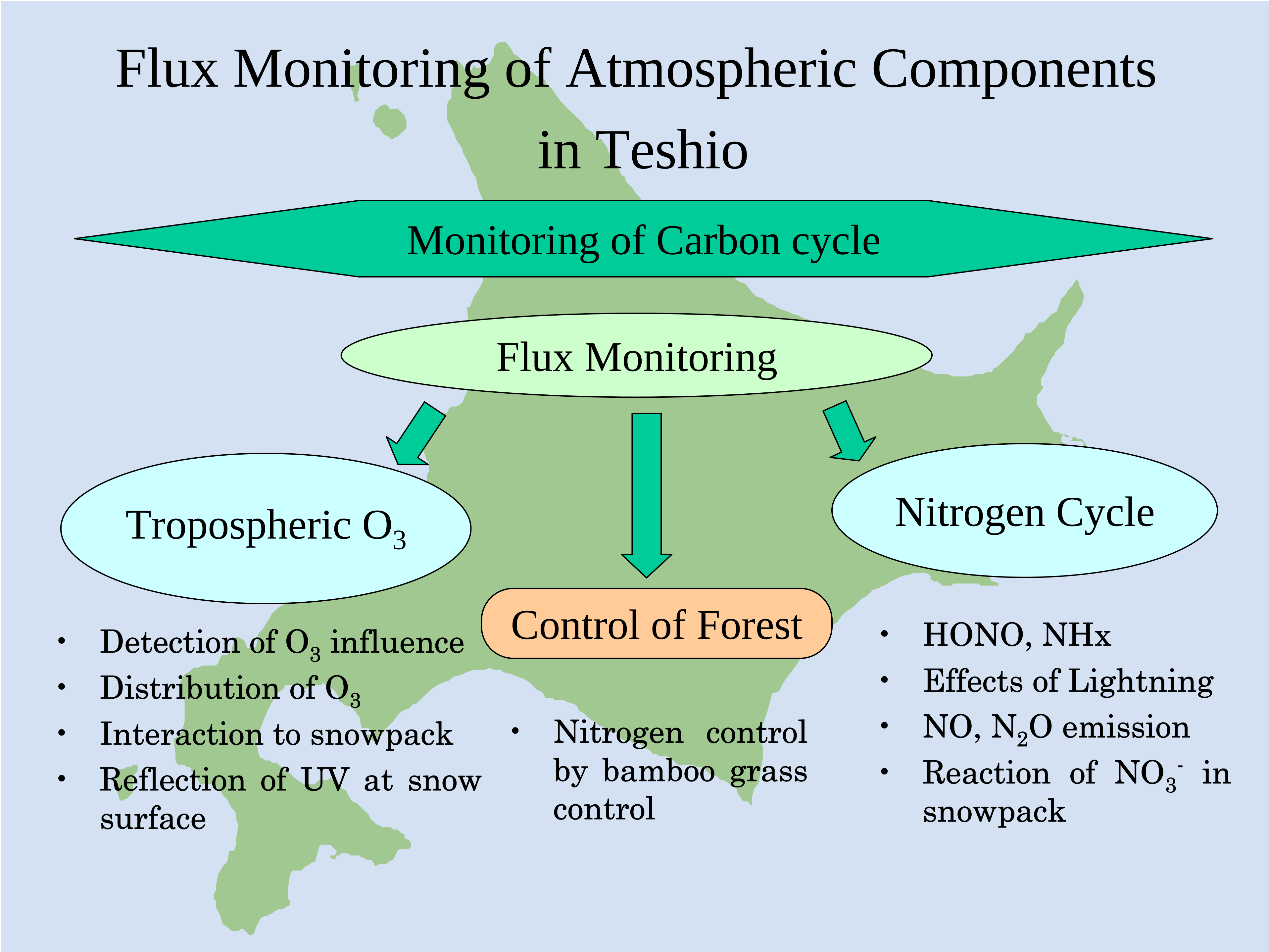
Fig. Relation with O^3 concentration and altitude (Ebana and Noguchi, 2008)

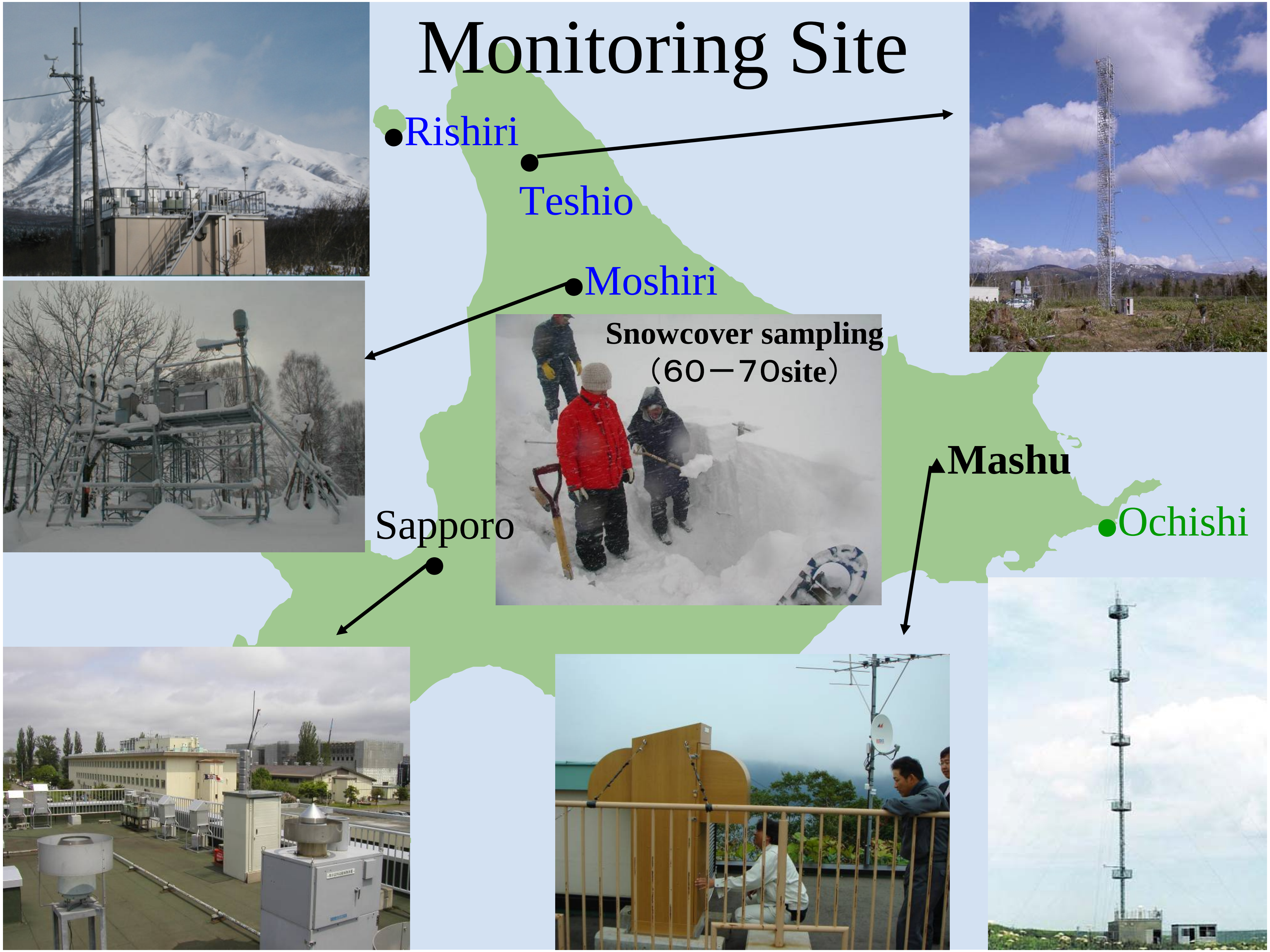
Concentrations of O_3 are high during March – May.

In addition, O_3 concentration are dominated altitude in inland area.

Significant references concerning the ozone in Teshio site

Transported tropospheric O_3 and its increasing trend. (K. Sudo and H. Akimoto, 2007)
Relationships with Forest damage and O_3 concentration. (T. Ishii et al., 2005)
High O_3 concentration and high AOT40 index in Teshio. (JELA, 2007)
High sensitive of Larch forest to O_3 due to lack of nitrogen. (Watanabe et al., 2006)


Flux Monitoring of Atmospheric Components
in Teshio
Monitoring of Carbon cycle
Flux Monitoring
Tropospheric O_3
Nitrogen Cycle
Control of Forest
• Detection of O_3 influence
• Distribution of O_3
• Interaction to snowpack
• Reflection of UV at snow surface
• Nitrogen control by bamboo grass control
• HONO, NHx
• Effects of Lightning
• NO, N_2O emission
• Reaction of NO_3^- in snowpack


Monitoring Site
Rishiri
Teshio
Moshiri
Snowcover sampling
（60－70site）
Mashu
Ochishi
Sapporo

Thank you for your attention.

Winter condition in Teshio