Background Air Monitoring of Persistent Organic Pollutants in East Asian Countries 2004-2006

POPs Monitoring Project in East Asian Countries, 2006

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1. Background and Objectives

Persistent organic pollutants (POPs) such as PCBs and DDTs are toxic, persistent and bioaccumlative and are transferred through the air, water and migratory species across international boundaries and deposited far from their location of emission and accumulate in terrestrial and aquatic ecosystems. It came to be internationally recognised that there were concerns about health impacts, *inter alia*, upon women and future generations due to exposure to POPs especially in developing countries.

It had been increasingly stressed that actions by only a limited number of countries were insufficient for the worldwide elimination and/or reduction of POPs, thus the Stockholm Convention on Persistent Organic Pollutants (hereinafter referred to as "Stockholm Convention") was adopted at the Conference of Plenipotentiaries held in Stockholm in May 2001. The Stockholm Convention entered into force on 17 May 2004. Approximately 2/3 countries in Asia among the five United Nations regions were parties to the Stockholm Convention.

Whereas increase of the parties is highly welcome, evaluating effectiveness of the Convention should be further recognised as crucial to its successful implementation. According to Article 16 of the Stockholm Convention, its effectiveness shall be evaluated starting four years after the date of entry into force of the Convention, i.e. before 17 May 2008. Furthermore, the 2nd Conference of the Parties of the Stockholm Convention (COP2) agreed to complete the first effective evaluation at its 4th meeting (COP4) in 2009[1].

For achieving broader coverage of the Convention over the world including developing countries and obtaining at least "core" representative data from all regions for the first effectiveness evaluation, various actions will be taken under the guidance of COPs in accordance with its decision (SC2/13). Given the above-mentioned timing constraints, however, the first effectiveness evaluation is expected to be based primarily on existing programmes and sources of information, and this evaluation will also be the opportunity to establish a large scale "base line" of information on POPs levels in the environment[2].

The participating countries in the POPs Monitoring Project in East Asian Countries are convinced that its framework, as one of the existing sub-regional initiatives of POPs monitoring that contribute to the effectiveness evaluation of the Stockholm Convention recognised in COP2[3], will provide comparable and scientifically sound data on the media considered to be essential (i.e. air deposition), and will contribute to further operationalising the global monitoring programme.

[1] SC2/13, paragraph 1.
[2] UNEP/POPS/COP.2/INF/15
[3] UNEP/POPS/COP.2/21

2. POPs Monitoring Project in East Asian Countries

The operation of the POPs Monitoring Project in East Asian Countries comprises of two parts: (1) organising workshops to which the participating countries are invited to discuss and guide the Project; and (2) providing technical assistance for background(*) field monitoring of POPs in air in terms of: (a) sampling; (b) high resolution GC/MS analysis including relevant capacity building elements; and (c) data validation, QA/QC and treatment and reporting of the obtained data. The treatment and reporting of the data are to be communicated and finalised among participating countries.

In December 2002, a representative of the host declared a kickoff at the opening of the 1st Workshop on Environmental Monitoring of POPs in East Asian Countries saying as follows: "…We think, in order to identify the levels of POPs remaining in the environment in East Asian Countries as required by the Convention, regional cooperative efforts are indispensable." The Workshop recognised insufficient information on levels of POPs in the environment, agreed that further efforts should be made to fill in the data gaps, and stressed that regional cooperative efforts in East Asia are crucial for identifying the environmental levels of POPs. The chairperson's summary of the Workshop noted that *"the Workshop recommended that regional efforts should be promoted* ***to establish a framework for environmental monitoring of POPs that suits the East Asian region*** *by taking into account all the various conditions relevant to the countries in the region."* This fundamental motivation shared among the participating countries has embodied the Project through the following Workshops. The history of the Workshops is summerised in Table 1. The Chairperson's Summaries were attached as Annex.

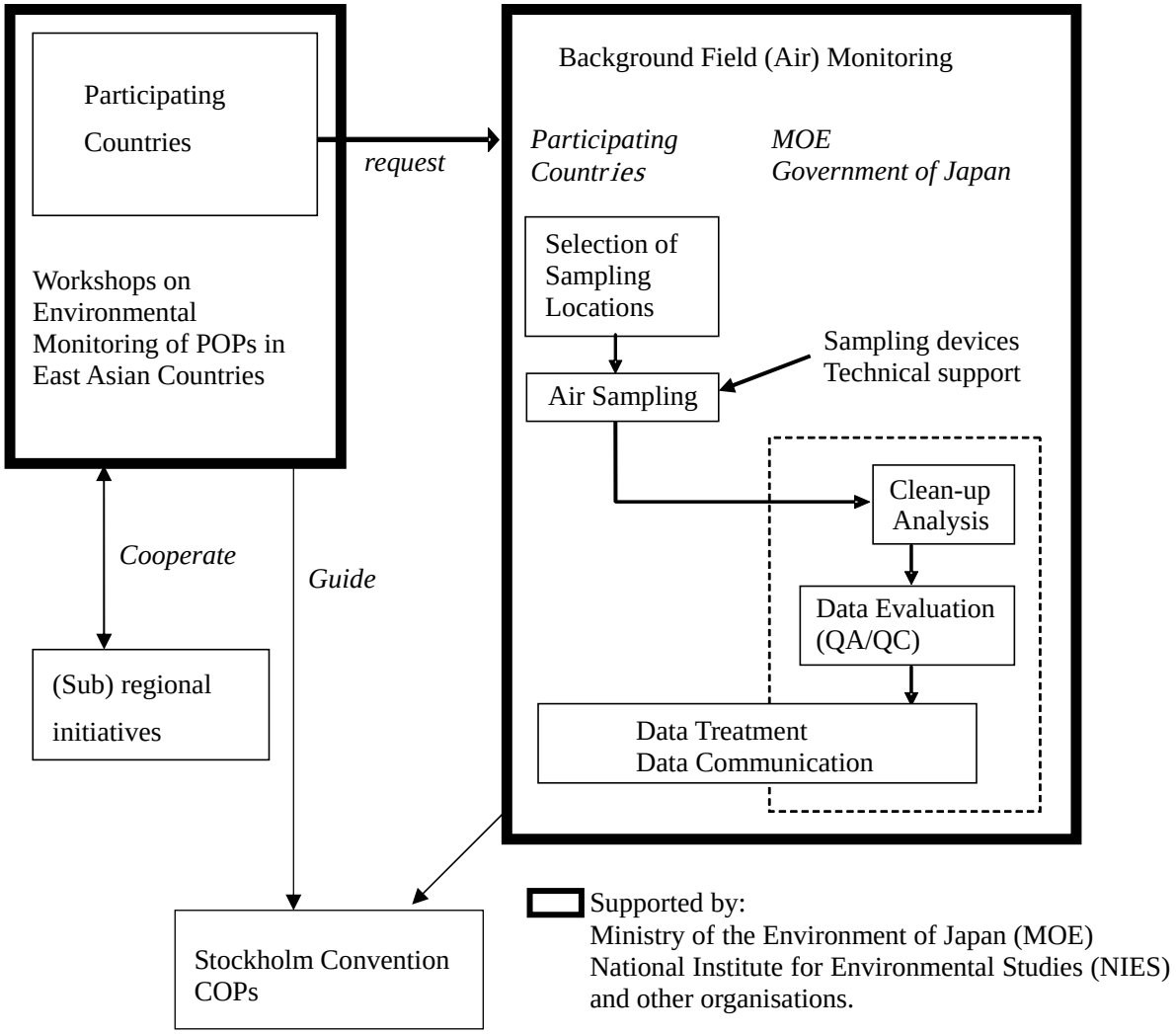
The 2nd Workshop, held in December 2003, agreed that further discussions on designing regional monitoring of POPs in East Asian sub region should be continued.

Table 1 Workshops and Meetings on POPs Monitoring in East Asian Countries

	Date and Venue	Participants	Other Experts and Observers
1st Workshop	2-4 December 2002 Tokyo and Tsukuba, Japan	Cambodia, China, Indonesia, Japan, Republic of Korea, Malaysia, the Philippines, Singapore, Thailand, Vietnam	AMAP[4], UNEP[5] Chemicals, UNEP/ROAP, GEF, UNEP/GEF PTS programme (region VII & VIII), UNU, Members of POPs Monitoring Committee of Japan, Japan Coast Guard, Peking Univ., Ehime Univ.
2nd Workshop	14-15 December 2003, Tsukuba, Japan	Cambodia, China, Indonesia, Japan, Republic of Korea, Malaysia, the Philippines, Singapore, Thailand, Vietnam	AMAP, GEF, AMAP, WWF, Stockholm Univ., UNU, Pref. Univ. Kumamoto, UNEP/GEF PTS programme (region VIII), JICA
1st Expert Working Group (EWG) Meeting	24 January 2004 Tokyo, Japan	Indonesia, Japan, Republic of Korea, the Philippines, Vietnam	UNU, Members of POPs Monitoring Committee of Japan
3rd Workshop 1st Policy Group (PG) Meeting 2nd EWG Meeting	11-13 October 2005, Tokyo, Japan	Cambodia, China, Indonesia, Japan, Republic of Korea, Lao PDR, Malaysia, Mongolia, the Philippines, Singapore, Thailand, Vietnam	UNEP, AMAP, NOWPAP[6], UNU[7], Stockholm Univ., Members of POPs Monitoring Committee of Japan
4th Workshop 2nd PG Meeting 3rd EWG Meeting	20-22 September 2006, Kyoto, Japan	Cambodia, Indonesia, Japan, Republic of Korea, Lao PDR, Malaysia, Mongolia, the Philippines, Singapore, Thailand, Vietnam	UNEP NOWPAP UNU

[4] Arctic Monitoring and Assessment Programme
[5] United Nations Environment Plan
[6] Northwest Pacific Action Plan
[7] United Nations University

Figure 1 Structure of the POPs Monitoring Project in East Asian Countries



Reflecting the discussions and conclusions of the 1st, 2nd and 3rd Workshops on Environmental Monitoring of Persistent Organic Pollutants in East Asian Countries, and the course of Trial Air Monitoring of POPs Chemicals at Background Sites in East Asian Countries, a plan for the POPs monitoring was revised by the Ministry of the Environment of Japan (MOE) and the National Institute for Environmental Studies of Japan (NIES). The present structure of the Project is shown in Figure 1.

At the 3rd Workshop, held in October 2005, the trial monitoring data in 2004 and/or QA/QC information from Indonesia, Republic of Korea and Vietnam were shared in the Expert Working Group, and the Workshop had common views that summary results from the trial monitoring would be made available to the public as a part of the proceedings from the 3rd Workshop, subject to the confirmation by the countries where the data were obtained.

3. Field Monitoring

(1) POPs to be Covered

Target substances and media of the field monitoring under the POPs Monitoring Project in East Asian Countries are shown in **Table 2**.

Table 2 Target POPs of Field Monitoring under the Project

No.	"12 POPs" listed in Annexes to the Stockholm Convention	Atmospheric Air & Precipitation
1	Aldrin	**X**
2	Dieldrin	**X**
3	Endrin	**X**
4	Heptachlor Heptachlor *cis*-Heptachlor epoxide *trans*-Heptachlor epoxide	**X**
5	Chlordanes *cis*-Chlordane *trans*-Chlordane Oxychlordane *cis*-Nonachlor *trans*-Nonachlor	**X**
6	HCB	**X**
7	Mirex	**X**
8	Toxaphenes Parlar-26 Parlar-50 Parlar-62	**X**
9	PCBs	
10	DDTs *p,p'*-DDT *o,p'*-DDT *p,p'*-DDE *o,p'*-DDE *p,p'*-DDD *o,p'*-DDD	**X**
11	PCDDs	
12	PCDFs	

(2) Criteria for Selecting Sampling Locations

Sampling sites were selected on the basis of the following protocol on background air sampling sites at present. In fact, however, it was practically difficult to comply with all of its requirements when selecting sampling locations for the field monitoring performed in 2004, 2005 and 2006.

- To be located on islands or at continental margins to gain an insight into transport across the sub regions.

- To be located so as to obtain information on temporal trends of regional sources.

- To be sufficiently remote from urban centres and industrial and other sources of POPs as to reflect concentrations typical of a large area around the location (at least 100 km radius).

- To be ensured that meteorological observations and trained personnel for sampling are available and back-trajectory analysis can be performed.

(3) Protocol for Sampling and Analysis

A typical air sampling is composed of duplicate twenty four-hour sampling by the two high volume (HV) air samplers for the three consecutive days.

Sampling, clean-up procedures and quantification using HRGC/HRMS were conducted according to the established protocols – "Monitoring Manual for POPs and their Related Substances" 2006 (herein after referred to as "Monitoring Manual 2006").

The sampling method is based on the conventional HV air sampling method for dioxins by using a combination of a quartz fibre filter (QFF) and polyurethane foam (PUF) plugs. A thin, soft disk of active carbon fibre felt (ACF), a strong absorbent for POPs and other chemicals, was sandwiched between the two PUF plugs to avoid breakthrough of relatively volatile chemicals, such as HCB and lower-chlorinated PCBs, during air sampling. The QFF, the first PUF plug and ACF were extracted for analyzing POPs. The second PUF plug behind the ACF was not analysed.
For large volume sampling using QFF, PUF and ACF combination, the HV sampler which allowed an airflow rate of 700 L/min was used. Total sampling volume of air was approximately 1,000 m^3 per sample. The result of an analysis obtained by using HV air samplers shall be the average of the three consecutive days' data.
The samples shall be prepared and analysed according to the procedure shown in Figure 2.

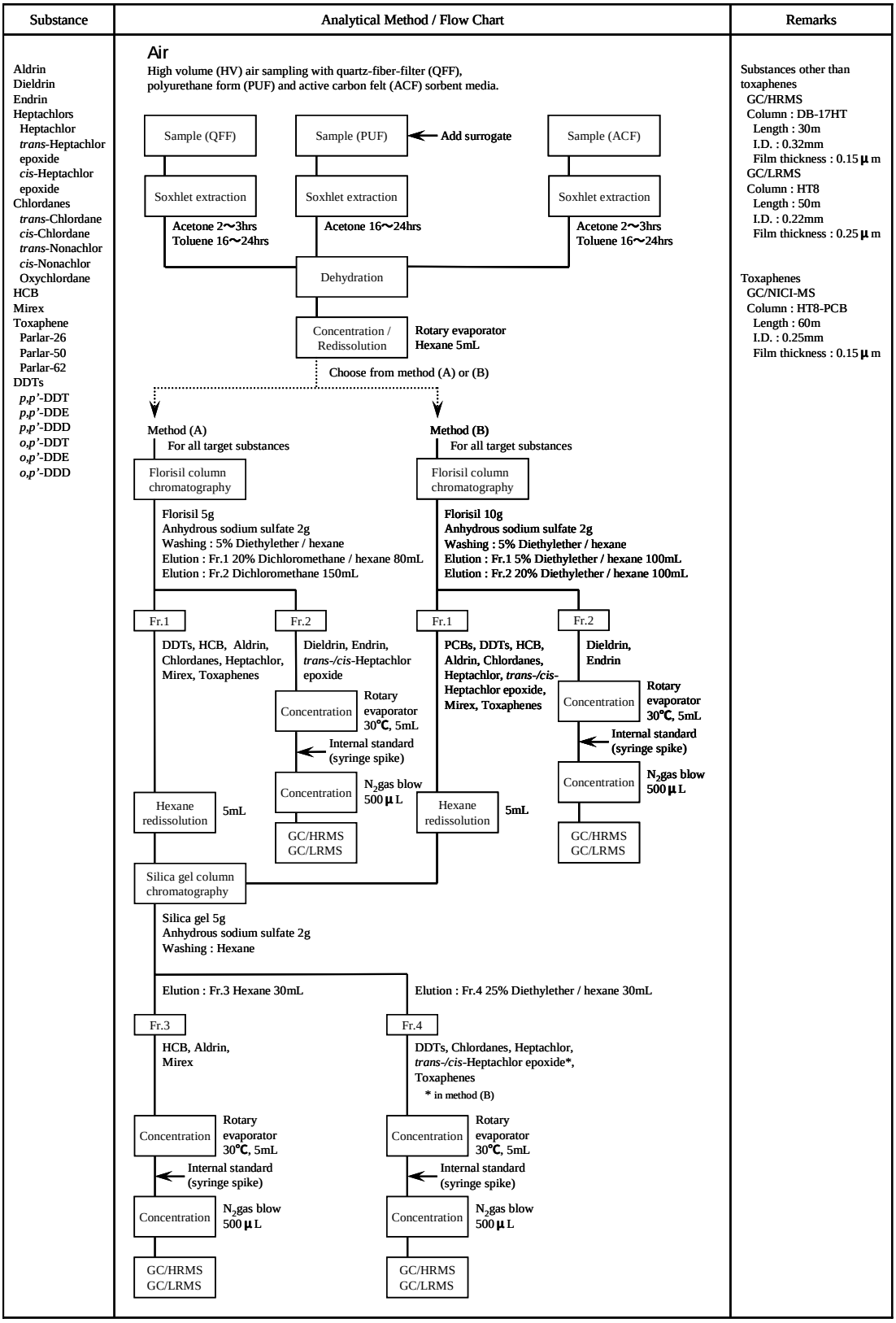


Figure 2 Flow Chart of Analytical Method for POPs in Air Samples

(4) Quality Control

Quality control (QC) should be carried out according to the Monitoring Manual 2006.
The analysis was conducted by the isotope-dilution method. Known amounts of isotope-labelled surrogate standards were added to PUF (typically several mm depth by a syringe) just prior to sampling. Quantification was conducted by comparing native/surrogate ratios of each chemical in the extracts of samples to those of

standard solutions containing known concentrations of both native and isotope-labelled standards.

Recoveries of each chemical during clean-up procedure was calculated separately from surrogates and were described in the results. In addition a travel blank was checked by conducting clean-up and analysis of blank absorbents, which were transported to the sampling sites and handled in the same way as real samples except for HV sampling process. The final data was presented by subtracting travel blanks. The reliability of the data was finally checked by duplicate analysis in this monitoring.

Four different limit values were defined in this programme; i.e., instrument detection limit (IDL). instrument quantification limit (IQL), method detection limit (MDL) and method quantification limit (MQL). The data exceeding MQL will be accepted while those equal or above MDL but below MQL will be presented as reference values. The values below MDL will be shown as not detected (n.d.). Also the data showing recoveries between 40 and 120 % will be accepted while those between 25 to 40 and 120 to 150 % will be shown as reference values.

(5) Data Communication and Ownership

All of the air samples were collected in cooperation with each organisation listed in **Table 3** and transported to Japan Environmental Sanitation Center for the analyses. The reliability of the obtained data and quality control information were verified by National Institute for Environmental Studies (NIES of Japan), and then sent to each participating country.
The data obtained were reviewed on their reliability in the 3rd Workshop on Environment Monitoring of POPs in East Asian Countries and the 2nd Expert Working Group meeting. And the data in 2006 were reviewed on the reliability in the 4th Workshop on Environmental Monitoring of POPs in East Asian Countries and 3rd Expert Working Group meeting.
The participating countries agreed that the ownership of these monitored data shall belong to each of the participating country, and assumed responsibility to keep, to disclose and to evaluate monitored data.

(6) Capacity Building and Technology Transfer Elements

MOE dispatched its officials and technical experts visited to several countries that participated in the field monitoring of the Project and carried out air sampling and the technological transfer. Training opportunities were provided for analytical methods for POPs. HRGC/HRMS determination was provided for scientists invited from two countries (Vietnam and Indonesia) for twelve days in Japan Environmental Sanitation Centre (JESC) and National Institute for Environmental Studies (NIES). The organisations which technological transfer was given are shown in **Table 3**.

Table 3 Capacity Building Opportunities

year	Country	Local Organisation	Technology Transfer
2005	Vietnam	Research Centre for Environmental Technology and Sustainable Development (CETASD), Hanoi University of Science	Sampling method using a high volume air sampler POPs analysis including clean-up procedure and the determination by HRGC/HRMS: one researcher
2005	Indonesia	Environmental Management Center (EMC-SARPEDAL)	Sampling method using a high volume air sampler POPs analysis including clean-up procedure and the determination using HRGC/HRMS: one researcher
2006	The Philippines	Research and Analytical Service Laboratory, Natural Sciences Research Institute, University of the Philippines	Sampling method by High volume air sampler
2006	Thailand	Pollution Control Department, Ministry of Natural Resources and Environment	Sampling method by High volume air sampler
2006	Mongolia	Ministry of Nature and Environment	Sampling method by High volume air sampler
2006	Cambodia	Environmental Pollution Control Department, The Ministry of Environment	Sampling method by High volume air sampler

4. Monitoring Data in East Asian Countries

4.1 POPs Concentrations in Ambient Air Samples in East Asian Countries

The monitoring of POPs in ambient air at Background sites were conducted in six countries where are Indonesia, Japan, Republic of Korea, the Philippines and Vietnam in 2004 through 2006. The sampling sites on the basis of the following protocol on background air sampling sites at present were chosen. In fact, however, it was difficult to comply with all the following protocol for sampling location in the research performed in 2004 through 2006.
- Some may be sited on islands or at continental margins to gain an insight into transport between regions.
- Others may be located centrally so as to obtain information on time trends of regional sources.
- The sites need to be sufficiently remote from urban centres and industrial and other sources of POPs as to reflect concentrations typical of a large area around the site (at least 100 km radius).
- Requirements include availability of meteorological observations, ability to perform back-trajectory analysis and trained personnel for sampling.

Air sampling were duplicately carried out with HV air samplers for 24 hours and then repeated for three days.

Target chemicals of this project were shown in **Table 2**. The air samples were analysed according to Monitoring Surveillance Manual for POPs and Their Related Compound (MOE Japan). Data measured in 2005 has already been discussed on the reliability in 3rd Workshop on Environment Air Monitoring of POPs in East Asian Countries and 2nd Expert Working Group Meeting at Tokyo in October 2005. And the data measured in 2006 has also discussed on the reliability in 4th workshop in Environmental Air Monitoring of POPs in East Asian Countries and 3rd Expert Working Group Meeting held at Kyoto in September 2006.

4.2 POPs Concentrations in Ambient Air Samples in Republic of Indonesia

1) Responsible Local Organisation

Ministry of Environment, Republic of Indonesia
Mrs. Rina APRISHANTY, Researcher, Environment Management Center (EMC), Ministry of Environment

2) Air Monitoring Data in 2005

a) Sampling Location

This sampling site is located about 30 km northwest of Jakarta (see **Figure 3**)

- Environmental Management Center (EMC /SARPEDAL),
  Kawasan PUSPIPTEK, Serpong Tangerang 15310, Indonesia
- Latitude: S 06o21.385' Logitude: E 106o40.067'
- Above sea level: approximately 100 m (Above ground level: 8.3 m)

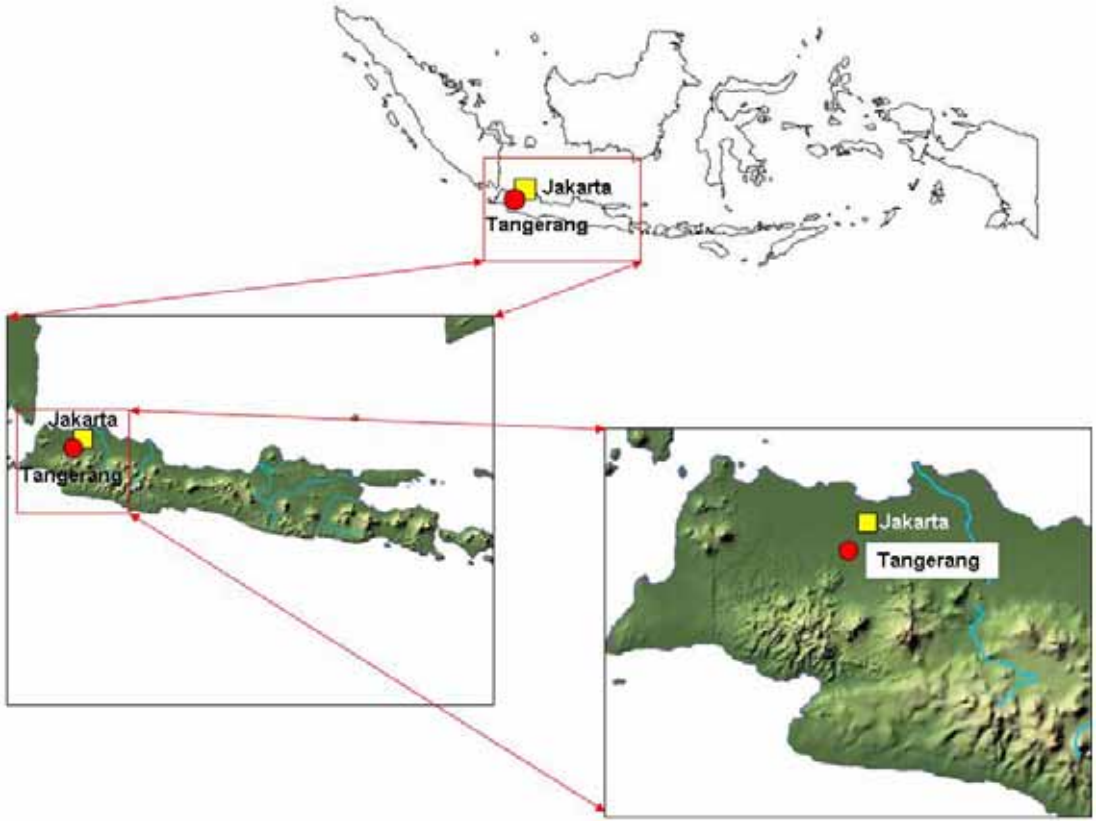


Figure 3 Map of Sampling Location in Indonesia in 2005

b) Sampling Records

Air sampling records are summarized in **Table 4**.

Table 4 Sampling Record in Serpnog Tangerang, Indonesia

		6 - 7 February 2006 (1st day)		7 - 8 February 2006 (2nd day)		8 - 9 February 2006 (3rd day)	
Sampler No. *1		A	B	A	B	A	B
Sampling time	Start	17:30	17:40	18:15	17:30	18:50	18:55
	End	17:30	17:40	18:15	17:30	18:50	18:55
Temperature (degC)	Start	32.2	30.9	33.8	32.2	27.2	26.8
	End	32.1	31.6	26.2	32.1	29.1	27.1
Atmospheric Pressure (hPa)	Start	999.7	1000.5	997.8	999.7	999.7	1000.5
	End	997.8	998.6	999.1	997.8	998.4	998.6
Weather	Start	rainy	rainy	cloudy	cloudy	rainy	rainy
	End	cloudy	cloudy	rainy	rainy	cloudy	cloudy
Flow Rate (L/min)		700	700	700	700	700	700
Sampling Volume (m^3)		1008	1007.9	1007.7	1007.9	1007.5	1007.7

*1: Both A and B is HV-1000F.

c) Results of HRGC/MS Analysis

Concentrations of POPs in ambient air collected by duplicate sampling are shown in **Table 5.** These concentrations were determined according to Monitoring Surveillance Manual for POPs and Their Related Compounds (2006).

Table 5 Concentrations of POPs in Ambient Air in Serpnog Tangerang, Indonesia on 1-4 June 2005.

Chemicals	Sample A		Sample B		Average	
	Conc. (pg/m^3)	Recovery (%)	Conc. (pg/m^3)	Recovery (%)	Conc. (pg/m^3)	Recovery (%)
HCB	100	47	110	44	110	46
Aldrin	n.a.	14	n.a.	7.6	n.a.	11
Dieldrin	34	58	34	60	34	59
Endrin	(1.5)	61	(1.5)	81	(1.5)	71
p,p'-DDT	*12*	*145*	*13*	*150*	*13*	*145*
p,p'-DDE	18	39	12	45	15	42
p,p'-DDD	1.9	82	2.1	82	2.0	82
o,p'-DDT	9.2	73	9.3	71	9.3	72
o,p'-DDE	1.6	49	1.5	50	1.6	50
o,p'-DDD	0.94	82	1.0	82	1.0	82
trans-Chlordane	18	88	18	83	18	86
cis-Chlordane	11		12		11	
trans-Nonachlor	9.4	94	9.3	90	9.3	92
cis-Nonachlor	2.4	76	2.2	75	2.3	76
Oxychlordane	(0.61)	71	(0.61)	73	(0.61)	72
Heptachlor	6.6	68	6.6	61	6.6	65
trans-Hepachlorepoxide	<0.09	71	<0.09	70	<0.09	71
cis-Hepachlorepoxide	0.77		0.80		0.79	
Mirex	0.33	41	0.23	42	0.28	42
Toxaphene (Parlar-26)	<0.07	51	<0.07	51	<0.07	51
Toxaphene (Parlar-50)	<0.08		<0.08		<0.08	

italic letter.: reference value because surrogate recovery was out of 40 to 120 percent.
n.a.: not available because surrogate recovery was out of 25 to 150 percent.
Values in parenthesis show that it was within IDL to IQL.

d) Results of Trajectory Analysis

To speculate the source of POPs in the collected air, trajectory analysis of the collected air was performed using the METEX programs. NCEP reanalysis dataset and 3D-wind model in METEX programs were used for the trajectory analysis. With reference to vertical coordinate in the 3D-wind model, the sigma coordinate was used for trajectory calculation in both forward and backward mode. The results of analysis showed in **Figure 4**.

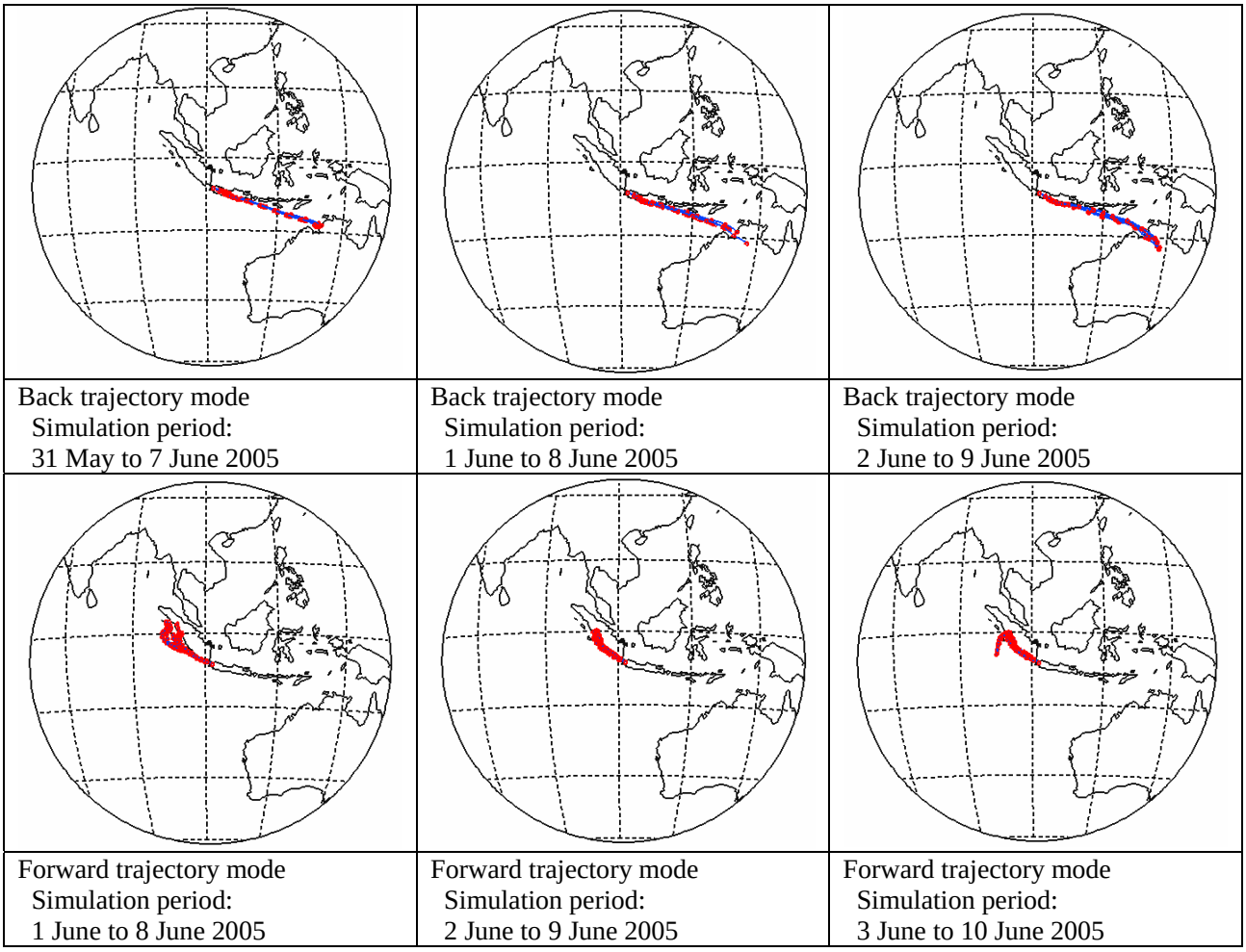


Figure 4 Trajectory Analysis of Ambient Air Collected in Serpnog Tangerang, Indonesia

These results of back and forward trajectory analyses indicated the possibilities of the long-rage transportation of POPs. When the height data was high, the transport speed of POPs in the air was relatively fast and long-range or trans-border transportation of POPs were possibly assumed at back trajectory mode and affected to far distant leeward. The less reliability of more than 3 day before or after of the trajectory data should be noticed.

e) Questions and Requests from Relevant Persons in Indonesia

- They hope that the POPs monitoring survey will be continued in the future. If it is possible, the period of duration should be about five years.
- A definition of the background should be given because the definition of the point of the background is vague. They think that the reason should be given.
- They want the monitoring survey to be carried out not only in the background location but also in the polluted locations in Indonesia.
- They hope that the investigation of PCDD/Fs and PCBs as well as the other POPs will be carried out.
- As EMC doesn't have any surrogate substances except DDT at the present time, when they collect samples without our help, they can use only DDT as a surrogate. This may create a disadvantage from the viewpoint of quality control. It is very difficult to obtain POPs standard solution and surrogate substances in Indonesia. Regarding this problem, especially the standard solutions such as PCBs, the transport (contained hand-carry) of the standards supplied in Japan to Indonesia is very difficult. At present a breakthrough is difficult in principle unless a manufacturer (AccuStandard, CIL, or Wellington) has a market directly in Indonesia and the Indonesian government appreciates the need fully. From now on, when we work for the technological transfer of POPs analysis in each country of the East Asian area, this

will be an important problem to be tackled at the government level.

- Initially we had planned to collect samples in Medan, but we changed to EMC near Jakarta due to the occurrence of an earthquake caused by volcanic activity. However, we will try to collect samples in Medan, if EMC is inappropriate as a background location.

3) Air Monitoring Data in 2006

a) Sampling Location

This sampling site in Berastagi is located about 50 km southeast of Medan in Sumatra island in Indonesia and about 350km west of Kuala Lumpur (see **Figure 5**). Further, above sea level of Berastagi is about 1,500m and the industry is mainly agriculture.

- Gundaling Hill, Berastagi, Indonesia
- Latitude: N03°11.321' Logitude: E098°30.109'
- Sea Level: 1470m

Figure 5 Map of Sampling Location in Indonesia in 2006

b) Sampling Records and Meteorological Information

Air sampling records are summarized in **Table 6** and meteorological information shows in **Table 7.**

Table 6 Sampling Record in Gundaling Hill, Berastagi, Indonesia

		6-7 February 2006 (1st day)		7 - 8 February 2006 (2nd day)		8 - 9 February 2006 (3rd day)	
Sampler No.*1		A	B	A	B	A	B
Sampling time	Start	17:15	17:20	17:48	17:55	20:18	20:20
	End	17:15	17:20	19:30*2	17:37	20:18	20:20
Temperature (DegC)	Start	24.4	21.2	26.8	25.3	23.2	25.1
	End	26.9	28.9	23.4	26.3	22	21
Atmospheric Pressure (hPa)	Start	857.2	860.1	853.4	856.9	856.6	859.4
	End	853.4	856.3	855.9	858.8	856.6	859.4
Weather	Start	fine	fine	cloudy	cloudy	rainy	rainy
	End	cloudy	rainy	rainy	rainy	fine	cloudy
Flow Rate (L/min)		700	700	700	700	700	700
Sampling Volume (m^3)		1008.1	1008.2	1008.6	998.4*3	1008	1008.1

*1: Both A and B is HV-700F.
*2: End time of sampling was delayed because electric supply had stopped from 14:00 to 15:30.
*3: PUF of entrance side was pressed flat.

Table 7 Meteorological Information Observed in Kuta Gadung Station - Karo District North Sumatra

Date	Precipitation	Temp. (DegC)	Wind Velocity (m/s)	Relative Humidity (%)
2006/2/3	0	18.7	0.82	87
2006/2/4	2	19.0	0.84	87
2006/2/5	0	15.7	0.77	89
2006/2/6	3	18.7	0.29	87
2006/2/7	0	18.2	0.90	85
2006/2/8	3	16.2	0.80	83
2006/2/9	9	18.8	1.21	83
2006/2/10	0	18.1	0.88	89
2006/2/11	0	19.1	0.74	90

c) Results of HRGC/MS Analysis

Concentrations of POPs in ambient air collected by duplicate sampling are shown in **Table 8.** These concentrations were determined according to Monitoring Surveillance Manual for POPs and Their Related Compounds (2006).

Table 8 **Concentrations of POPs in Ambient Air in Berastagi, Indonesia on 6-9 February 2006.**

Chemicals	Sample A (pg/m^3)				Sample B (pg/m^3)				Average (pg/m^3)			
	1st day	2nd day	3rd day	Average	1st day	2nd day	3rd day	Average	1st day	2nd day	3rd day	Average
HCB	110	110	100	110	n.a.	n.a.	100	100	110	110	100	110
Aldrin	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Dieldrin	16	14	22	17	n.a.	23	23	23	16	19	23	19
Endrin	8.4	7.1	13	9.5	n.a.	15	15	15	8.4	11	14	11
p,p'-DDT	32	40	43	38	n.a.	51	47	49	32	46	45	41
p,p'-DDE	79	71	110	87	n.a.	120	110	120	79	96	110	95
p,p'-DDD	3.2	3.1	3.0	3.1	n.a.	2.3	1.8	2.1	3.2	2.7	2.4	2.8
o,p'-DDT	19	18	27	21	n.a.	30	28	29	19	24	28	24
o,p'-DDE	2.4	2.1	2.9	2.5	n.a.	2.6	2.6	2.6	2.4	2.4	2.8	2.5
o,p'-DDD	1.3	1.3	1.6	1.4	n.a.	1.0	1.1	1.1	1.3	1.2	1.4	1.3
trans-Chlordane	2.7	2.0	2.7	2.5	n.a.	1.8	2.3	2.1	2.7	1.9	2.5	2.4
cis-Chlordane	1.8	1.6	1.9	1.8	n.a.	1.4	1.7	1.6	1.8	1.5	1.8	1.7
trans-Nonachlor	1.3	1.1	1.3	1.2	n.a.	0.84	1.1	0.97	1.3	0.97	1.2	1.2
cis-Nonachlor	0.23	0.22	0.25	0.2	n.a.	0.15	0.17	0.16	0.23	0.19	0.21	0.21
Oxychlordane	0.28	0.29	0.22	0.3	n.a.	0.29	0.22	0.26	0.28	0.29	0.22	0.26
Heptachlor	1.6	1.3	1.4	1.4	n.a.	1.0	1.2	1.1	1.6	1.2	1.3	1.4
trans-Heptachlorepoxide	<0.05	<0.05	<0.05	<0.05	n.a.	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
cis-Heptachlorepoxide	0.48	0.44	0.51	0.48	n.a.	0.37	0.39	0.38	0.48	0.41	0.45	0.45
Mirex	0.25	0.45	0.22	0.31	n.a.	0.27	0.29	0.28	0.25	0.36	0.26	0.29
Toxaphene (Parlar-26)	13	10	21	14.48	n.a.	24	19	22	13	17	20	17
Toxaphene (Parlar-50)	13	10	22	15.15	n.a.	27	21	24	13	19	21	18
Toxaphene (Parlar-62)	<16	<16	<16	<16	n.a.	<16	<16	<16	<16	<16	<16	<16

italic letter.: reference value because surrogate recovery was out of 40 to 120 percent.
n.a.: not available because surrogate recovery was out of 25 to 150 percent.
Values in parenthesis show that it was within IDL to IQL.

d) Results of Trajectory Analysis

To speculate the source of POPs in the collected air, trajectory analysis of the collected air was performed using the METEX programs. NCEP reanalysis dataset and 3D-wind model in METEX programs were used for the trajectory analysis. With reference to vertical coordinate in the 3D-wind model, the sigma coordinate was used for trajectory calculation in both forward and backward mode. The results of analysis showed in **Figure 6**.

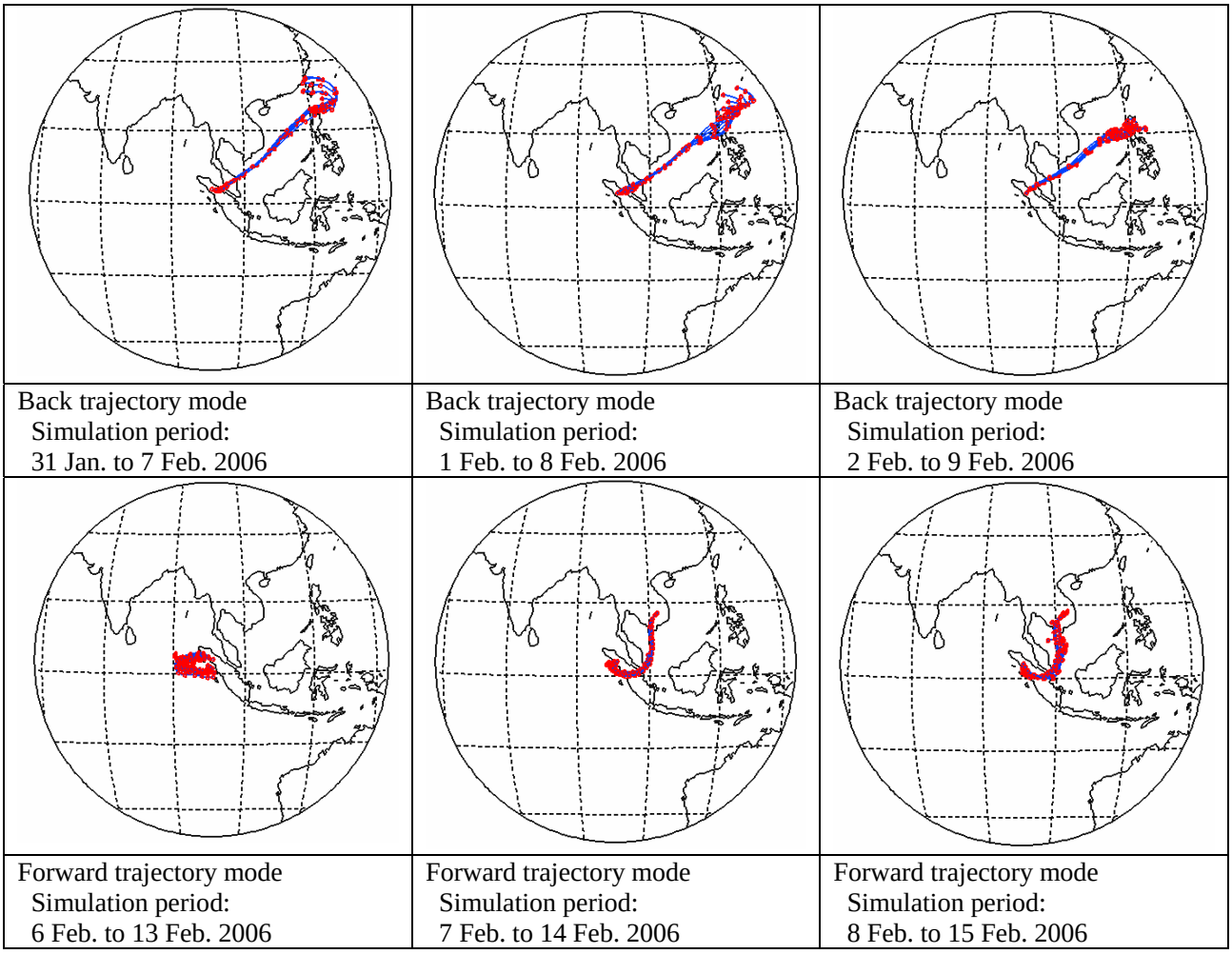


Figure 6 Trajectory Analysis of Ambient Air Collected in Berastagi, Indonesia

These results of back and forward trajectory analyses indicated the possibilities of the long-rage transportation of POPs. When the height data was high, the transport speed of POPs in the air was relatively fast and long-range or trans-border transportation of POPs were possibly assumed at back trajectory mode and affected to far distant leeward. The less reliability of more than 3 day before or after of the trajectory data should be noticed.

e) Issues in This Sampling and in the Future

- The sampling site is Berastagi located about 50 km southeast of Medan in Sumatra island in Indonesia in this research. Further, above sea level of Berastagi is about 1,500m and the industry is mainly agriculture. As referred to above, we thought this sampling point has the proper conditions to background air monitoring site.

However, the results that I conducted interview for local agent staffs of Forestry and Environmental Service and plantation owner, DDTs and HCHs have been still irregularly sold and used. In particular, it is very difficult for control and regulation of pesticide used irregularly because these pesticides have been mixed with approved pesticides and then sold.

Therefore, to assess effect due to the pesticides used irregularly for POPs concentrations in Air samples from Berastagi, monitoring survey of agricultural soil, river water, and river sediment need to be simultaneously carried out.

4.3 POPs Concentrations in Ambient Air Samples in Japan

The monitoring of POPs in ambient air in Japan at Hateruma Island was conducted by Japanese Environmental Monitoring Project. Air sampling was duplicately carried out with HV air samplers for 24 hours and then repeated for three days.

1) Responsible Local Organisation

National Institute for Environmental Studies (NIES), Japan
Dr. Yasuyuki Shibata, Division Head, Environmental Chemistry Division, National Institute for Environmental Studies.

2) Air Monitoring in 2004, 2005 and 2006

a) Sampling locations
This sampling sites is located about 1600 km south west of Tokyo (see **Figure 7**). These sampling sites are available micro meteorological information because there is Background Air Monitoring Station of NIES.

- Rooftop of Monitoring Station, Hateruma Island, Okinawa-Pref., Japan
- Latitude: N xx^{o} x' Logitude: E xxx^{o} x'

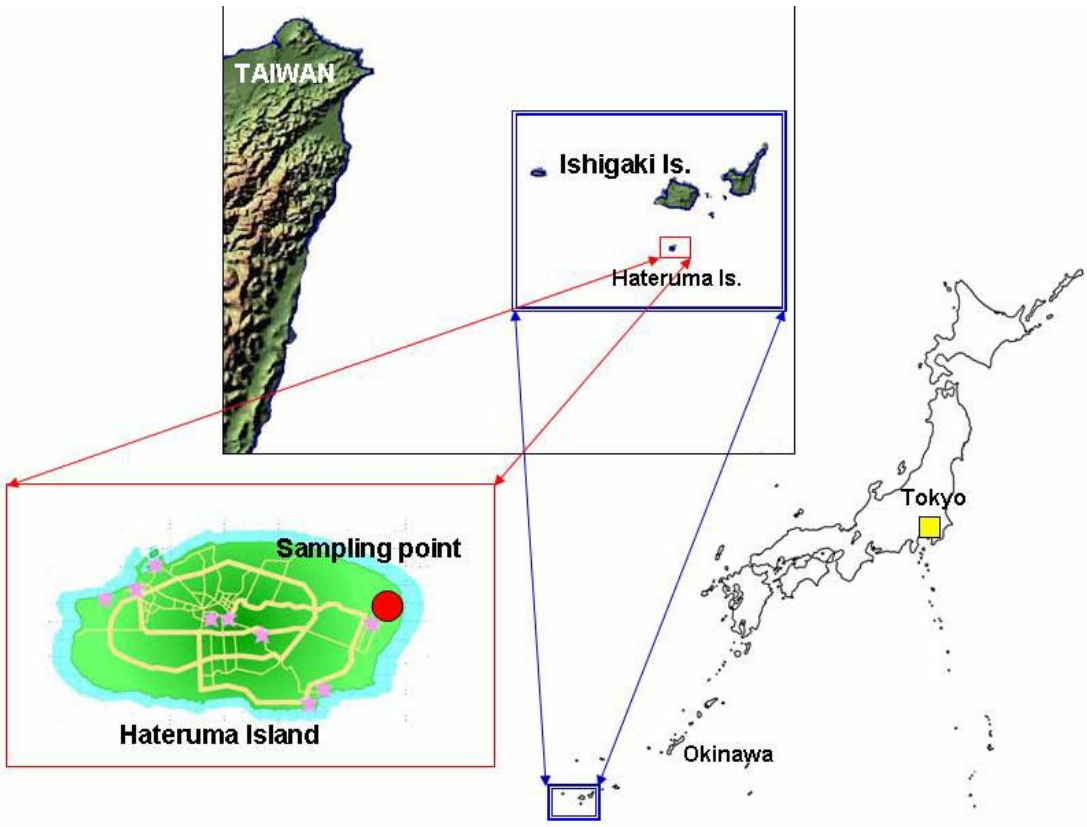


Figure . 7 Map of Sampling Location of Hateruma Island in Japan

b) Sampling Records and Meteorological Information
Air sampling records are summarized in **Table 9-1 – 9-3.**

Table 9-1 Sampling Record at Hateruma Island in Japan in 2004.

	Apr. 12-13	July 12-13	Aug. 9-10	Sept. 8-9	Oct. 12-13	Nov. 16-17	Dec. 14-15
sampling time (start)	11:36	10:51	11:51	12:25	12:43	15:31	12:07
sampling time (finish)	12:05	11:00	12:32	12:45	13:27	15:38	12:48
sampling volume (m^3)	1028.3	1014.3	1036.3	1021.7	1038.9	1013.2	1036.2
temp. max	-	-	42.3	36.4	35.0	29.1	34.4
temp. min	-	-	31.9	27.9	27.3	25.0	27.3
humidity max	-	-	68	80	59	65	80
humidity min	-	-	46	59	41	56	61
atmos. pressure (hPa)	-	-	1006.8	1013.8	1018.3	1024.0	1021.5
flow rate (L/min)	700	700	700	700	700	700	700

Table 9-2 Sampling Record at Hateruma Island in Japan in 2005.

	Jan 19-20	Mar. 15-16	May 18-19	June 14-15	July 12-13	Aug. 9-10	Sept. 13-14	Nov. 8-9	Dec. 12-13
sampling time (start)	16:36	14:25)	9:40	12.20	12:28	12.36	12:39	12:37	15:56
sampling time (finish)	16:19	14:07	9:07	12:34	13:17	12:40	12:28	13:36	17:04
sampling volume (m^3)	988.5	995.5	985.3	1017.8	1042.0	1010.8	1000.1	1049.2	1072.9
temp. max	23.4	31.5	39.3	38.3	41.6	39.3	40.4	37.8	32.1
temp. min	-	23.9	28.7	29.1	32.8	28.2	30.2	29.4	24.8
humidity max	74	68	68	67	70	71	74	74	66
humidity min	-	42	51	53	48	52	50	50	46
atmos. pressure (hPa)	1027.8	1025.9	1014.4	1014.3	1015.1	1017.6	1018.9	1018.9	1022.7
flow rate (L/min)	700	700	700	700	700	700	700	700	700

Table 9-3 Sampling Record at Hateruma Island in Japan in 2006.

	Mar. 15-16	Apr. 11-12	May 16-17	July 16-17	Aug. 15-16
sampling time (start)	11:34	11:52	12:48	11:45	17:41
sampling time (finish)	12:11	13:58	12:30	12:12	18:52
sampling volume (m^3)	1033.9	1096.2	995.4	1026.9	1057.7
temp. max	36.7	33.2	37.3	38.3	38.9
temp. min	28.7	26.3	29.3	30.1	29.9
humidity max	84	68	84	84	83
humidity min	57	50	60	58	56
atmos. pressure (hPa)	1017.7	1023.4	1020.2	1012.0	1015.1
flow rate (L/min)	700	700	700	700	700

c) Results of HRGC/MS Analysis
Concentrations of POPs in ambient air collected by two kinds of sampling methods which were Japanese method and U.S.EPA method, are shown in **Table 10-1, 10-2** and **10-3.** These concentrations were determined according to Monitoring Surveillance Manual for POPs and Their Related Compounds (2006).

Table 10-1 Concentrations of POPs in Ambient Air at Hateruma Island, Japan in 2004.

unit: pg/m^3

	Apr.	July	Aug.	Sept.	Oct.	Nov.	Dec.
HCB	42	108	16	99	65	43	115
Aldrin	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Dieldrin	2.2	4.1	3.7	2.6	n.d.	(0.86)	n.d.
Endrin	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
p,p'-DDT	n.d.	n.d.	n.d.	3.0	1.7	n.d.	n.d.
p,p'-DDE	1.5	(0.48)	(0.43)	8.0	0.82	0.94	2.9
p,p'-DDD	(0.32)	(0.44)	(0.27)	2.0	n.d.	5.9	n.d.
o,p'-DDT	3.1	n.d.	n.d.	26	1.8	3.8	3.7
o,p'-DDE	2.1	0.26	(0.037)	12	0.66	0.85	3.3
o,p'-DDD	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
trans-Chlordane	22	4.4	4.8	14	1.8	4.6	19
cis-Chlordane	17	5.2	4.9	12	2.0	3.6	15
trans-Nonachlor	12	3.1	3.1	8.7	1.8	3.0	13
cis-Nonachlor	1.5	(0.62)	(0.54)	(1.22)	n.d.	n.d.	1.4
Oxychlordane	(0.83)	n.d.	n.d.	n.d.	n.d.	n.d.	(0.80)
Heptachlor	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
trans-Heptachlorepoxide	1.7	0.53	0.43	0.65	0.71	0.68	0.41
cis-Heptachlorepoxide	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Mirex	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Toxaphene (Parlar-26)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Toxaphene (Parlar-50)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Toxaphene (Parlar-62)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

n.d.: not detected.
italic letter.: reference value because surrogate recovery was out of 40 to 120 percent.
n.a.: not available because surrogate recovery was out of 25 to 150 percent.
Values in parenthesis show that it was within IDL to IQL.

Table 10-2 Concentrations of POPs in Ambient Air at Hateruma Island, Japan in 2005.

unit: pg/m^3

	Jan.	Mar.	May	June	July	Aug.	Sept.	Nov.	Dec.
HCB	305	57	114	71	41	39	44	52	49
Aldrin	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Dieldrin	19	n.d.	2.9	n.d.	(1.8)	n.d.	n.d.	(0.98)	n.d.
Endrin	n.d.	n.d.	n.d.	n.d.	(0.42)	n.d.	n.d.	n.d.	n.d.
p,p'-DDT	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
p,p'-DDE	5.2	0.40	1.3	0.50	(0.40)	n.d.	(0.31)	(0.60)	4.7
p,p'-DDD	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
o,p'-DDT	6.0	n.d.	1.8	n.d.	(1.3)	n.d.	(0.48)	1.8	(1.1)
o,p'-DDE	4.3	n.d.	0.70	0.30	0.28	(0.10)	(0.11)	0.46	1.9
o,p'-DDD	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
trans-Chlordane	30	n.d.	2.3	(0.60)	n.d.	n.d.	n.d.	(1.3)	n.d.
cis-Chlordane	20	(0.60)	2.4	(0.70)	(0.52)	(0.50)	(0.74)	1.7	(0.55)
trans-Nonachlor	15	(0.40)	1.5	3.7	(0.39)	(0.33)	(0.45)	1.0	(0.47)
cis-Nonachlor	3.3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Oxychlordane	1.0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Heptachlor	5.2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	(0.57)	n.d.
trans-Heptachlorepoxide	1.2	n.d.	n.d.	n.d.	n.d.	0.50	0.80	0.55	n.d.
cis-Heptachlorepoxide	n.d.	n.d.	n.d.	n.d.	(0.13)	(0.14)	(0.12)	(0.15)	n.d.
Mirex	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Toxaphene (Parlar-26)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Toxaphene (Parlar-50)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Toxaphene (Parlar-62)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

n.d.: not detected.
italic letter.: reference value because surrogate recovery was out of 40 to 120 percent.
n.a.: not available because surrogate recovery was out of 25 to 150 percent.
Values in parenthesis show that it was within IDL to IQL.

Table 10-3 Concentrations of POPs in Ambient Air at Hateruma Island, Japan in 2006.

unit: pg/m^3

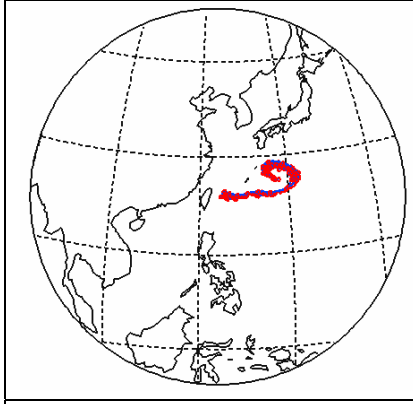
	Mar.	Apr.	May	July	Aug.
HCB	47	26	25	13	35
Aldrin	*n.d.*	*n.d.*	*n.d.*	*n.d.*	*n.d.*
Dieldrin	n.d.	n.d.	n.d.	n.d.	(0.76)
Endrin	n.d.	n.d.	n.d.	n.d.	n.d.
p,p'-DDT	n.d.	n.d.	n.d.	n.d.	n.d.
p,p'-DDE	n.d.	n.d.	n.d.	n.d.	n.d.
p,p'-DDD	2.3	2.9	1.8	1.6	0.84
o,p'-DDT	(0.55)	2.3	1.9	2.2	(0.90)
o,p'-DDE	0.55	0.57	0.31	0.46	(0.15)
o,p'-DDD	n.d.	n.d.	n.d.	n.d.	n.d.
trans-Chlordane	(0.66)	(0.60)	n.d.	(0.67)	(1.6)
cis-Chlordane	(0.76)	(0.59)	n.d.	(0.58)	1.4
trans-Nonachlor	n.d.	n.d.	n.d.	n.d.	n.d.
cis-Nonachlor	n.d.	n.d.	n.d.	n.d.	n.d.
Oxychlordane	n.d.	n.d.	n.d.	n.d.	n.d.
Heptachlor	n.d.	n.d.	(0.66)	2.9	n.d.
trans-Heptachlorepoxide	0.57	0.68	0.71	0.68	0.77
cis-Heptachlorepoxide	n.d.	n.d.	n.d.	n.d.	n.d.
Mirex	n.d.	n.d.	n.d.	n.d.	n.d.
Toxaphene (Parlar-26)	n.d.	n.d.	n.d.	n.d.	n.d.
Toxaphene (Parlar-50)	n.d.	n.d.	n.d.	n.d.	n.d.
Toxaphene (Parlar-62)	n.d.	n.d.	n.d.	n.d.	n.d.

n.d.: not detected.
italic letter.: reference value because surrogate recovery was out of 40 to 120 percent.
n.a.: not available because surrogate recovery was out of 25 to 150 percent.
Values in parenthesis show that it was within IDL to IQL.

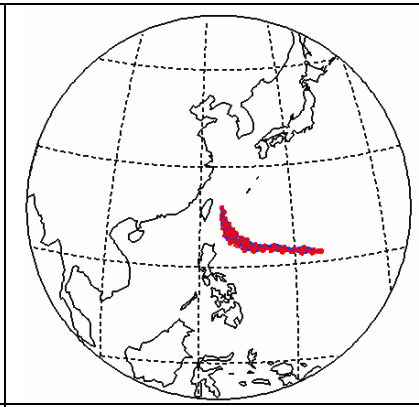
d) Results of Trajectory Analysis

To speculate the source of POPs in the collected air, trajectory analysis of the collected air was performed using the METEX programs. NCEP reanalysis dataset and 3D-wind model in METEX programs were used for the trajectory analysis. With reference to vertical coordinate in the 3D-wind model, the sigma coordinate was used for trajectory calculation in both forward and backward mode. The results of analysis showed in **Figure 8 - 13**.

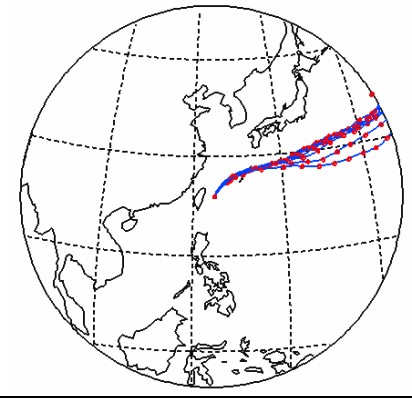
These results of back and forward trajectory analyses indicated the possibilities of the long-rage transportation of POPs. When the height data was high, the transport speed of POPs in the air was relatively fast and long-range or trans-border transportation of POPs were possibly assumed at back trajectory mode and affected to far distant leeward. The less reliability of more than 3 day before or after of the trajectory data should be noticed.



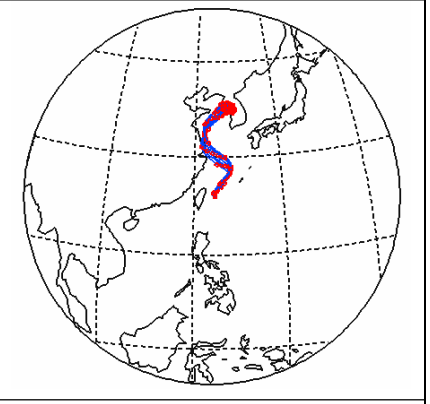
Back trajectory mode
Simulation period:
6 Apr. to 13 Apr. 2004



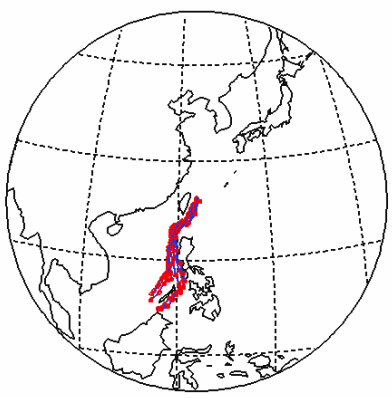
Back trajectory mode
Simulation period:
6 July to 13 July 2004



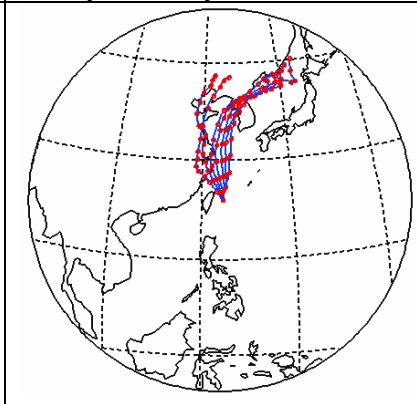
Back trajectory mode
Simulation period:
3 Aug. to 10 Aug. 2004



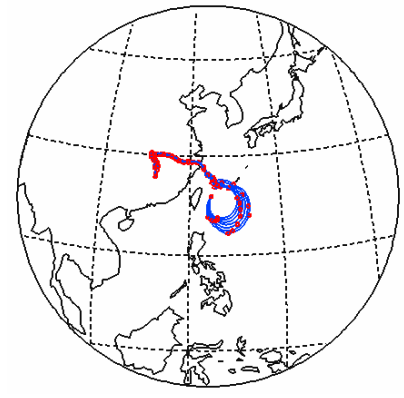
Back trajectory mode
Simulation period:
2 Sept. to 9 Sept. 2004



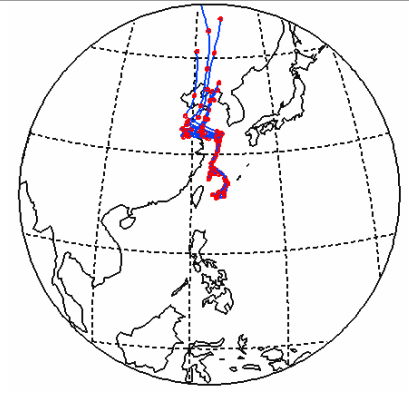
Forward trajectory mode
Simulation period:
12 Apr. to 19 Apr. 2004



Forward trajectory mode
Simulation period:
12 July to 19 July 2004

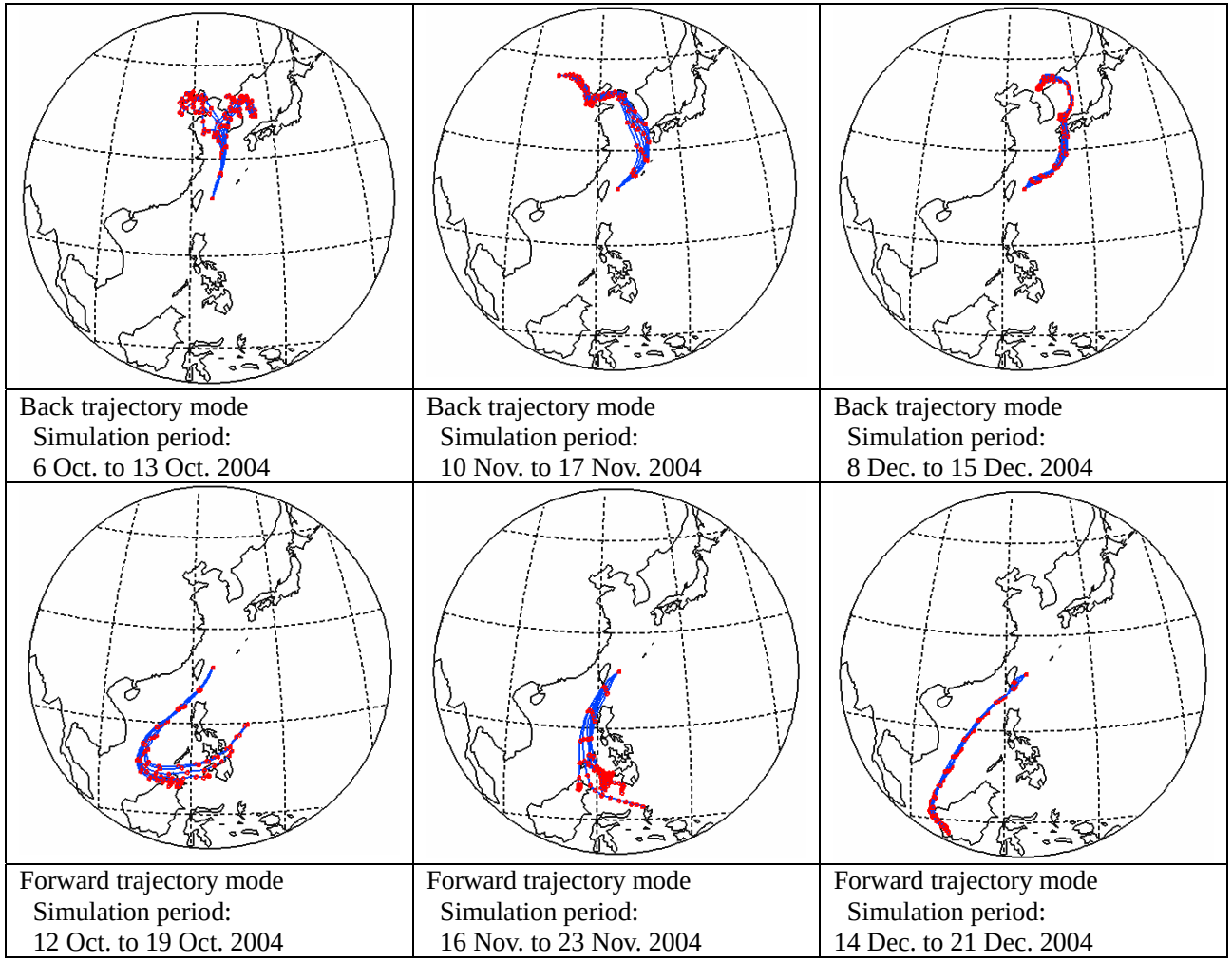


Forward trajectory mode
Simulation period:
9 Aug. to 13 Aug. 2004



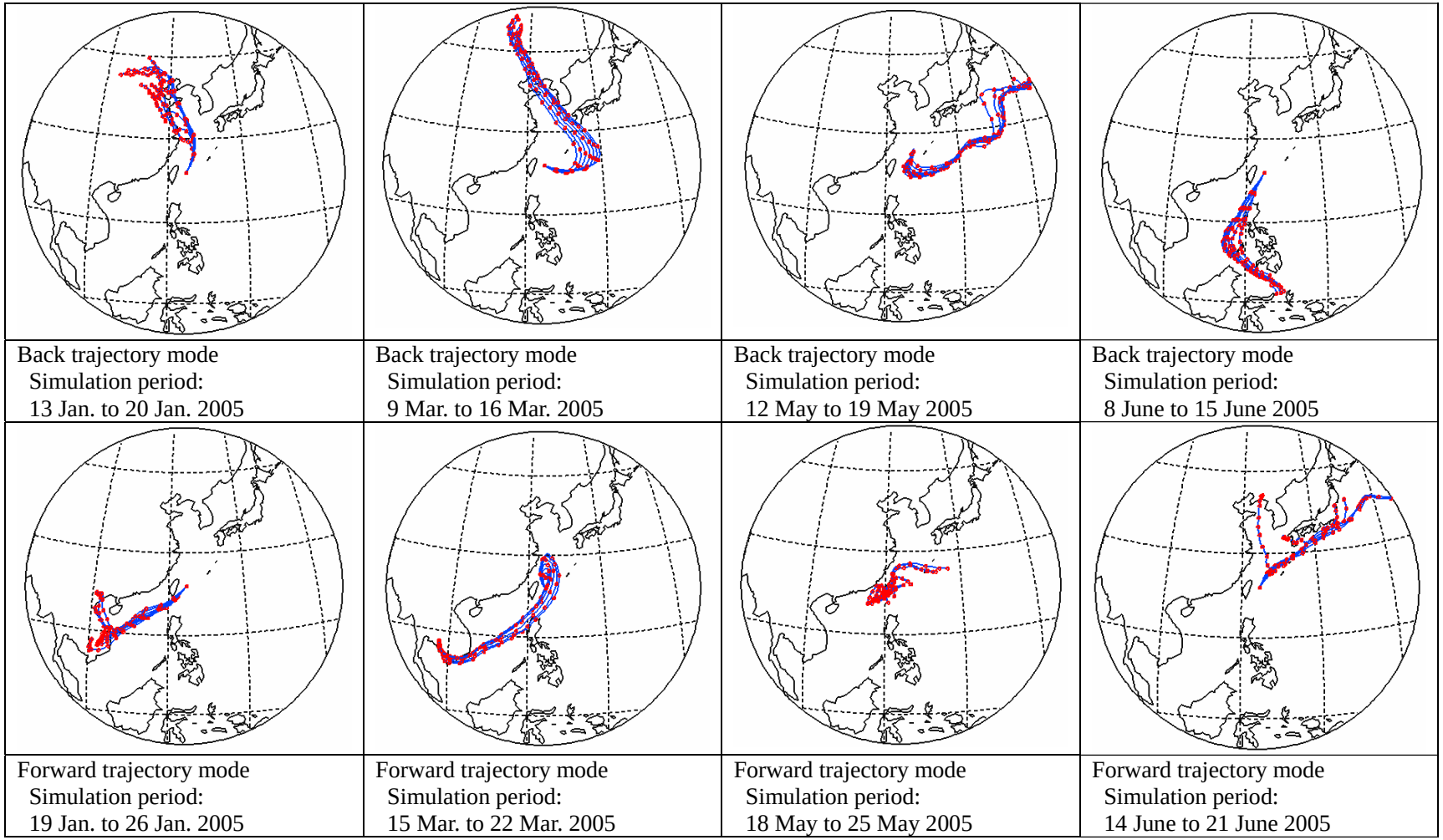
Forward trajectory mode
Simulation period:
8 Sept. to 15 Sept. 2004

Figure 8 **Trajectory Analysis of Ambient Air Collected at Hateruma Island in Japan.**



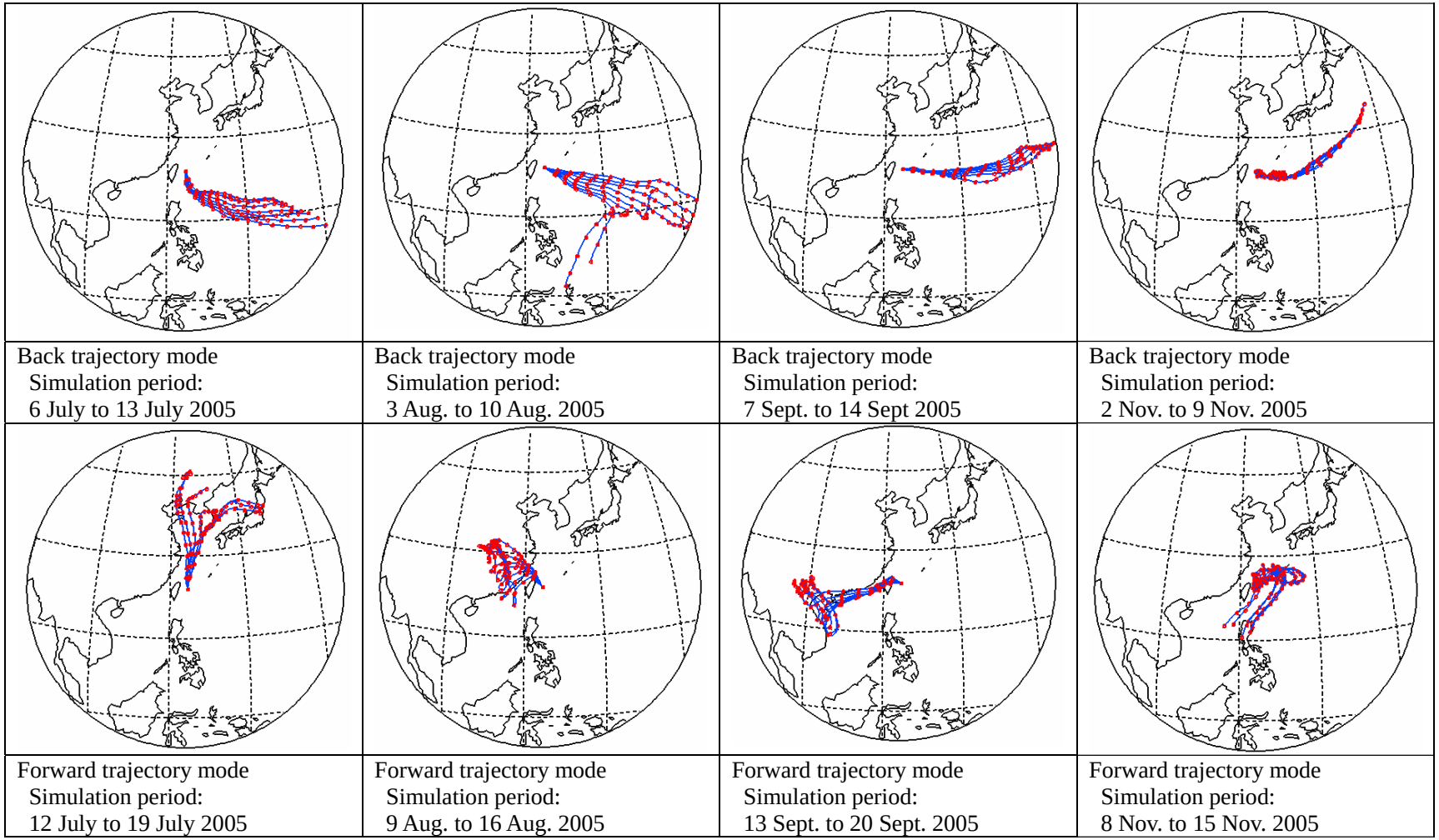
Back trajectory mode Simulation period: 6 Oct. to 13 Oct. 2004	Back trajectory mode Simulation period: 10 Nov. to 17 Nov. 2004	Back trajectory mode Simulation period: 8 Dec. to 15 Dec. 2004
Forward trajectory mode Simulation period: 12 Oct. to 19 Oct. 2004	Forward trajectory mode Simulation period: 16 Nov. to 23 Nov. 2004	Forward trajectory mode Simulation period: 14 Dec. to 21 Dec. 2004

Figure 9 **Trajectory Analysis of Ambient Air Collected at Hateruma Island in Japan.**



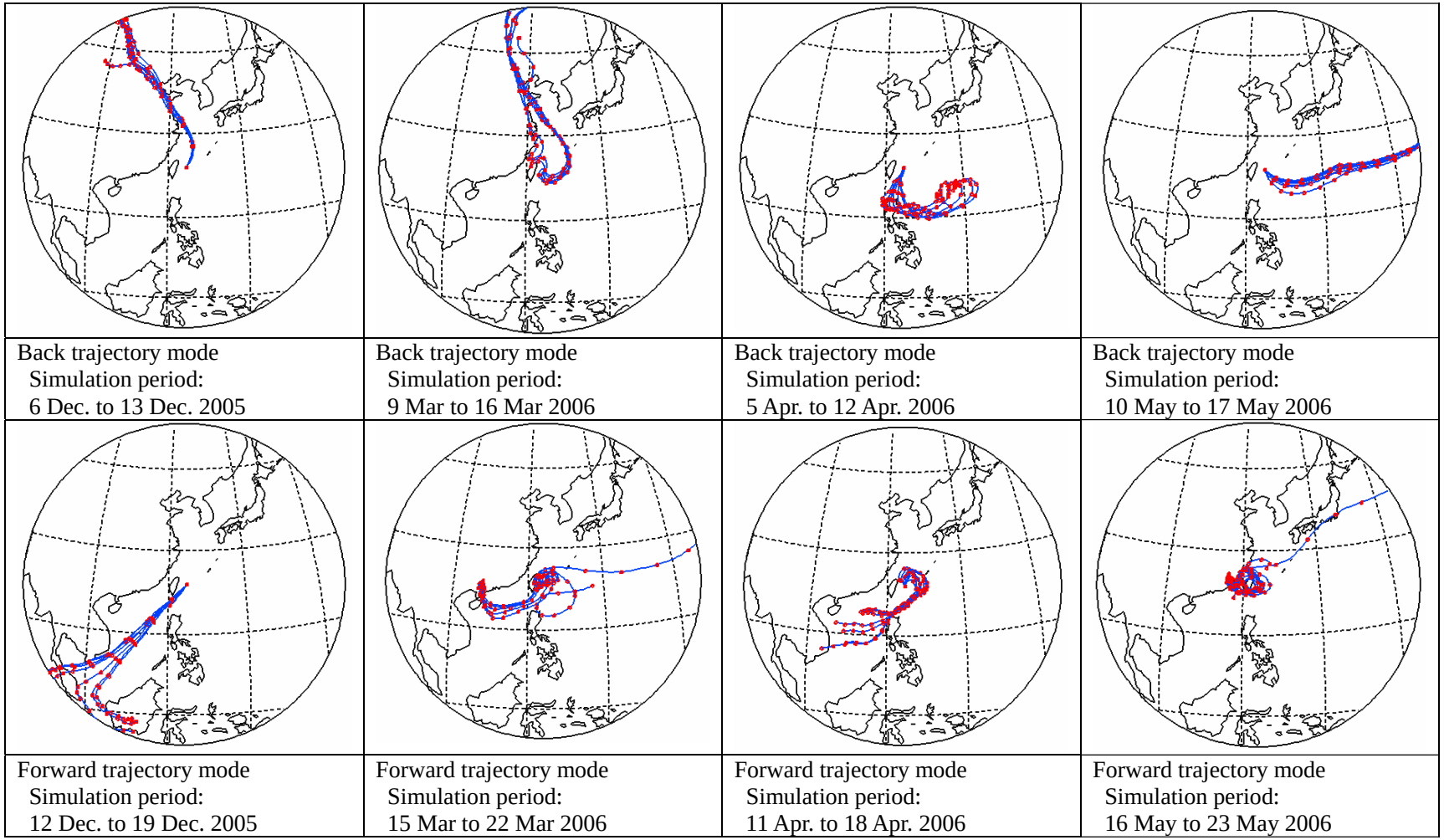
Back trajectory mode Simulation period: 13 Jan. to 20 Jan. 2005	Back trajectory mode Simulation period: 9 Mar. to 16 Mar. 2005	Back trajectory mode Simulation period: 12 May to 19 May 2005	Back trajectory mode Simulation period: 8 June to 15 June 2005
Forward trajectory mode Simulation period: 19 Jan. to 26 Jan. 2005	Forward trajectory mode Simulation period: 15 Mar. to 22 Mar. 2005	Forward trajectory mode Simulation period: 18 May to 25 May 2005	Forward trajectory mode Simulation period: 14 June to 21 June 2005

Figure 10 **Trajectory Analysis of Ambient Air Collected at Hateruma Island in Japan.**



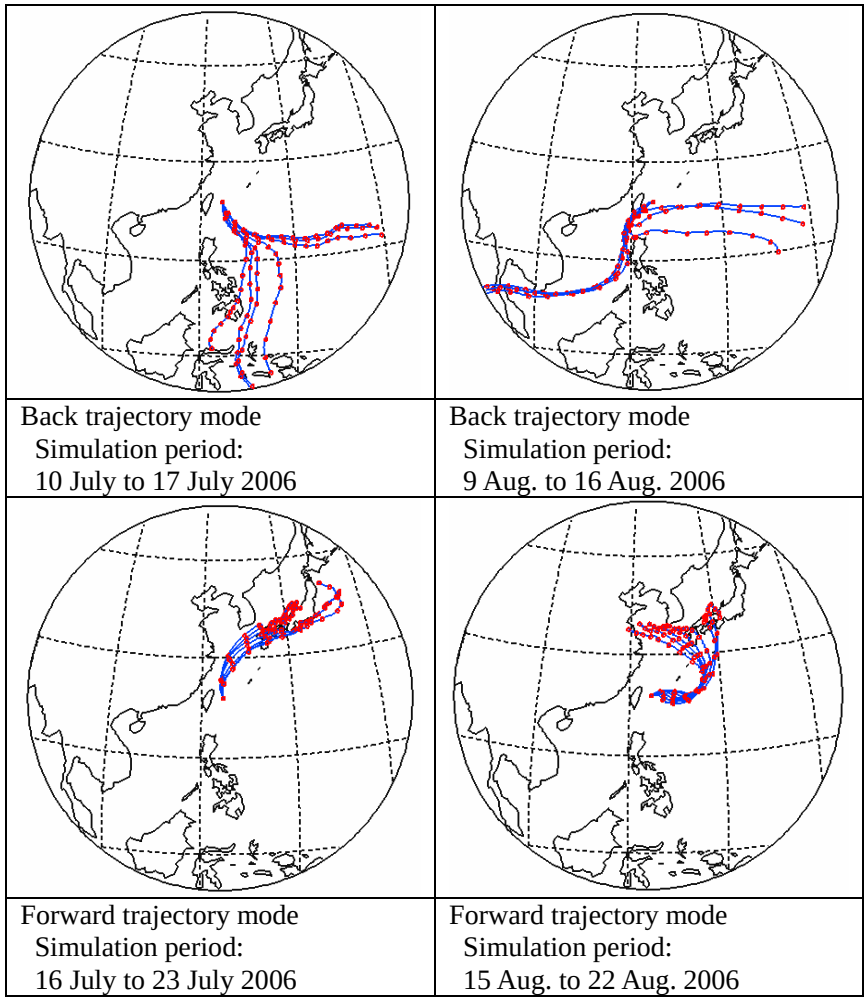
Back trajectory mode Simulation period: 6 July to 13 July 2005	Back trajectory mode Simulation period: 3 Aug. to 10 Aug. 2005	Back trajectory mode Simulation period: 7 Sept. to 14 Sept 2005	Back trajectory mode Simulation period: 2 Nov. to 9 Nov. 2005
Forward trajectory mode Simulation period: 12 July to 19 July 2005	Forward trajectory mode Simulation period: 9 Aug. to 16 Aug. 2005	Forward trajectory mode Simulation period: 13 Sept. to 20 Sept. 2005	Forward trajectory mode Simulation period: 8 Nov. to 15 Nov. 2005

Figure 11 **Trajectory Analysis of Ambient Air Collected at Hateruma Island in Japan.**



Back trajectory mode Simulation period: 6 Dec. to 13 Dec. 2005	Back trajectory mode Simulation period: 9 Mar to 16 Mar 2006	Back trajectory mode Simulation period: 5 Apr. to 12 Apr. 2006	Back trajectory mode Simulation period: 10 May to 17 May 2006
Forward trajectory mode Simulation period: 12 Dec. to 19 Dec. 2005	Forward trajectory mode Simulation period: 15 Mar to 22 Mar 2006	Forward trajectory mode Simulation period: 11 Apr. to 18 Apr. 2006	Forward trajectory mode Simulation period: 16 May to 23 May 2006

Figure 12 **Trajectory Analysis of Ambient Air Collected at Hateruma Island in Japan.**



Back trajectory mode Simulation period: 10 July to 17 July 2006	Back trajectory mode Simulation period: 9 Aug. to 16 Aug. 2006
Forward trajectory mode Simulation period: 16 July to 23 July 2006	Forward trajectory mode Simulation period: 15 Aug. to 22 Aug. 2006

Figure 13 **Trajectory Analysis of Ambient Air Collected at Hateruma Island in Japan.**

4.4 POPs Concentrations in Ambient Air Samples in Republic of Korea

The trial monitoring of POPs in ambient air in Republic of Korea at two sampling points were conducted by their own activities. Air sampling were carried out with HV air samplers for 24 hours.

1) Responsible Local Organisation

Republic of Korea
Dr. Jong-Woo CHOI, Researcher, Environmental Measurement Standards Division, National Institute of Environmental Research

2) Air Monitoring in 2006

a) Sampling locations

These sampling sites are located about 120km south east of Seoul (Goisan) and 100 km south-south west of Seoul (Taean) (see **Figure 14**). These sampling sites are available micro meteorological information because there are Background Air Monitoring Station of Korea.

<**Goisan**>

This place is a rural area surrounded by mountain, of which population is approximately 300, located at about 160 km apart to the southeast from Seoul. At this place, for checking a background air quality, 'Local Ambient Air Monitoring Station' is installed and operated (Duckpyungri Chungchunmyun Goisangun Choongchungbukdo, Republic of Korea) (Fig.1). From the station, meteorological information, such as temperature, humidity, wind direction and velocity, can be obtained together with SO_2, CO, O_3, NOx, PM-10, etc

- Latitude: N 36° 43′ 41.407″ Longitude: E 127° 48′ 35.066″
- Approximately 172m above sea level (5m above ground level)
- Air Quality : SO_2 0.002 ppm/year, NO_2 0.005~0.007 ppm/year, O_3 0.017~0.028 ppm/year, CO 0.6~0.7 ppm/year, and PM-10 45~54 pg/m^3/year

<**Taean**>

This place is a coastal area of West Sea, of which population is approximately 200, located at about 150 km apart to the southwest from Seoul. Also, at this place, for checking a background air quality, 'National Ambient Air Monitoring Station' is installed and operated (Padori Sowonmyun Taeangun Choongchungnamdo) (Fig.1). From the station, meteorological information, such as temperature, humidity, wind direction and wind velocity, can be obtained together with SO_2, CO, O_3, NOx, PM-10, etc

- Latitude: N 36° 44′ 03.661″ Longitude: E 126° 08′ 05.381″
- Approximately 7m above sea level (5m above ground level)
- Air Quality : SO_2 0.002~0.003 ppm/year, NO_2 0.003~0.006 ppm/year, O_3 0.035~0.042 ppm/year, CO 0.1~0.4 ppm/year, and PM-10 51~57 pg/m^3/year

Figure 14 Map of Sampling Location in Republic of Korea in FY2006

b) Sampling Conditions

Air samplings were carried out two times at each sampling sites, using two methods: one is US EPA Method, and the other is Japan proposal method. To compare the sampling efficiencies or recovery rates between two methods, samplings were simultaneously done for 24hr per each run, using two different types of high volume air sampler (HVAS): one is of TISCH Environmental, Inc.(model TE1000PUF), the other is of Sibata Ltd. (model 700F). Prior to starting a sampling, 2~4 ng of ^{13}C-surrogates of all target POPs were spiked onto the quartz fiber filter. The air sampling conditions are summarized in **Table 11.**

Table 11 Ambient Air Sampling Conditions in Republic of Korea

Year		2005 (winter)		2006 (summer)			
Site		Goisan		Goisan		Taean	
Sampling Methods		EPA	Japan	EPA	Japan	EPA	Japan
Sampling time	Start	11:00 22 Feb.	11:00 22 Feb.	15:00 29 Aug.	15:00 29 Aug.	15:00 18 Aug.	15:00 18 Aug.
	End	12:25 24 Feb.	12:25 24 Feb.	16:45 31 Aug.	16:45 31 Aug.	16:45 20 Aug.	16:45 20 Aug.
Temperature (deg C)	Start	2.0	2.0	30	30	31	31
	End	1.4	1.4	29	29	28	28
Atmospheric pressure (hPa)	Start	1001	1001	989	989	999	999
	End	996	996	985	985	1002	1002
Weather	Start	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny
	End	Cloudy	Cloudy	Sunny	Sunny	Sunny	Sunny
Flow rate (L/min)		245	700	250	700	255	700
Sampling volume (m^3)		355	1015	362	948	340	938

c) Comparison of Recovery Rates of EPA to Japan Proposal method

An aspiration was made at a speed of 225 L/min through quartz fiber filter (ϕ10.2 cm), double-layer PUF and XAD-2(15 g) for EPA method, and 700 L/min through quartz fiber filter (20 x 25 cm),double-layer PUF and active carbon fiber felt (ACF, ϕ84 mm) for Japan methods.

As a result, we got the fairly good recovery rates of ^{13}C-surrogates on target POPs in ambient air sampling except for aldrin and hexachlorobenzene (HCB). The recovery rates of whole processes, including sampling and clean-up procedures, on target POPs averaged 63.5% as EPA method and 88.9% as Japan method, respectively. And, the recovery rates of clean-up process only were 105.7 % as EPA method and 112.4 % as Japan method on average. Also, we were able to get a good correlation between two methods with a little values of standard deviation to the ratio of recovery rate of EPA method to Japan method. On the whole, as for the standard deviations of recovery rates of either whole or clean-up process, EPA method showed the less values than Japan method.

A noticeable thing is that winter season showed the relatively smaller values of standard-deviation than summer season in the recovery rates of whole process (**Table 12** and **13**).

Table 12 Comparison of EPA methods and Japan proposal methods during winter season on 22-24 Feb. 2005.

Surrogate Chemicals	Recovery Rates of Whole Process (%)		Recovery Rates of Clean-up Process (%)		Ratio of Recovery Rate of EPA Method to Japan Method	
	EPA Method	Japan Method	EPA Method	Japan Method	Whole Process	Clean-up Process
HCB	27	46	71	66	0.59	1.1
Aldrin	0	0	90	95		0.95
Dieldrin	82	110	110	110	0.73	0.97
Endrin	77	120	86	100	0.63	0.83
p,p'-DDE	62	85	110	110	0.73	0.98
o,p'-DDT	79	130	140	180	0.59	0.76
o,p'-DDE	62	83	100	110	0.75	0.97
trans-Chlordane	74	97	120	130	0.76	0.95
trans-Nonachlor	71	95	120	120	0.75	0.98
cis-Nonachlor	65	89	110	110	0.73	0.95
Oxychlordane	76	89	120	130	0.85	0.95
Heptachlor	70	110	72	75	0.66	0.96
Heptachlorepoxide	74	98	100	100	0.76	0.99
Mirex	68	89	140	140	0.76	0.96
Average	64	89	110	110	0.76	0.95
S.D.	22	33	20	27	0.08	0.07

Table 13 Comparison of EPA method to Japan proposal method during summer season on 29-31 Aug. 2006.

Surrogate Chemicals	Recovery Rates of Whole Process (%)		Recovery Rates of Clean-up Process (%)		Ratio of Recovery Rate of EPA Method to Japan Method	
	EPA Method	Japan Method	EPA Method	Japan Method	Whole Process	Clean-up Process
HCB	26	37	66	71	0.70	0.93
Aldrin	7	9	96	99	0.78	0.97
Dieldrin	110	77	76	94	1.4	0.81
Endrin	120	160	89	120	0.77	0.75
o,p'-DDD	130	140	89	110	0.96	0.79
p,p'-DDD	140	170	80	110	0.83	0.71
o,p'-DDE	97	82	110	110	1.2	0.98
p,p'-DDE	150	120	87	120	1.3	0.75
o,p'-DDT	120	130	72	85	0.91	0.85
p,p'-DDT	80	120	88	96	0.67	0.92
Trans-Chlordane	120	140	87	160	0.84	0.55
Trans-Nonachlor	120	120	110	110	1.0	0.96
Oxychlordane	110	130	88	120	0.86	0.75
Heptachlor	63	65	86	100	0.97	0.83
Heptachlorepoxide	95	90	100	110	1.1	0.91
Mirex	96	140	100	110	0.71	0.88
Average	100	110	89	110	0.93	0.83
S.D.	31	36	12	20	0.20	0.12

d) Results of HRGC/MS Analysis

The concentrations of target POPs were determined by high resolution gas chromatograph/ high resolution mass spectrometer (HRGC/HRMS): Hewlett Packard 6890 GC coupled with AutoSpec Ultima (Micromass Co.). Selected ion monitoring for 2 ions was performed with electron impact of 36 eV above a resolution of 10,000, using a HT8 SGE column of 50 m x 0.22 mm ID x 0.25 μm. POPs concentration in ambient air samples were shown in **Table 14.**

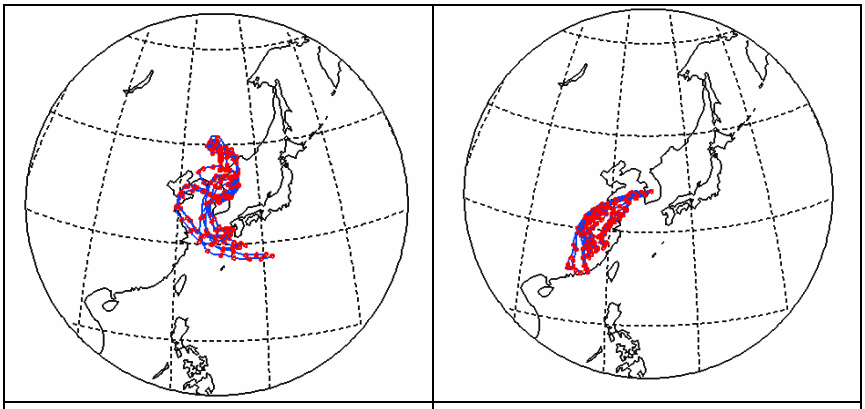
Table 14 Concentrations of POPs in Ambient Air in Republic of Korea

Chemicals	2005 (Winter)		2006 (Summer)			
	Goisan (rural area)		Goisan (rural area)		Taean (coastal area)	
	EPA	Japan	EPA	Japan	EPA	Japan
HCB	-	-	*109*	*70*	*94*	*75*
Aldrin	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Dieldrin	<0.2	<0.06	<0.2	<0.06	<0.2	<0.06
Endrin	<0.3	<0.1	<0.3	<0.1	<0.3	<0.1
o,p'-DDD	-	-	<0.1	<0.04	*2.0*	<0.04
p,p'-DDD	-	-	<0.2	<0.07	<0.2	<0.07
o,p'-DDE	<0.03	0.4	<0.03	<0.01	<0.03	<0.01
p,p'-DDE	2.6	2.0	<0.06	<0.02	<0.06	<0.02
o,p'-DDT	<0.1	<0.03	<0.1	<0.03	<0.1	<0.03
p,p'-DDT	-	-	<0.3	<0.10	<0.3	<0.10
trans-Chlordane	<0.06	<0.02	<0.06	*1.4*	<0.06	*2.3*
trans-Nonachlor	<0.06	<0.02	<0.06	<0.02	<0.06	<0.02
Oxychlordane	<0.2	<0.08	<0.2	<0.08	<0.2	<0.08
Heptachlor	<0.09	<0.03	<0.09	<0.03	1.9	<0.03
Heptachlorepoxide	<0.06	<0.02	<0.06	<0.02	<0.06	1.1
Mirex	<0.02	<0.005	<0.02	<0.005	<0.02	<0.005
Toxaphene	<40	<10	<40	<10	<40	<10

italic letter.: reference value because surrogate recovery was out of 40 to 120 percent.
n.a.: not available because surrogate recovery was out of 25 to 150 percent.
Values in parenthesis show that it was within IDL to IQL.

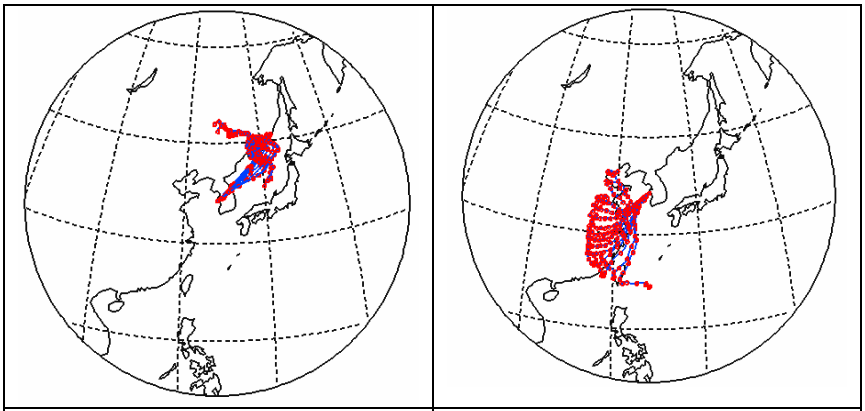
e) Results of Trajectory Analysis

To speculate the source of POPs in the collected air, trajectory analysis of the collected air was performed using the METEX programs. NCEP reanalysis dataset and 3D-wind model in METEX programs were used for the trajectory analysis. With reference to vertical coordinate in the 3D-wind model, the sigma coordinate was used for trajectory calculation in both forward and backward mode. The results of analysis showed in **Figure 14** and **Figure 15**.



Back trajectory mode Simulation period: 24 Aug. to 31 Aug. 2006	Forward trajectory mode Simulation period: 29 Aug. to 5 Sept. 2006

Figure 14 Trajectory Analysis of Ambient Air Collected at Goisan in Republic of Korea on 30 August - 1 September 2006.



Back trajectory mode Simulation period: 13 Aug. to 20 Aug. 2006	Forward trajectory mode Simulation period: 18 Aug. to 25 Aug. 2006

Figure 15 Trajectory Analysis of Ambient Air Collected at Taean in Republic of Korea on 18 - 20 August 2006.

These results of back and forward trajectory analyses indicated the possibilities of the long-rage transportation of POPs. When the height data was high, the transport speed of POPs in the air was relatively fast and long-range or trans-border transportation of POPs were possibly assumed at back trajectory mode and affected to far distant leeward. The less reliability of more than 3 day before or after of the trajectory data should be noticed.

f) Consumption of OCPs in Republic of Korea

Korean government had already banned the usage, production and import of organo-chlorine pesticides (OCPs) before 1980. **Table 15** shows the consumption of OCPs in Republic of Korea.

Table 15 Consumption of POPs (OCPs) at Agriculture in Republic of Korea

Chemicals	Consumption (ton, A.I.)	Period
Drins(Aldrin, Dieldrin, Endrin, Isodrin)	**147.2**	**1962~1972**
Chlordane	**3**	**1965~1969**
Heptachlor	**597.4**	**1962~1979**
Hexachlorobezene	**0**	**-**
Mirex	**0**	**-**
Toxaphene	**200.7**	**1969~1980**
DDT	**1,063.5**	**1948~1971**

*** A.I. : Active Ingredient**

g) Sampling and in-the-future Issues

- Further research was requested from the other participating countries to determine which spiking part, such as quartz fiber filter or PUF is suitable for better recovery rates in summer season.
- Both Korea and Japan will try to solve the low recovery rates of aldrin and HCB when sampling.
- In order to speculate the source of POPs in the region of East Asia, Korea will keep on the POPs monitoring in ambient air with gradually increasing the sampling sites, including Goisan, Taean, and Kosan located at Jeju Island.

4.5 POPs Concentrations in Ambient Air Samples in the Philippines

1) Ownership of Data and a Person in Charge

Republic of the Philippines
Dr., Prof. Evangeline Santiago, Head, Research and Analytical Service Laboratory, Natural Sciences Research Institute

2) Air Monitoring Data in 2006

a) Sampling Location (see **Figure 16**)
This sampling site is located about 200 km north of Manila.
- Sto Tomas Mountaine, Bagio City, Philippines
- Latitude: N16°21.488', Logitude: E120°33.456'
- Above Sea Level: 2,040m

The sampling site in Sto Tomas Mountain is used as background site for monitoring pollution from precipitation studies. The site has a structure that houses equipment (radar) for tracking low pressure area and similar weather disturbances. The site has electric generators as supplementary source of electricity for its equipment. Although it is quite far from the population center (about 30 minutes drive from Baguio City), vegetable (leafy) and fruit (strawberry) farming activities can be observed at the slopes of the mountain area.
The sampling location in the Philippines in this research has the proper conditions to background air monitoring site as follows;
1) Although this location is near from Bagio city of which population is about two hundred thirty-thousand, the above sea level is 2,000m and very high.
2) This location is available micro meteorological information such as temperature, humidity, wind direction, and wind velocity because there is precipitation observed station.
3) The electric supply is stable because there are two private power generators in this station.

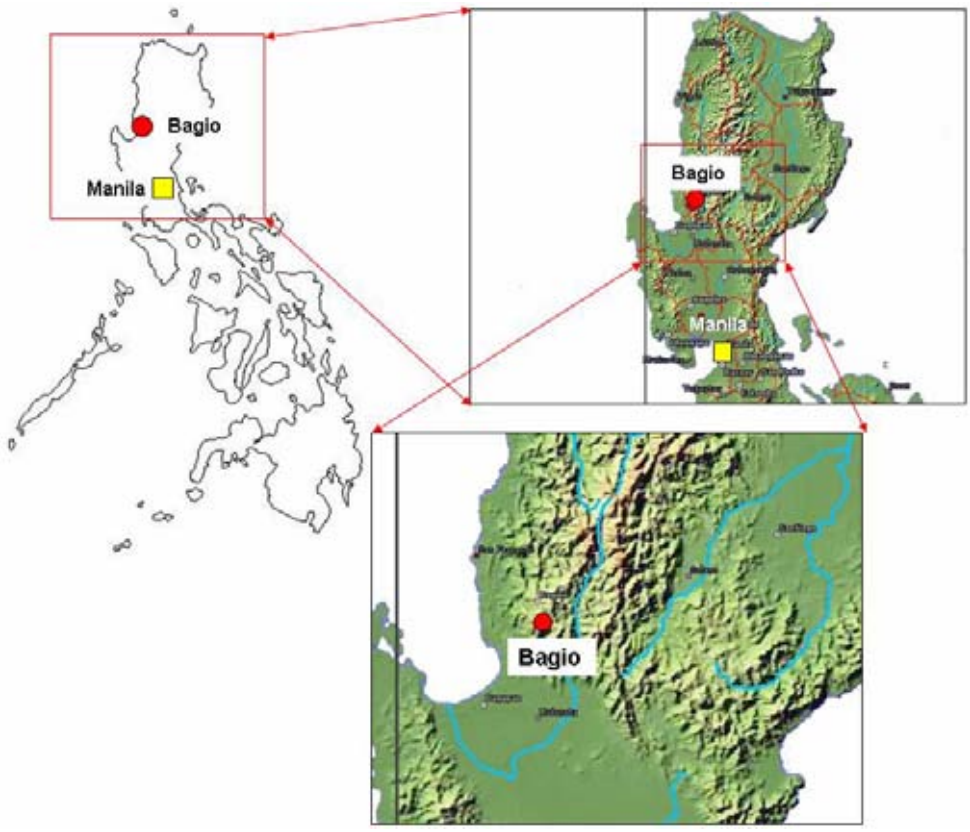


Figure 16 Map of Sampling Location in the Philippines in 2006

b) Sampling Records and Meteorological Information

Air sampling records are summarized in **Table 16** and meteorological information shows in **Table 17.**

Table 16 Sampling Record in Bagio, Philippines

		9 - 10 January 2006 (1st day)		10 - 11 January 2006 (2nd day)		11 - 12 January 2006 (3rd day)	
Sampler No.[*1]		A	B	A	B	A	B
Sampling time	Start	12:52	13:01	20:30	20:18	21:05	21:12
	End	19:21*	19:21[*2]	20:30	20:18	21:05	21:12
Temperature (DegC)	Start	19.7	19.2	17.2	14.2	15.1	15.5
	End	15.7	15	16.3	14.7	15.6	14.9
Atmospheric Pressure (hPa)	Start	801	798.9	799.5	803.6	804.2	800.1
	End	798.9	803.6	800.1	804.6	799.5	804.2
Weather	Start	foggy	foggy	foggy	foggy	fine	fine
	End	foggy	foggy	fine	fine	foggy	foggy
Flow Rate (L/min)		700	700	650	700	650	700
Sampling Volume (m^3)		943.6[*2]	1008	954.2[*2]	1007.9	935.9	1007.8

*1: A is HV-700FT and B is HV-1000F.

*2: Power supply was cut off at 7:30 a.m. because of the failure of private power generator.
It took long to repair the generator for 6 hours. Air sampling was restarted without replacing of filter at 1:21 p.m.

*3: PUF was pressed flat.

Table 17 Meteorological Information Observed in Sto Tomas Observing Station

	2006/1/9	2006/1/10	2006/1/11	2006/1/12
Wind direction	SW	SW	N	SE
Wind velocity (m/s)	1	2	0	1
Max. temp. (DegC)	17.2	18.5	19	22
Min. temp. (DegC)	9.2	10.8	9.8	11.3
Dry-bulb temp.(℃)	12.2	14	13	19
Wet-bulb temp.(℃)	10.1	13.3	11.6	12.5

c) Results of HRGC/MS Analysis

Concentrations of POPs in ambient air collected by duplicate sampling are shown in **Table 18.** These concentrations were determined according to Monitoring Surveillance Manual for POPs and Their Related Compounds (2006).

d) Discussion

- Average % Recovery in samples for surrogates of Aldrin (8.3), Heptachlor (36) were below acceptable values. The average % Recovery for HCB (50) was lower than most surrogate OCPs (62-96).
- % Recovery in blanks for surrogates of Aldrin (49) and Heptachlor (23) and HCB (27) were also low.
- Chlordanes were detected in highest concentrations (1.6-4.3 pg/m^3) in air samples
- Nonachlors were second highest (1.2- 2.6 pg/m^3).
- Heptachlor is third most prevalent (0.9-1.8 pg/m^3).
- p,p' DDT and p,p' DDE were detected in concentrations from 0.73-1.4 pg/m^3 and o,p' DDT and o,p' DDE 0.18-1.0 pg/m^3.
- Dieldrin was detected in concentrations from 0.50-1.3 pg/m^3.
- Mirex was detected at concentrations slightly higher than the travel and method blank levels.
- All other pesticides were not detected except HCB which was detected in very high concentration. HCB was detected in high concentrations (83-140 pg/m^3), however, this compound was never registered in the Philippines as a pesticide.

Table 18 Concentrations of POPs in Ambient Air in Bagio, Philippines on 9-12 January 2006.

Chemicals	Sample A (pg/m^3)				Sample B (pg/m^3)				Average (pg/m^3)			
	1st day	2nd day	3rd day	Average	1st day	2nd day	3rd day	Average	1st day	2nd day	3rd day	Average
HCB	140	140	100	130	130	83	99	91	140	110	100	110
Aldrin	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Dieldrin	0.97	0.86	1.3	1	0.54	0.50	0.93	0.715	0.76	0.68	1.1	0.88
Endrin	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	1.1	1.4	1.0	1.2	0.73	0.87	0.92	0.90	0.92	1.1	0.96	1.0
p,p'-DDE	0.95	1.2	0.82	1.0	0.77	0.76	0.76	0.8	0.86	1.0	0.79	0.88
p,p'-DDD	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
o,p'-DDT	0.77	1.0	0.71	0.83	0.58	0.58	0.55	0.57	0.68	0.79	0.63	0.70
o,p'-DDE	0.33	0.30	0.18	0.27	0.26	0.17	0.18	0.18	0.30	0.24	0.18	0.22
o,p'-DDD	(0.055)	(0.071)	(0.049)	(0.058)	(0.066)	(0.070)	(0.061)	(0.066)	(0.061)	(0.071)	(0.055)	(0.062)
trans-Chlordane	4.3	3.8	3.8	4.0	3.6	2.4	3.5	3.0	4.0	3.1	3.7	3.5
cis-Chlordane	2.6	2.5	2.4	2.5	2.4	1.6	2.5	2.1	2.5	2.1	2.5	2.3
trans-Nonachlor	1.9	2.1	1.8	2	1.8	1.2	1.9	1.6	1.9	1.7	1.9	1.7
cis-Nonachlor	0.45	0.46	0.35	0.42	0.30	0.29	0.32	0.31	0.38	0.38	0.34	0.36
Oxychlordane	0.31	0.29	0.26	0.29	0.25	0.20	0.25	0.23	0.28	0.25	0.26	0.26
Heptachlor	*1.5*	1.6	*1.7*	*1.6*	1.3	*0.9*	*1.8*	*1.4*	*1.4*	1.3	*1.8*	*1.5*
trans-Heptachlorepoxide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
cis-Heptachlorepoxide	0.41	0.44	0.33	0.39	0.34	0.27	0.32	0.30	0.38	0.36	0.33	0.34
Mirex	0.013	0.082	0.12	0.072	(0.011)	0.13	0.11	0.12	0.012	0.11	0.12	0.10
Toxaphene (Parlar-26)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toxaphene (Parlar-50)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toxaphene (Parlar-62)	<14	<14	<14	<14	<14	<14	<14	<14	<14	<14	<14	<14

italic letter.: reference value because surrogate recovery was out of 40 to 120 percent.
n.a.: not available because surrogate recovery was out of 25 to 150 percent.
Values in parenthesis show that it was within IDL to IQL.

e) Results of Trajectory Analysis

To speculate the source of POPs in the collected air, trajectory analysis of the collected air was performed using the METEX programs. NCEP reanalysis dataset and 3D-wind model in METEX programs were used for the trajectory analysis. With reference to vertical coordinate in the 3D-wind model, the sigma coordinate was used for trajectory calculation in both forward and backward mode. The results of analysis showed in **Figure 17**.

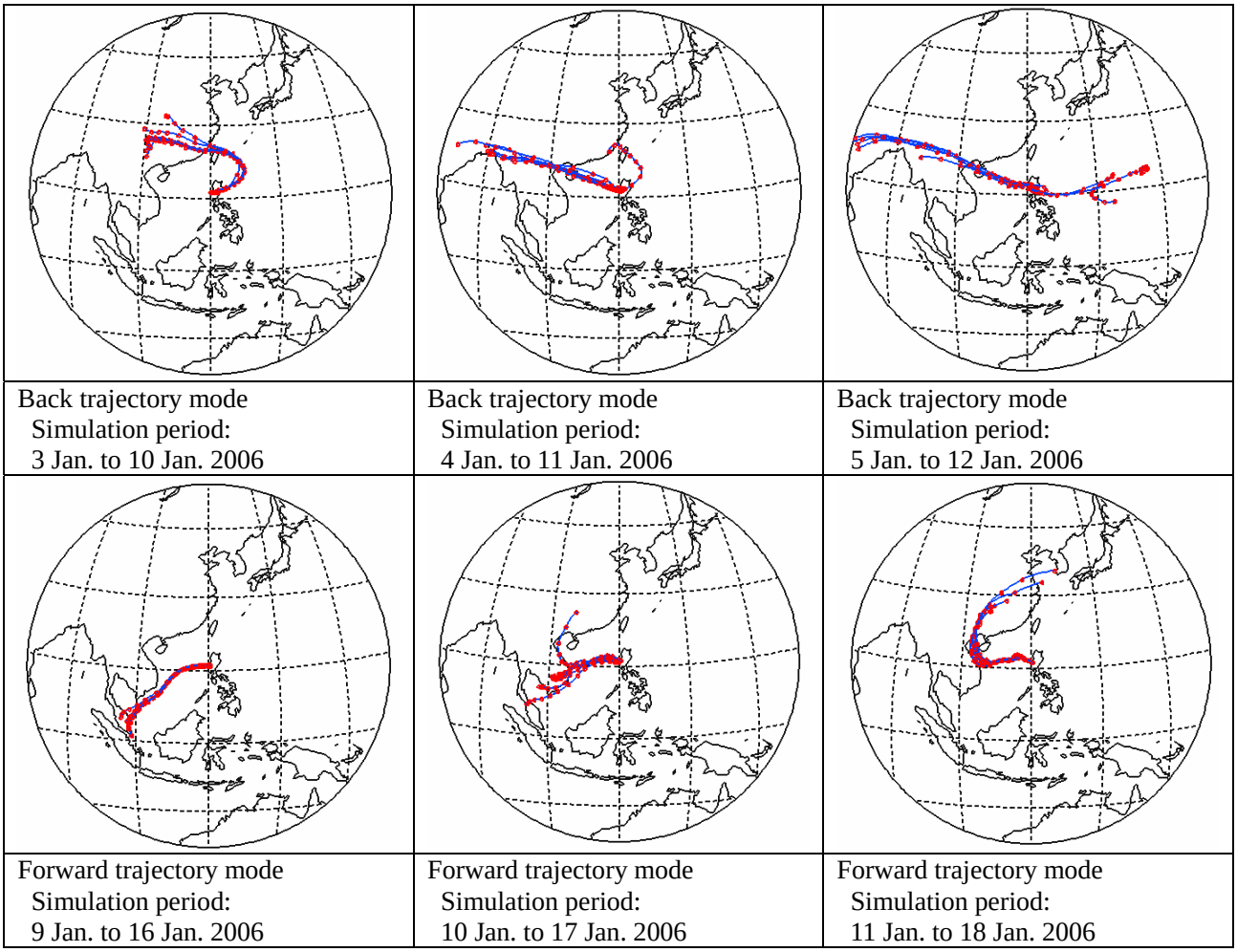


Figure 27 Trajectory Analysis of Ambient Air Collected in Bagio, Philippines on 9–12 January 2006.

These results of back and forward trajectory analyses indicated the possibilities of the long-rage transportation of POPs. When the height data was high, the transport speed of POPs in the air was relatively fast and long-range or trans-border transportation of POPs were possibly assumed at back trajectory mode and affected to far distant leeward. The less reliability of more than 3 day before or after of the trajectory data should be noticed.

4.6 POPs Concentrations in Ambient Air Samples in Thailand in 2006

1) Ownership of Data and a Person in Charge

Thailand
Ms. Nuchida Rungthawornwong, Environmental Officer, Waste and Hazardous Substance Management Bureau, Pollution Control Department, Ministry of Natural Resources and Environment"

2) Air Monitoring Data in 2006

a) Sampling Location

This sampling site is located about 70 km north of Bangkok (see **Figure 18**)
- Ayutthaya, Thailand
- Latitude: N14°21.3' Logitude: E100°21.3'
- Above sea level: 300m

This sampling site, Ayutthaya, is located in the flat river plain of the Chao Phraya River valley making the province a major rice farming area. Ayutthaya covers the area of 2,556.6 km^2 and there are 727,277 inhabitants. The population density is 284 inhabitants/km^2. The sampling site is located in town surrounded by tourist attractions. The micro meteorological information is available such as temperature, humidity, wind direction, and wind velocity as it is a permanent air sampling station. The electric supply is generally stable.

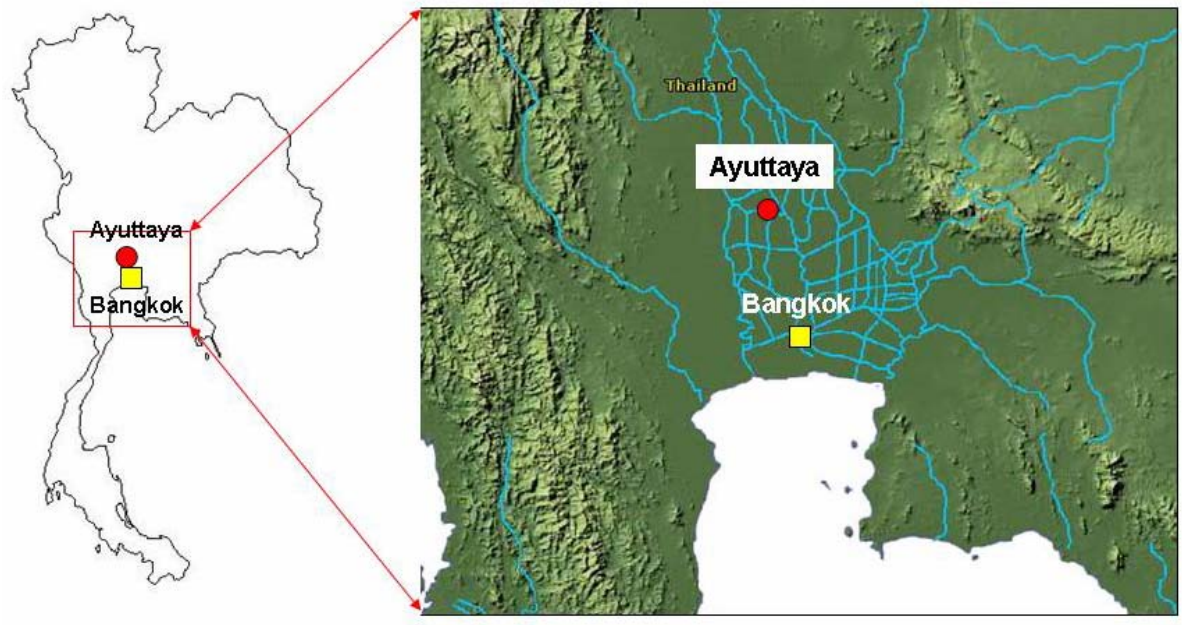


Figure 18 Map of Sampling Location in Thailand in 2006

b) Sampling Records and Meteorological Information

Air sampling records are summarized in **Table 19** and meteorological information is shown in **Table 20.**

Table 19 Sampling Record in Ayutthaya, Thailand

		17 - 18 January 2006 (1st day)		18 - 19 January 2006 (2nd day)		19 - 20 January 2006 (3rd day)	
Sampler No.*1		A	B	A	B	A	B
Sampling time	Start	12:46	12:46	13:59	13:59	14:58	14:58
	End	12:46	12:46	13:59	13:59	14:58	14:58
Temperature (DegC)	Start	36.9	37.4	36.1	37.6	34.1	34.1
	End	34.5	35.6	36.5	37.4	32.8	32.8
Atmospheric Pressure (hPa)	Start	1022.1	1016.8	1020.2	1013.2	1018.9	1013.8
	End	1021.5	1016.2	1019.6	1015	1018.9	1013.2
Weather	Start	fine	fine	fine	fine	fine	fine
	End	fine	fine	fine	fine	fine	fine
Flow Rate (L/min)		700	700	700	700	700	700
Sampling Volume (m^3)		1008.6	1008.4	1007.9	1007.9	1007.9	1007.9

*1: Both A and B is HV-1000F.

Table 20 Meteorological Information Observed in Ayutthaya Observing Station

	2006/1/17 13:00 to 1/18 13:00		2006/1/18 13:00 to 1/19 13:00		2006/1/19 13:00 to 1/20 13:00	
Avergage temp. (DegC)	26.2		26.2		25.5	
Avergage RH (DegC)	75.3		74.2		67.1	
Wind direction Wind velocity	Wind direction	Wind velocity (m/s)	Wind direction	Wind velocity (m/s)	Wind direction	Wind velocity (m/s)
13:00	S	1.3	S	1.8	S	1.8
19:00	S	1.4	S	1.4	S	1
1:00	S	1.4	SE	0.9	SE	0.9
7:00	S	1.7	S	0.9	S	2

c) Results of HRGC/MS Analysis

Concentrations of POPs in ambient air collected by duplicate sampling are shown in **Table 21.** These concentrations were determined according to Monitoring Surveillance Manual for POPs and Their Related Compounds (2006).

Table 21 Concentrations of POPs in Ambient Air in Ayutthaya, Thailand on 17-20 January 2006.

Chemicals	Sample A (pg/m^3)				Sample B (pg/m^3)				Average (pg/m^3)			
	1st day	2nd day	3rd day	Average	1st day	2nd day	3rd day	Average	1st day	2nd day	3rd day	Average
HCB	*460*	*320*	*250*	*343*	*450*	*350*	*270*	*310*	*460*	*340*	*260*	*330*
Aldrin	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Dieldrin	35	40	31	35	36	32	40	36	36	36	36	36
Endrin	1.4	0.93	0.79	1.0	1.3	0.76	0.91	0.84	1.4	0.85	0.85	0.94
p,p'-DDT	23	24	19	22	23	21	24	23	23	23	21.5	22
p,p'-DDE	16	15	12	14	16	12	15	14	16	14	13.5	14
p,p'-DDD	2.4	2.5	2.1	2.3	2.2	1.8	2.3	2.1	2.3	2.15	2.2	2.2
o,p'-DDT	7.1	7.7	5.8	6.9	7.5	6.1	7.8	7.0	7.3	6.9	6.8	6.9
o,p'-DDE	4.0	2.9	2.0	3.0	4.1	2.1	2.9	2.5	4.1	2.5	2.5	2.7
o,p'-DDD	0.92	1.1	0.74	0.92	0.98	0.78	1.2	1.0	0.95	0.9	1.0	1.0
trans-Chlordane	47	48	37	44	50	38	52	45	49	43	45	45
cis-Chlordane	28	29	22	26	30	23	31	27	29	26	27	27
trans-Nonachlor	21	20	16	19	22	17	22	20	22	19	19	19
cis-Nonachlor	3.7	3.4	2.6	3.2	3.4	2.6	3.6	3.1	3.6	3.0	3.1	3.2
Oxychlordane	1.9	1.9	1.3	1.7	1.8	1.5	1.7	1.6	1.9	1.7	1.5	1.7
Heptachlor	19	25	21	22	21	27	23	25	20	26	22	23
trans-Heptachlorepoxide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
cis-Heptachlorepoxide	2.5	2.7	2.3	2.5	2.6	2.1	2.9	2.5	2.6	2.4	2.6	2.5
Mirex	1.7	1.7	1.6	1.7	1.8	1.7	2.0	1.9	1.8	1.7	1.8	1.8
Toxaphene (Parlar-26)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toxaphene (Parlar-50)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toxaphene (Parlar-62)	<14	<14	<14	<14	<14	<14	<14	<14	<14	<14	<14	<14

italic letter.: reference value because surrogate recovery was out of 40 to 120 percent.
n.a.: not available because surrogate recovery was out of 25 to 150 percent.
Values in parenthesis show that it was within IDL to IQL.

d) Results of Trajectory Analysis

To speculate the source of POPs in the collected air, trajectory analysis of the collected air was performed using the METEX programs. NCEP reanalysis dataset and 3D-wind model in METEX programs were used for the trajectory analysis. With reference to vertical coordinate in the 3D-wind model, the sigma coordinate was used for trajectory calculation in both forward and backward mode. The results of analysis showed in **Figure 19**.

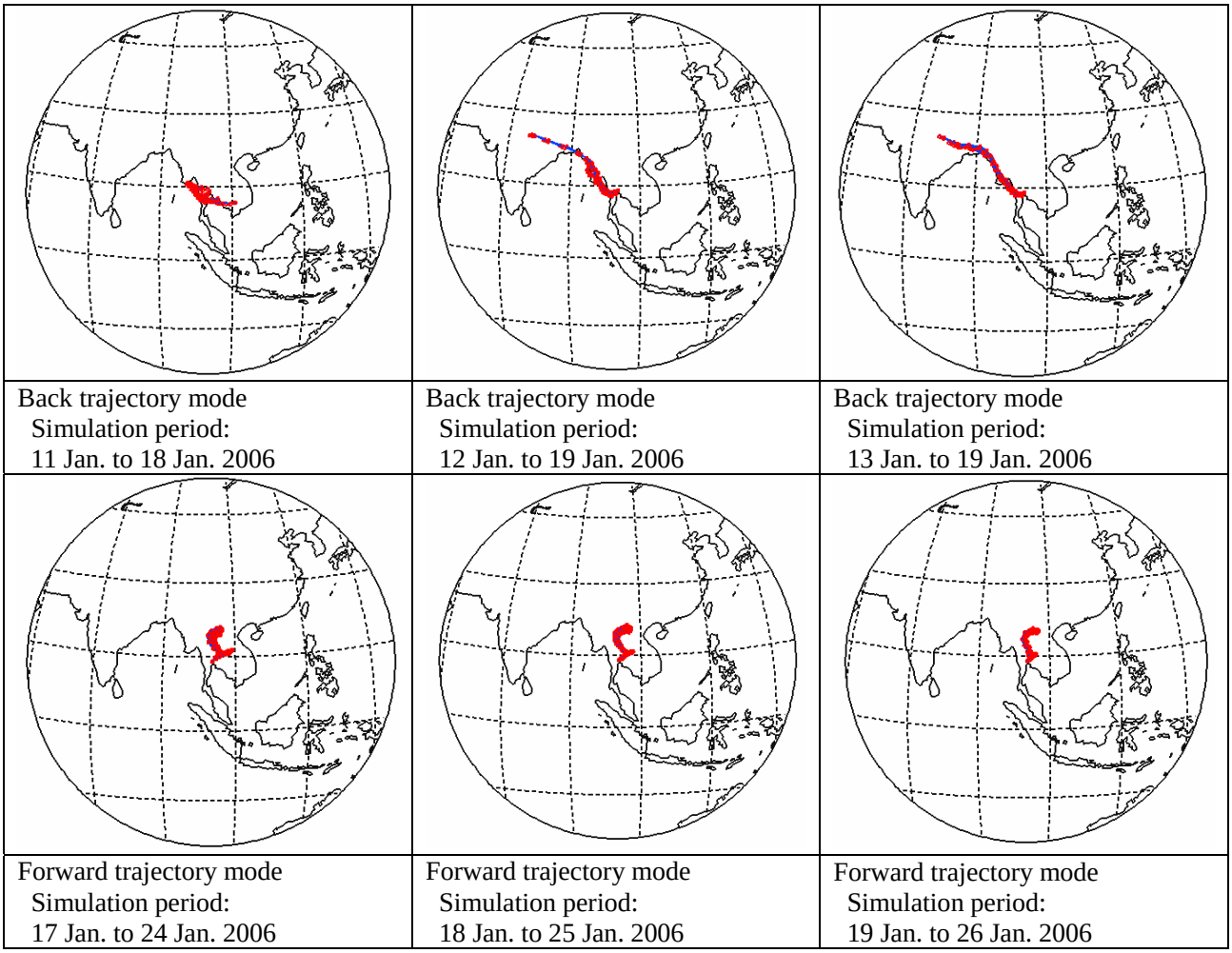


Figure 19 Trajectory Analysis of Ambient Air Collected in Ayutthaya, Thailand on 17-20 January 2006.

These results of back and forward trajectory analyses indicated the possibilities of the long-rage transportation of POPs. When the height data was high, the transport speed of POPs in the air was relatively fast and long-range or trans-border transportation of POPs were possibly assumed at back trajectory mode and affected to far distant leeward. The less reliability of more than 3 day before or after of the trajectory data should be noticed.

e) Issues in This Sampling and in the Future

- The sampling site, Ayutthaya is located about 70 km north of Bangkok, the Capitol of Thailand in this research. The sampling point was usually used as an environmental monitoring center of Thailand and located in the area of Elementary School. The car traffic road was surrounding this point, however the density of the traffic was relatively few.

The monitoring results of chlordanes might be caused by the vaporization from the old wooden houses surrounding the sampling point.

4.7 POPs Concentrations in Ambient Air Samples in Socialist Republic of Vietnam

1) Ownership of Data and a Person in Charge

Vietnam
Prof., Dr. Pham Hung Viet, Director of Centre of Environmental Technology and Sustainable Development (CETASD), Hanoi University of Science, Vietnam National University

2) Sampling Location

<2005>
This sampling site is located about 50 km north of Hanoi (see **Figure 20**).
- Green World Hotel, Khu Du Lich Tam Dao, VinH Phuc, Vietnam
- Latitude: N 21° 27.220’ Longitude: E 105° 38.714’:
- Above sea level: approximately 950 m (Above ground level: 8 m)

<2006>
This sampling site is located about 50 km north of Hanoi (see **Figure 20**). The sampling site is available micro meteorological information because there is Tam Dao observing station now.
- Rooftop of Green Hotel, Khu Du Lich Tam Dao, VinH Phuc, VIETNAM
- Latitude: N 21° 27.492 ’ Logitude: E 105° 38.741 ’
- Above Sea Level: 934m (above ground level: 20m)

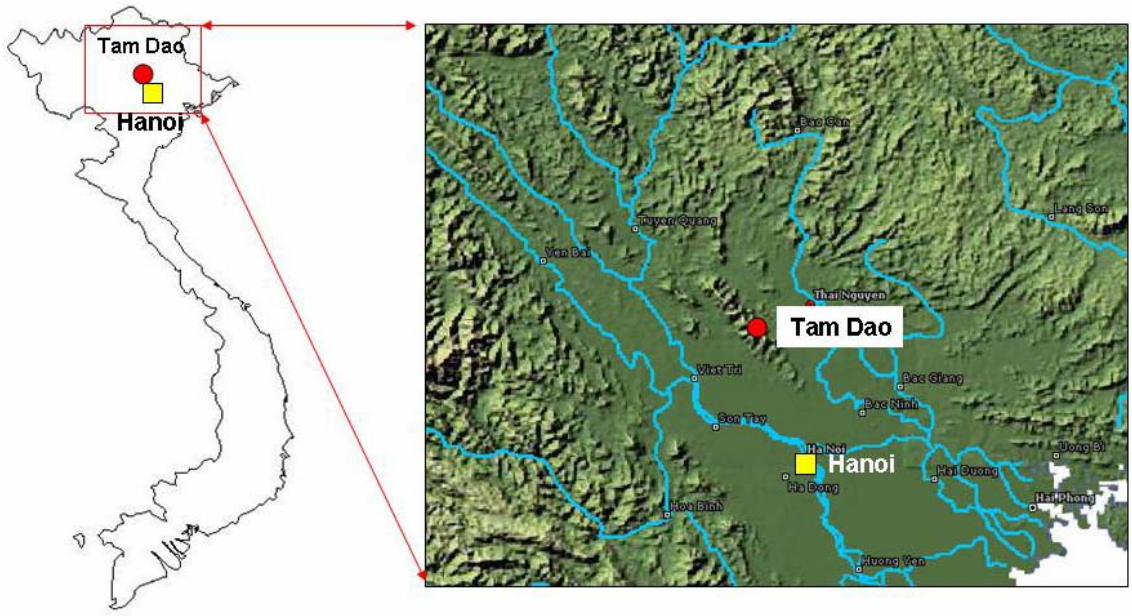


Figure 20 Map of Sampling Location in Vietnam in 2005

3) Air Monitoring Data in 2005

a) Sampling Records

Air sampling records are summarized in **Table 22**

Table 22 Air Sampling Record in Tam Dao, Vietnam

		7 - 8 March 2005 (1st day)		8 - 9 March 2005 (2nd day)		9- 10 March 2005 (3rd day)	
Sampler No.[*1]		A	B	A	B	A	B
Sampling time	Start	19:00	19:03	19:52	20:00	20:33	20:41
	End	19:00	19:03	19:52	20:00	21:20[*2]	21:27[*2]
Temperature (DegC)	Start	15	14.8	16.6	16.2	18	18.3
	End	16.7	16.3	19.2	18.6	22.5	24.2
Atmospheric pressure (hPa)	Start	913.2	912.7	909.4	908.9	906.2	905.7
	End	908.8	908.2	906.2	905.7	903.6	900.6
Weather	Start	foggy	foggy	foggy	foggy	foggy	foggy
	End	cloudy	cloudy	foggy	foggy	foggy	foggy
Flow rate (L/min)		700	700	700	700	700	700
Sampling Volume (m^3)		1007.8	1007.8	1007.9	1007.7	1008.3	1008.7

*1: Both A and B is HV-7000F.

*2: End time of sampling was delayed because electric supply had stopped and had not restarted automatically until about 17:00

b) Results of HRGC/MS Analysis

Concentrations of POPs in ambient air samples collected by duplicate sampling were shown in **Table 23** The concentrations were determined according to Monitoring Surveillance Manual for POPs and Their Related Compounds (2006).

Table 23 Concentrations of POPs in Ambient Air in Tam Dao, Vietnam on 7-10 March 2005.

Chemicals	Sample A		Sample B		Average	
	Conc. (pg/m^3)	Recovery (%)	Conc. (pg/m^3)	Recovery (%)	Conc. (pg/m^3)	Recovery (%)
HCB	91	69	94	69	92	69
Aldrin	0.14	4.1	0.083	2.9	0.11	3.5
Dieldrin	1.2	52	1	71	1.1	61
Endrin	n.d.	44	n.d.	73	n.d.	59
p,p'-DDT	29	68	12	90	21	79
p,p'-DDE	12	65	11	59	11	62
p,p'-DDD	3.7	68	2.1	85	2.9	76
o,p'-DDT	39	60	30	79	35	69
o,p'-DDE	6.2	57	5.5	60	5.8	59
o,p'-DDD	13	68	1.3	85	7.1	76
trans-Chlordane	3.0	83	2.6	79	2.8	81
cis-Chlordane	2.2		2.0		2.1	
trans-Nonachlor	1.8	81	1.5	83	1.7	82
cis-Nonachlor	0.42	53	0.34	69	0.38	61
Oxychlordane	n.d.	74	n.d.	84	n.d.	79
Heptachlor	0.76	75	0.80	79	0.78	77
trans-Hepachlorepoxide	n.d.	66	n.d.	77	n.d.	71
cis-Hepachlorepoxide	0.42		0.39		0.40	
Mirex	0.42	45	0.20	57	0.31	51
Toxaphene (Parlar-26)	n.d.	48	n.d.	51	n.d.	50
Toxaphene (Parlar-50)	n.d.		n.d.		n.d.	

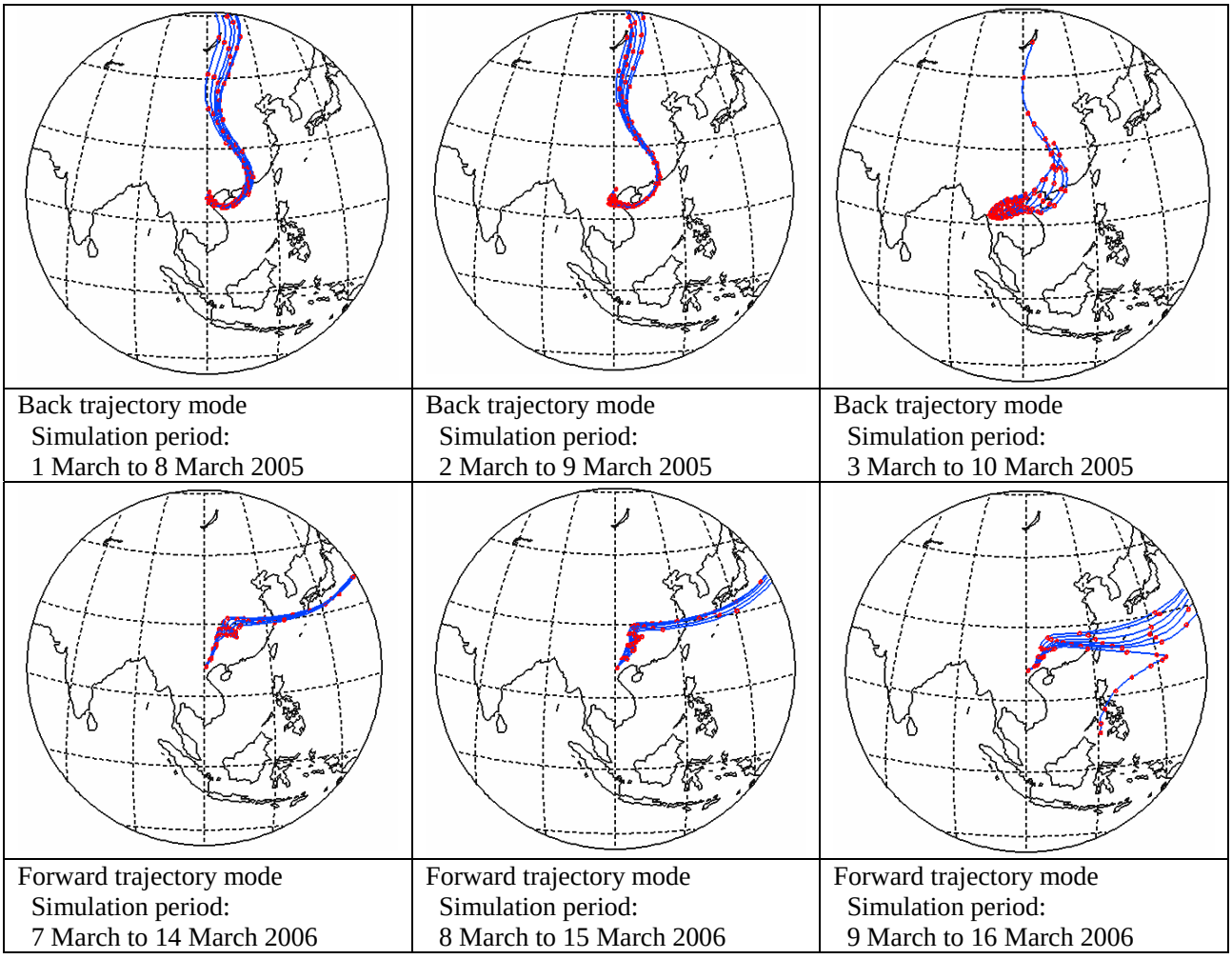
italic letter.: reference value because surrogate recovery was out of 40 to 120 percent.

n.a.: not available because surrogate recovery was out of 25 to 150 percent.

Values in parenthesis show that it was within IDL to IQL.

c) Results of Trajectory Analysis

To speculate the source of POPs in the collected air, trajectory analysis of the collected air was performed using the Meteorological Data Explorer (METEX), developed by Jiye Zeng at the Centre for Global Environmental Research (CGER). National Centers for Environmental Prediction (NCEP) reanalysis dataset and 3D-wind model in METEX programs was used for the trajectory analysis. With reference to vertical coordinate in the 3D-wind model, the sigma coordinate was used for trajectory calculation in both forward and backward mode. The results of analysis showed in **Figure 21**.



Back trajectory mode Simulation period: 1 March to 8 March 2005	Back trajectory mode Simulation period: 2 March to 9 March 2005	Back trajectory mode Simulation period: 3 March to 10 March 2005
Forward trajectory mode Simulation period: 7 March to 14 March 2006	Forward trajectory mode Simulation period: 8 March to 15 March 2006	Forward trajectory mode Simulation period: 9 March to 16 March 2006

Figure 21 Trajectory Analysis of Ambient Air Collected in Tam Dao, Vietnam on 7-10 March 2005.

These results of back and forward trajectory analyses indicated the possibilities of the long-rage transportation of POPs. When the height data was high, the transport speed of POPs in the air was relatively fast and long-range or trans-border transportation of POPs were possibly assumed at back trajectory mode and affected to far distant leeward. The less reliability of more than 3 day before or after of the trajectory data should be noticed.

d) Issues in This Sampling and in the Future

- It is of concern that the transformers and capacitors have a high possibility of becoming PCB hot spots because a great number of those in Tam Dao were decrepit.
- There is a problem securing a power supply to run the HV air sampler in the background location.
- In fact, the power supply was cut off in the primary sampling point (small hotel) and the HV air sampler stopped. Therefore, the sampling point was changed to another hotel with a private electric generator. However, the power supply was cut off in the hotel again and then the HV did not restart automatically.
- It is reasonable to expect that the electric power will not be supplied stably, especially in the background areas in developing countries. Therefore, it is considered that we should show local researchers the stance that unless we regularly monitor the equipment's running status during the sampling term except for during the lunch hour, at night, and at meal times, we cannot be confident of the actual operating results of the HV sampling.
- The HV air sampler used in this monitoring can be restarted automatically when the electric supply stops.

However, the equipment was not restarted automatically when the electric supply failed in this monitoring in Vietnam. We guessed that it had some relation with not reverting automatically to transform from 100V to 220V because the model which was brought and used in this monitoring was made in Japan. On this matter, we got the following answer from the manufacturer which made the sampler: The reason is not the transformer connected to the sampler because the export model for foreign countries only has a miniature transformer connected to the model. According to the manufacturer, a similar case was reported in China. Therefore, the controller with the sampler might not recognize an electric power failure because the degree of the voltage decline in developing countries is different to the rapid voltage decline that occurs due to a blackout in Japan. There is no solution to the problem with the machine at present. We are waiting for confirmation of the phenomenon and then improvement on the manufacturer's side.

- As for the sampling point in a background area, it is desirable that the power supply is steady wherever possible and that new types of transformers and capacitors which do not include PCBs are installed for avoiding the contamination from hot spots.
- From now on, it is important that related concrete information such as photographs of the sampling location is collected on the expected area as background study before a trainer visits the field from Japan.

4) Air Monitoring Data in 2006

a) Sampling Records and Meteorological Information

Air sampling records are summarized in **Table 24** and meteorological information shows in **Table 25.**

Table 24 Sampling Record in Tam Dao, Vietnam.

		24 - 25 February 2006 (1st day)		25 - 26 February 2006 (2nd day)		26 - 27 February 2006 (3rd day)	
Sampler No.[*1]		A	B	A	B	A	B
Sampling time	Start	7:40	7:46	8:26	8:32	8:56	9:12
	End	7:40	7:46	8:31[*2]	8:32	8:56	9:12
Temperature (DegC)	Start	13.9	14.8	15.7	15.4	16	15.8
	End	15.3	16.3	15.5	15.2	15.8	15.3
Atmospheric Pressure (hPa)	Start	910.7	912.7	907.5	906.3	906.8	905.7
	End	907.5	908.2	906.8	905.7	905.6	904.4
Weather	Start	foggy	foggy	foggy	foggy	foggy	foggy
	End	foggy	foggy	foggy	foggy	foggy	foggy
Flow Rate (L/min)		700	700	700	700	700	700
Sampling Volume		1007.9	1007.7	1012.5	1008.1	1007.9	1008

*1: Both A and B is HV-700F.

*2: HV sampler stopped at 5 min after the beginning of sampling but was immediately restarted.

Table 25 Meteorological Information Observed in Tam Dao Observing Station

	2006/2/24 7:00 to 2/25 7:00		2006/2/25 7:00 to 2/26 7:00		2006/2/26 7:00 to 2/27 7:00	
Avergage temp. (DegC)	11.9		12.1		12.3	
Avergage RH (DegC)	100		100		100	
Precipitation (mm)	4		4		7	
Wind direction Wind velocity	Wind direction	Wind velocity	Wind direction	Wind velocity	Wind direction	Wind velocity
7:00	NE	3	S	1	S	2
13:00		0	SE	1		0
18:00	SE	4	SE	2	E	2
1:00	NE	6	SW	1	E	3

b) Results of HRGC/MS Analysis

Concentrations of POPs in ambient air collected by duplicate sampling are shown in **Table 26.** These concentrations were determined according to Monitoring Surveillance Manual for POPs and Their Related Compounds (2006).

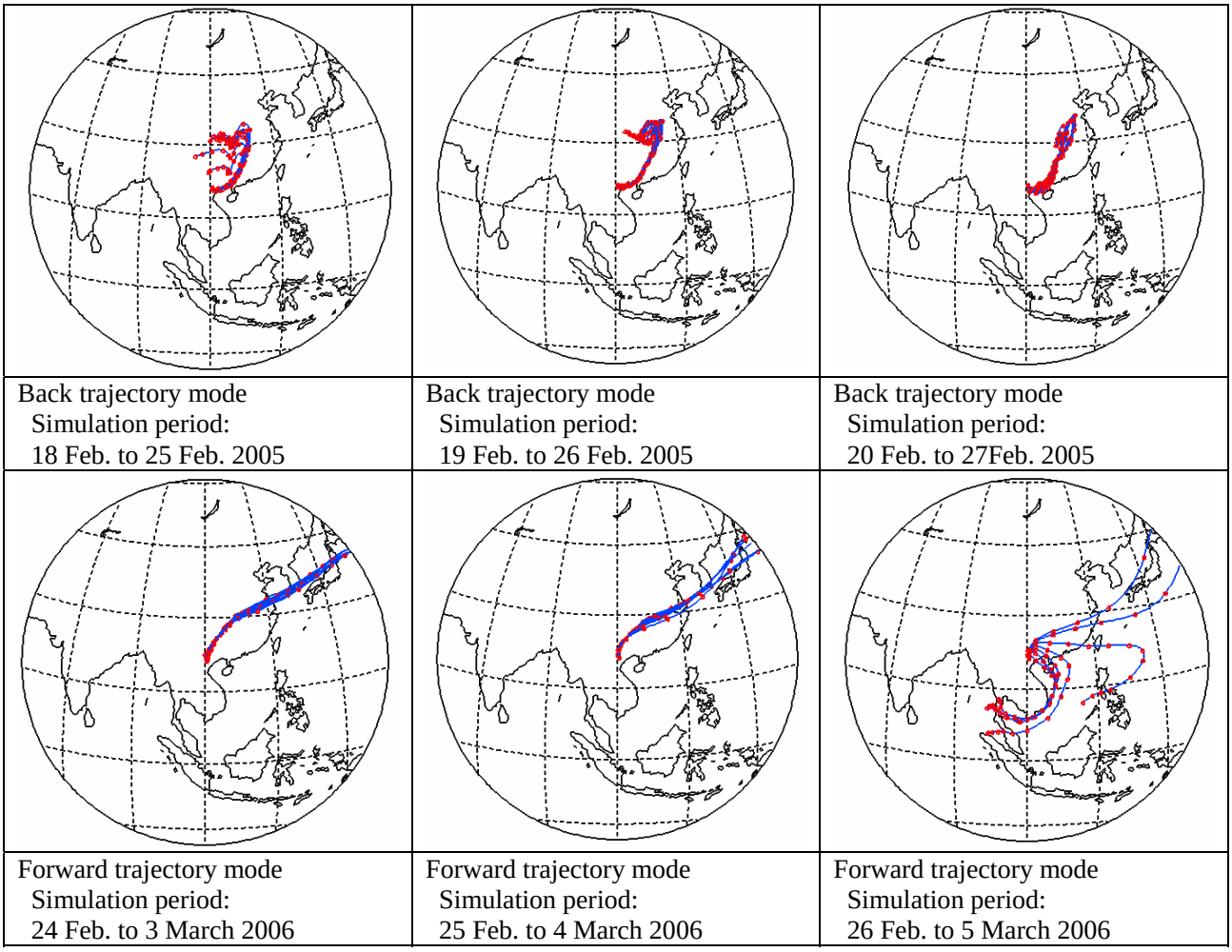
Table 26 Concentrations of POPs in Ambient Air in Tam Dao, Vietnam on 24-27 February 2006.

Chemicals	Sample A (pg/m^3)				Sample B (pg/m^3)				Average (pg/m^3)			
	1st day	2nd day	3rd day	Average	1st day	2nd day	3rd day	Average	1st day	2nd day	3rd day	Average
HCB	380	330	320	340	370	330	320	330	380	330	320	330
Aldrin	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Dieldrin	0.46	0.94	0.47	0.62	0.4	0.78	0.73	0.76	0.43	0.86	0.60	0.69
Endrin	*<0.1*	*<0.1*	<0.1	<0.1	*<0.1*	<0.1	<0.1	<0.1	*<0.1*	<0.1	<0.1	<0.1
p,p'-DDT	*16*	*15*	*18*	*16*	13	12	17	15	15	*14*	18	15
p,p'-DDE	16	13	15	15	13	12	13	13	15	13	14	14
p,p'-DDD	*2.7*	2.0	*3.7*	2.8	2.5	*1.9*	3.5	2.7	2.6	2.0	3.6	2.8
o,p'-DDT	*25*	*20*	*21*	*22*	23	*18*	20	19	24	*19*	21	21
o,p'-DDE	11	8.1	*8.7*	9.3	11	8.1	8.5	8.3	11	8.1	8.6	8.8
o,p'-DDD	2.0	1.7	*2.4*	2.0	1.9	*1.6*	2.1	1.9	2.0	1.7	2.3	1.9
trans-Chlordane	3.5	3.0	2.2	2.9	3.7	2.8	2.4	2.6	3.6	2.9	2.3	2.8
cis-Chlordane	2.9	2.4	1.8	2.4	3.1	2.3	2.0	2.2	3.0	2.4	1.9	2.3
trans-Nonachlor	1.0	0.92	0.67	0.86	1.2	0.90	0.73	0.82	1.1	0.91	0.70	0.84
cis-Nonachlor	0.08	0.05	0.05	0.06	0.13	0.04	0.07	0.05	0.11	0.04	0.06	0.06
Oxychlordane	0.28	0.23	0.21	0.24	0.22	(0.16)	0.23	0.20	0.25	0.20	0.22	0.22
Heptachlor	1.4	1.3	0.7	1.1	1.4	1.2	0.9	1.0	1.4	1.3	0.8	1.1
trans-Heptachlorepoxide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
cis-Heptachlorepoxide	0.31	0.29	0.28	0.29	0.33	0.29	0.29	0.29	0.32	0.29	0.29	0.29
Mirex	0.64	0.46	0.41	0.50	0.67	0.47	0.40	0.44	0.66	0.47	0.41	0.47
Toxaphene (Parlar-26)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toxaphene (Parlar-50)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toxaphene (Parlar-62)	<14	<14	<14	<14	<14	<14	<14	<14	<14	<14	<14	<14

italic letter.: reference value because surrogate recovery was out of 40 to 120 percent.
n.a.: not available because surrogate recovery was out of 25 to 150 percent.
Values in parenthesis show that it was within IDL to IQL.

c) Results of Trajectory Analysis

To speculate the source of POPs in the collected air, trajectory analysis of the collected air was performed using the METEX programs. NCEP reanalysis dataset and 3D-wind model in METEX programs were used for the trajectory analysis. With reference to vertical coordinate in the 3D-wind model, the sigma coordinate was used for trajectory calculation in both forward and backward mode. The results of analysis showed in **Figure 22**.



Back trajectory mode Simulation period: 18 Feb. to 25 Feb. 2005	Back trajectory mode Simulation period: 19 Feb. to 26 Feb. 2005	Back trajectory mode Simulation period: 20 Feb. to 27Feb. 2005
Forward trajectory mode Simulation period: 24 Feb. to 3 March 2006	Forward trajectory mode Simulation period: 25 Feb. to 4 March 2006	Forward trajectory mode Simulation period: 26 Feb. to 5 March 2006

Figure 22 Trajectory Analysis of Ambient Air Collected in Tam Dao, Vietnam on 24 - 27 February 2006.

These results of back and forward trajectory analyses indicated the possibilities of the long-rage transportation of POPs. When the height data was high, the transport speed of POPs in the air was relatively fast and long-range or trans-border transportation of POPs were possibly assumed at back trajectory mode and affected to far distant leeward. The less reliability of more than 3 day before or after of the trajectory data should be noticed.

d) Issues in This Sampling and in the Future

- The hotel where was installed HV air samplers in last research was exchanged to new neighboring hotel in this research because the new hotel is more stable for electric supply and more multistory than the hotel installed air samplers in last research.
- In this research, we sent materials such as polyurethane foam, quarts fibre filter, and activated carbon fibre felt from Japan to Vietnam. The air sampling with these matters was conducted by some researchers in Hanoi University. However, it required about one month until they had received these materials in order to procedure for tax free import. These materials had left to stand in airport during the procedure. Because this case might be caused the contamination of POPs, we need to take care for timing of their transportation.