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Mercury Projects in Japan Relating to F&T Activities

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Outline

- General issues of mercury program in Japan relating to F&T activities
- Mercury monitoring as hazardous air pollutants
- Monitoring project at Cape Hedo
- Multimedia modeling
- Additional trials
  - Gridded emission inventory of Japan by 1x1 km resolution
  - Trial monitoring at additional Shizuoka (urban area)

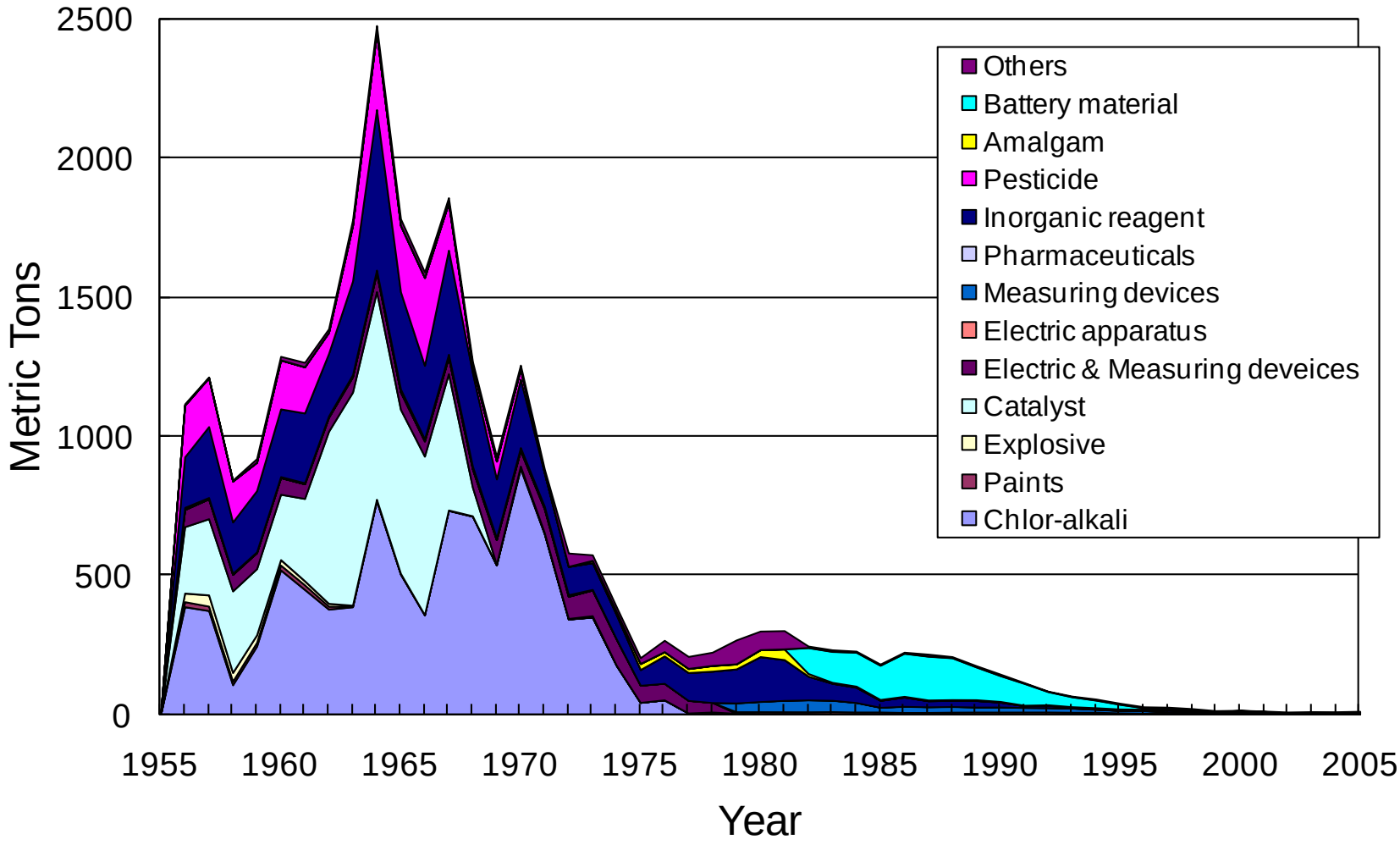
GENERAL ISSUES OF MERCURY PROGRAM IN JAPAN RELATING TO F&T ACTIVITIES

History of Mercury Reduction Efforts in Japan

1968	• Government announced that Minamata disease was caused by methylmercury – starting point of environmental administration in Japan
1960-70	• VCM manufacturing process using mercuric catalyst was converted to the mercury free processes.
1973	• Stop production of mercurochrome • Use of all mercuric pesticides was banned
1974	• No mercury mining since the closure of the mine in Hokkaido
1978	• National Institute for Minamata Disease (NIMD) founded
1986	• No mercury process in Chlor-Alkali plants in Japan (replaced mainly by ion-exchange membrane method) • Japan Waste Management Association set up the nationwide collection system for waste dry batteries • MHWL issued a guidance to municipalities on separating batteries in waste collection and recovery of mercury
1991	• Mercury free completed in manganese battery
1992	• Mercury free completed in alkaline battery
1995	• Stop production of mercury battery
1999	• Japan Waste Management Association started a collaborative collection and recovery initiative for fluorescent lumps

Mercury Use in Japan

- Japan has made considerable efforts to minimize mercury use in various products and manufacturing processes.



Atmospheric emissions of mercury in Japan (2005)

No	Category	Atmospheric mercury emissions (ton/year)
1	Stationary combustion	3.1
2	Non-ferrous metals production	0.52～4.6
3	Pig iron and crude steel production	3.3
4	Cement production	8.9
5	Gold production	-
6	Mercury production (primary sources)	-
7	Incineration of municipal wastes	1.6～5.6
8	Caustic soda production	-
9	Other sources	3.4～3.6
Total		20.8～29.1

Environmental quality standards for mercury

	Application	Standard quality	Related law
Ambient air	Atmosphere (Guideline value)	• 40 ng/m^3 (mercury and its compounds)	Air Pollution Control Law (Law No. 97 of 1968) Guideline for hazardous air pollutants (2003)
Water body	Public waters (Environmental standard for protecting human health)	• <0.0005 mg/L (total mercury) • Not detectable (alkyl mercury)	The Basic Environment Law (Law No. 91 of 1993) Water Pollution Control Law (Law No. 138 of 1970)
	Ground water	• <0.0005 mg/L (total mercury) • Not detectable (alkyl mercury)	Law concerning amendment of Water Pollution Control Law (Law No. 58 of 1996)
Soil	(Environmental quality standard)	• <0.0005 mg/L (total mercury) • Not detectable (alkyl mercury)	Environmental Quality Standards for Soil Pollution (Issued No. 46 of 1991)
Sediment	Lake and river	• 25 mg/Kg (Removal standard)	Provisional Removal Standards for Sediment (Notification No.119 of 1975)

Advice for Pregnant Women on Fish Consumption and Mercury Ministry of Health, Labour and Welfare (2005)

- Recommendations for pregnant women to select and eat fish and shellfish

Recommended amount (muscle)	Fish and shellfish
Up to about 80 grams (average 1 meal) per 2 months (10 grams/week)	Bottlenose dolphin
Up to about 80 grams (1 meal) per 2 weeks (40 grams/week)	Short-finned pilot whale
Up to 80 grams (1 meal) per week*1 (80 grams/week)	Alfonsino, Swordfish, Bluefin tuna ,Bigeye tuna, Finely-striate buccinum, Baird' beaked whale, Sperm whale
Up to 160 grams (average 2 meals) per week*1 (160 grams/week)	Yellowback seabream, Marlin, Hilgendorf saucord, Southern bluefin tuna, Blue shark, Dall's porpoise

Note 1: Other tuna species not on the list and canned tuna have no particular restriction.
Note 2: The average weight of fish and shellfish according to consumption-form:
Sushi and sashimi 1 unit: 15 g; Sashimi 1 serving: 80 g; Fish cutlet 1 serving: 80 g

MHLW expects that this advice will gain proper understanding so that it will not lead to the reduced consumption of fish and shellfish or the spread of harmful rumor.

MERCURY MONITORING AS HAZARDOUS AIR POLLUTANTS

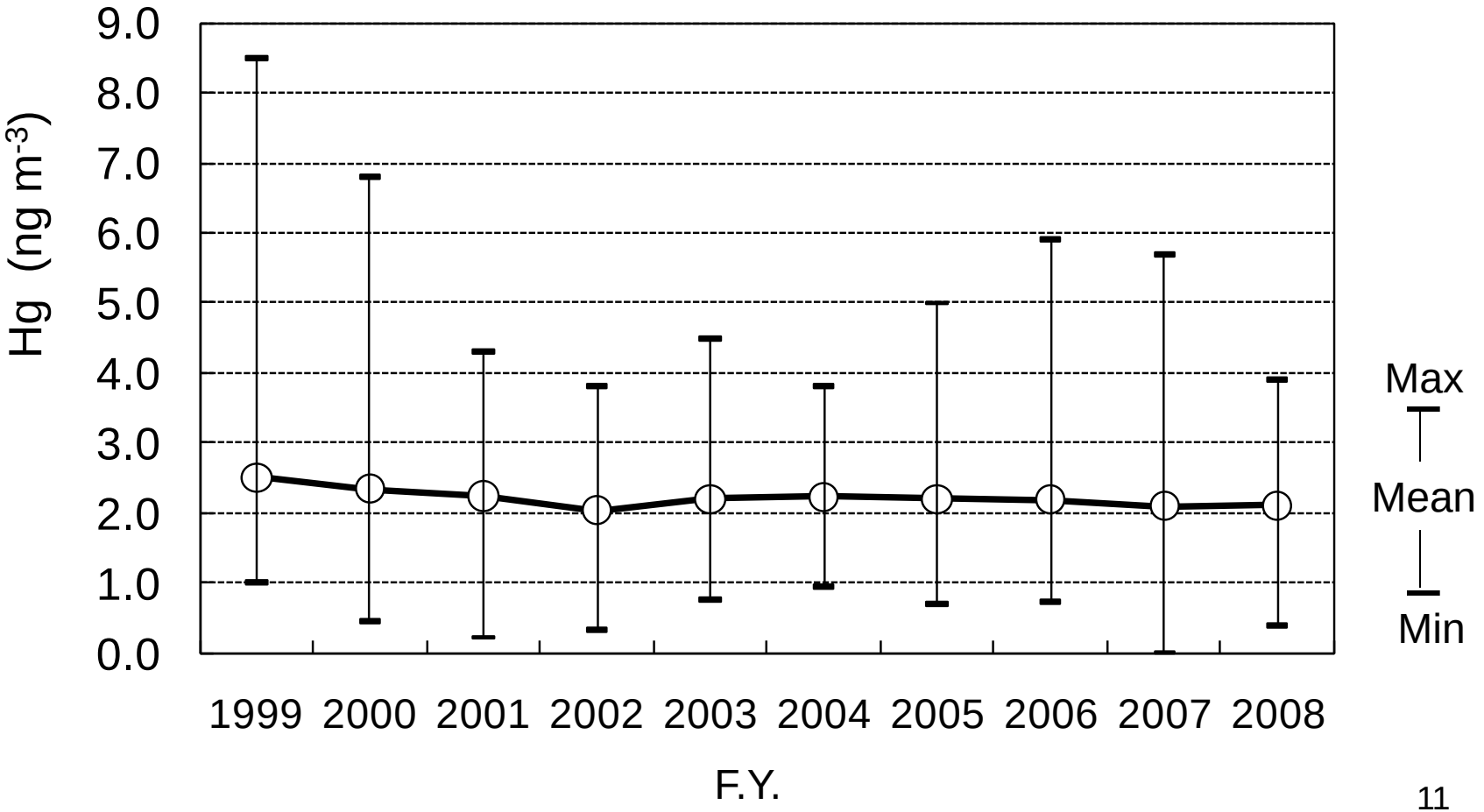
Mercury monitoring as hazardous air pollutants

- Ambient air monitoring by MOEJ and Municipalities
  - There are three types of monitoring stations:
    1) Ambient air pollution monitoring station
    2) Stationary source monitoring station
    3) Roadside air pollution monitoring station
  - Mercury data of about 200 ambinet air monitoring stations from F.Y.1999 to 2008 are used in this overview.
- Analytical and sampling method
  - Gold amalgamation with Cold Vapor Atomic Absorption Spectrometry (CVAAS)

    - The manual for the measurement methods for hazardous air pollutants, Ministry of the Environment, Japan (March, 1999)

Overview of ambient mercury levels in Japan

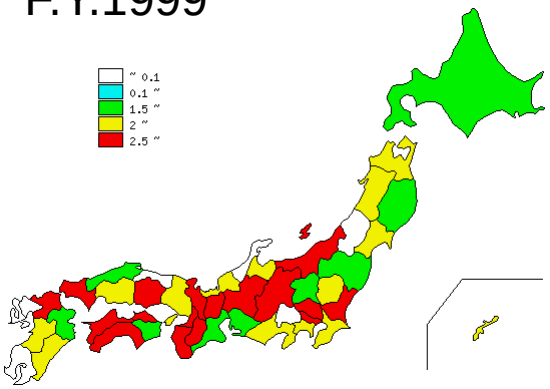
- Yearly trend of annual average concentration of gaseous mercury in Japan



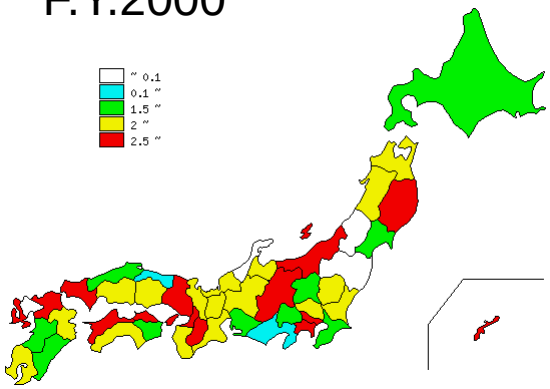
Distribution of ambient mercury concentration

summarized by prefecture (1)

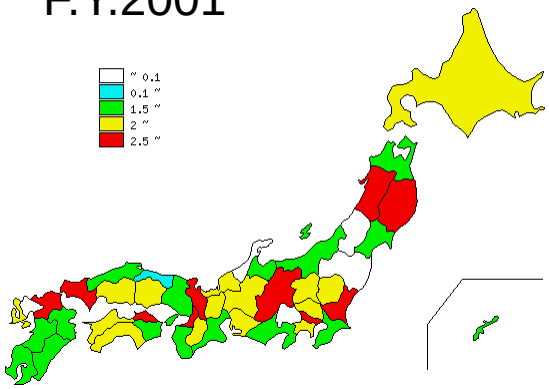
F.Y.1999



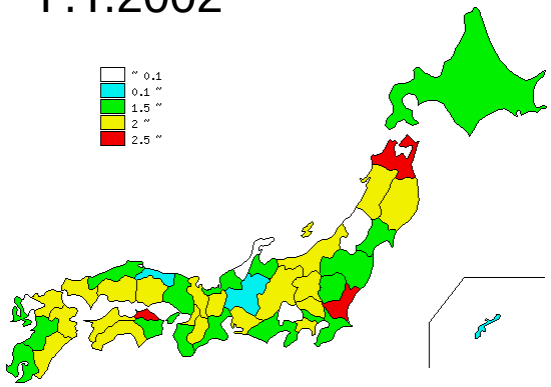
F.Y.2000



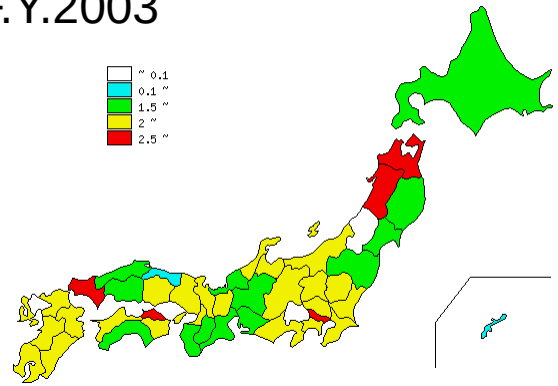
F.Y.2001



F.Y.2002



F.Y.2003



ng m^{-3}

No data

~ 1.5

1.5~ 2.0

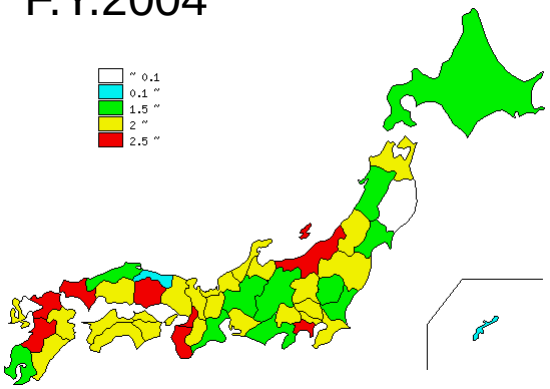
2.0~ 2.5

2.5~

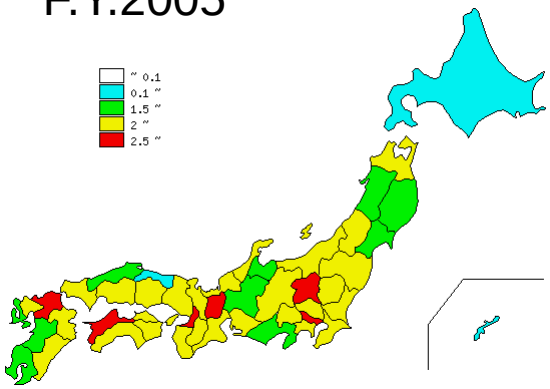
Distribution of ambient mercury concentration

summarized by prefecture (2)

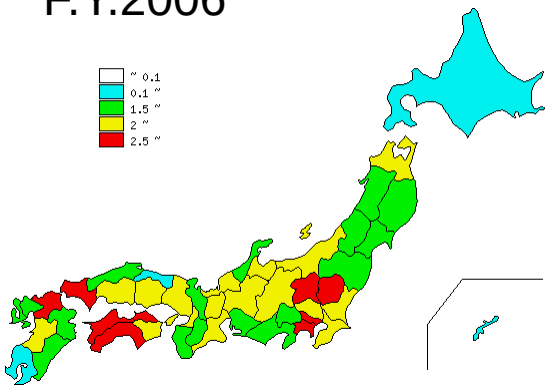
F.Y.2004



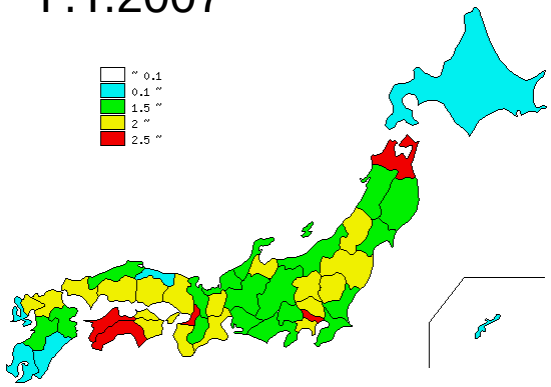
F.Y.2005



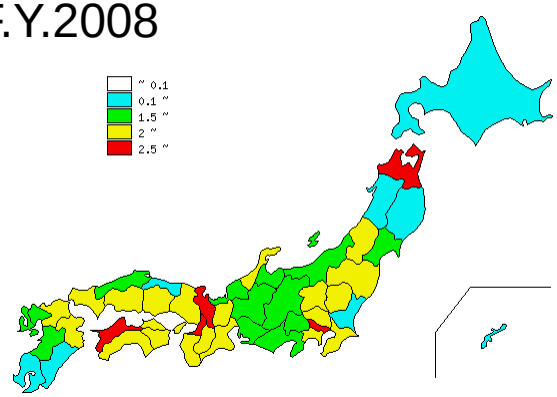
F.Y.2006

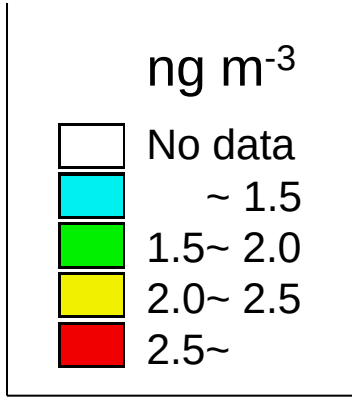


F.Y.2007



F.Y.2008





Summary of ambient air monitoring

- General observations
  - Nearly constant trend of around 2 ng m^{-3} in national scale from 1999 to 2008
  - No apparent spatial distribution in prefecture scale
  - Higher level of around 2-3 ng m^{-3} in urban industrial areas, lower level of around 1-2 ng m^{-3} in other areas
- Possible implications
  - Contamination level is nearly constant in recent 10 years
  - Even background contamination over whole country
    - Significant but limited impact from local sources in large cities

MONITORING PROJECT AT CAPE HEDO

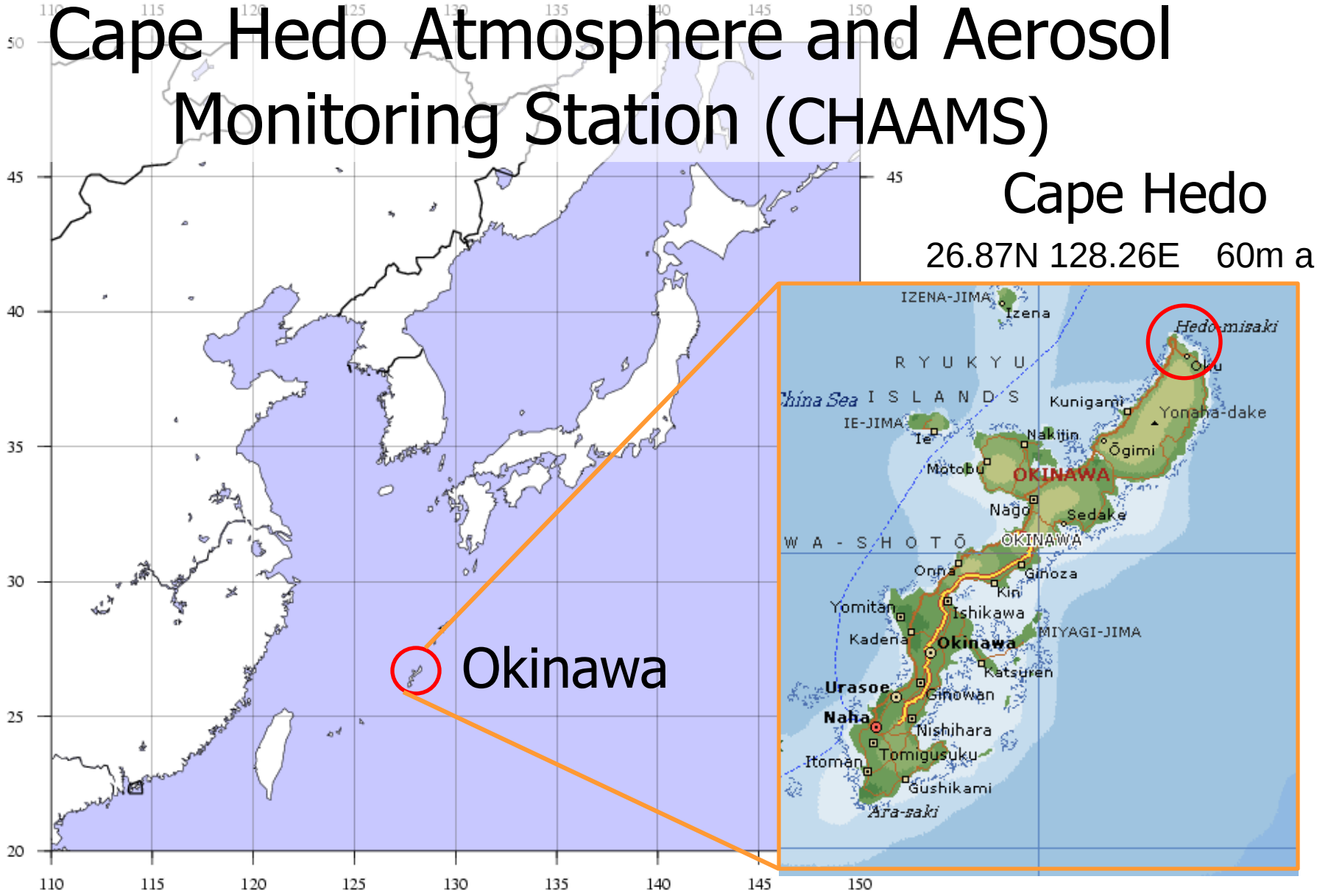
Pilot monitoring project for atmospheric mercury & other heavy metals in remote background area

by Ministry of the Environment, FY2006-2009

Objectives:

- Monitor current levels of mercury and other heavy metals in air, particles, and precipitation;
- Obtain useful information on the long-range transportation of trace elements in Asia-Pacific region;
- Develop monitoring Methodologies;
- Contribute to the international efforts in atmospheric monitoring

Cape Hedo Atmosphere and Aerosol Monitoring Station (CHAAMS)

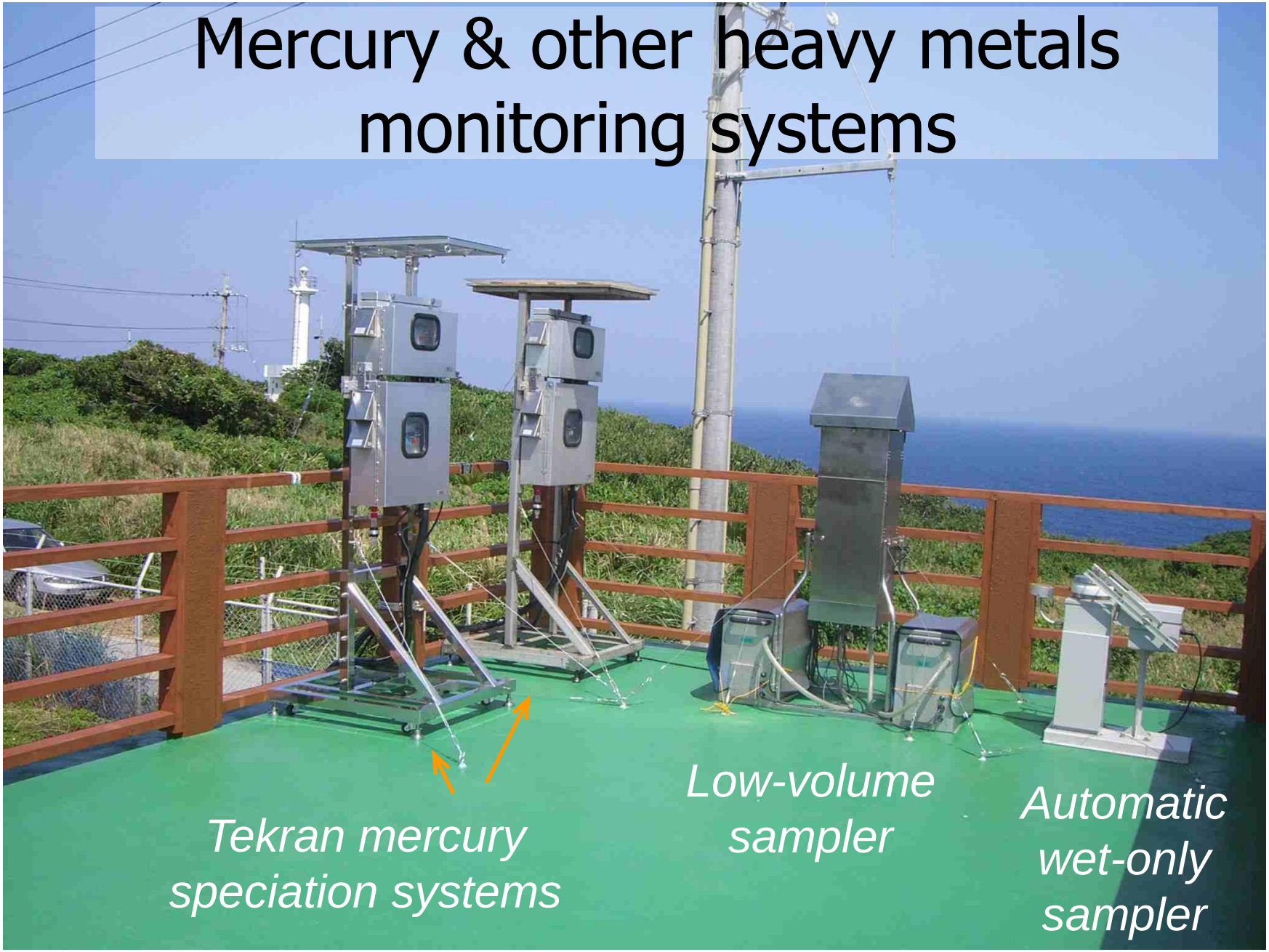


CHAAMS operated by National Institute for Environment Studies

Measurement items, sampling, and analytical methods

Component	Measurement items		Sampling and analytical methods
Atmosphere	Mercury	Mercury speciation (Hg(0), RGM, PHg)	Continuous measurement with Tekran mercury speciation system
		Hg	24 hours continuous sampling by gold amalgamation method and followed by CVAAS
	Particulate matter	Pb, Cd, Cu, Zn, As, Cr, V, Ni, Se, Sb, Ba, Co, Mn, Sn, Te, Tl, Be, Al, Fe, Ca, Na, K	7 days continuous sampling by the low-volume sampler and analyzed by ICP/MS
Precipitation	Hg		Sampling by the automatic wet-only sampler and analyzed by CVAAS (EPA method 1631)

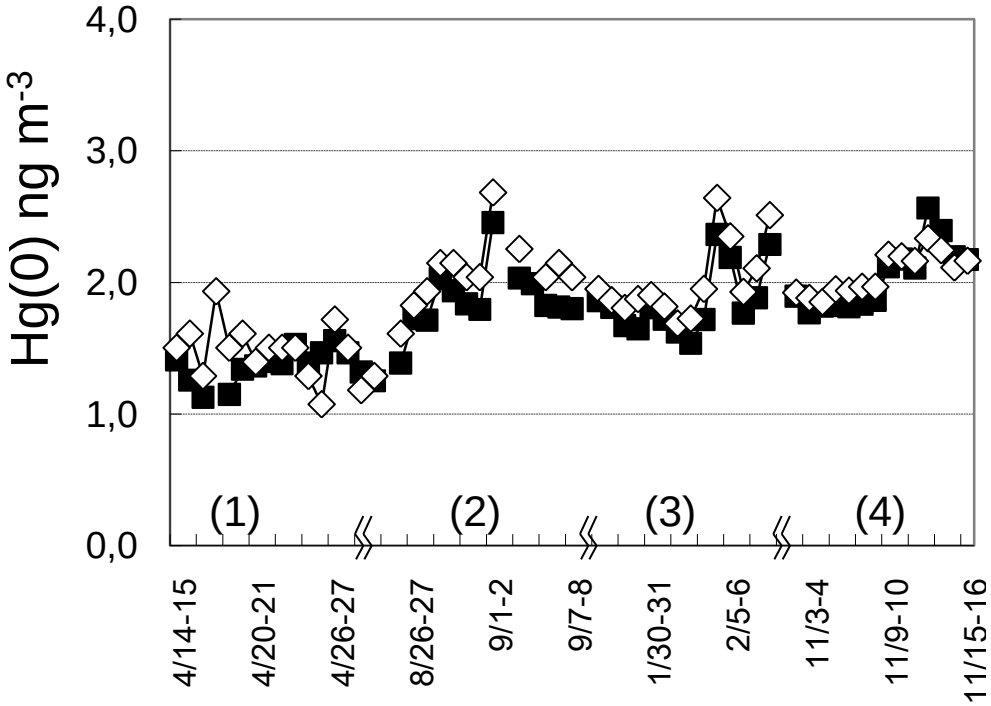
Mercury & other heavy metals monitoring systems



Comparison of Hg(0) measurement values

■ Tekran Hg Analyzer

◇ MOEJ Manual Method*

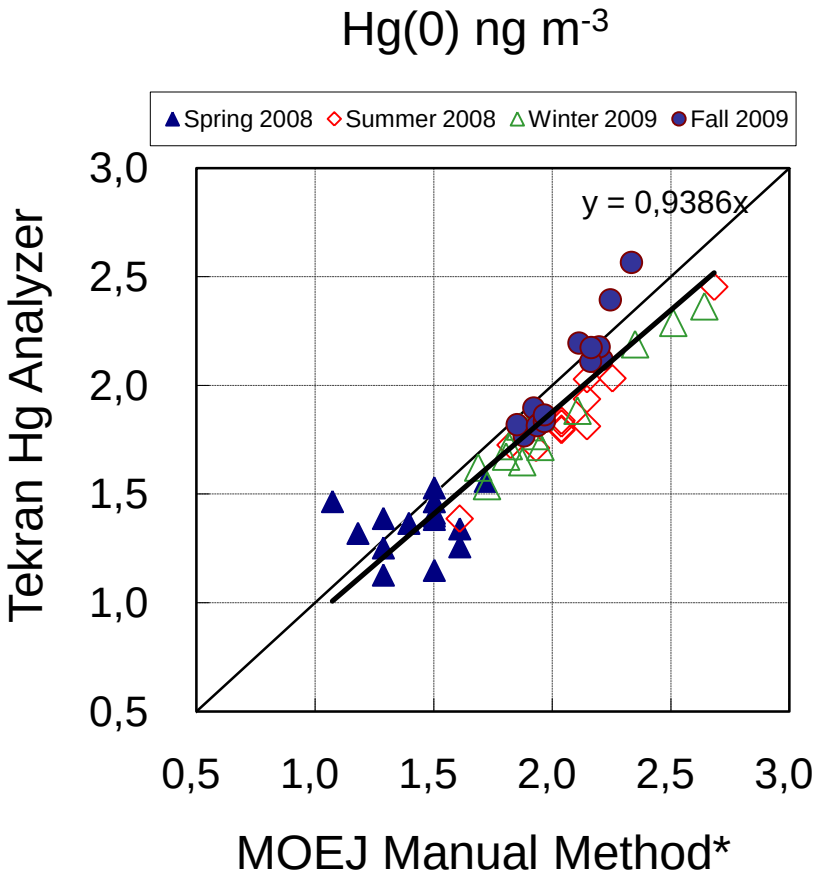


(1) Spring: 14 -30 Apr. 2008

(2) Summer: 25 Aug. - 8 Sep. 2008

(3) Winter: 26 Jan. - 8 Feb. 2009

(4) Fall: 2 Nov. – 16 Nov. 2009



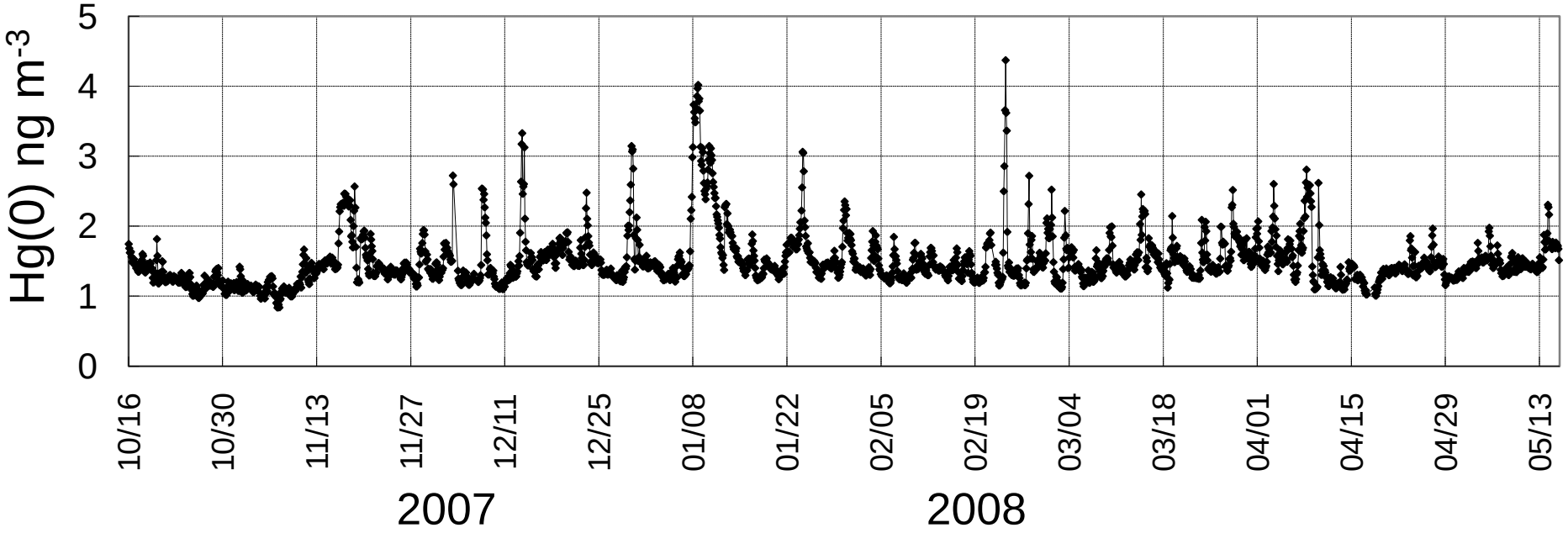
* Install sodalime trap just before gold cartridge

* Gaseous mercury including Hg(0) and RGM

Observations of mercury species

Gaseous elemental mercury Hg(0)

Oct. 2007 – May 2008



ng m-3	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Mean	1.3	1.4	1.5	1.7	1.5	1.5	1.5	1.5
Min	1.0	0.8	1.1	1.2	1.1	1.1	1.0	1.3
Max	1.8	2.6	3.3	4.0	4.4	2.5	2.8	2.3

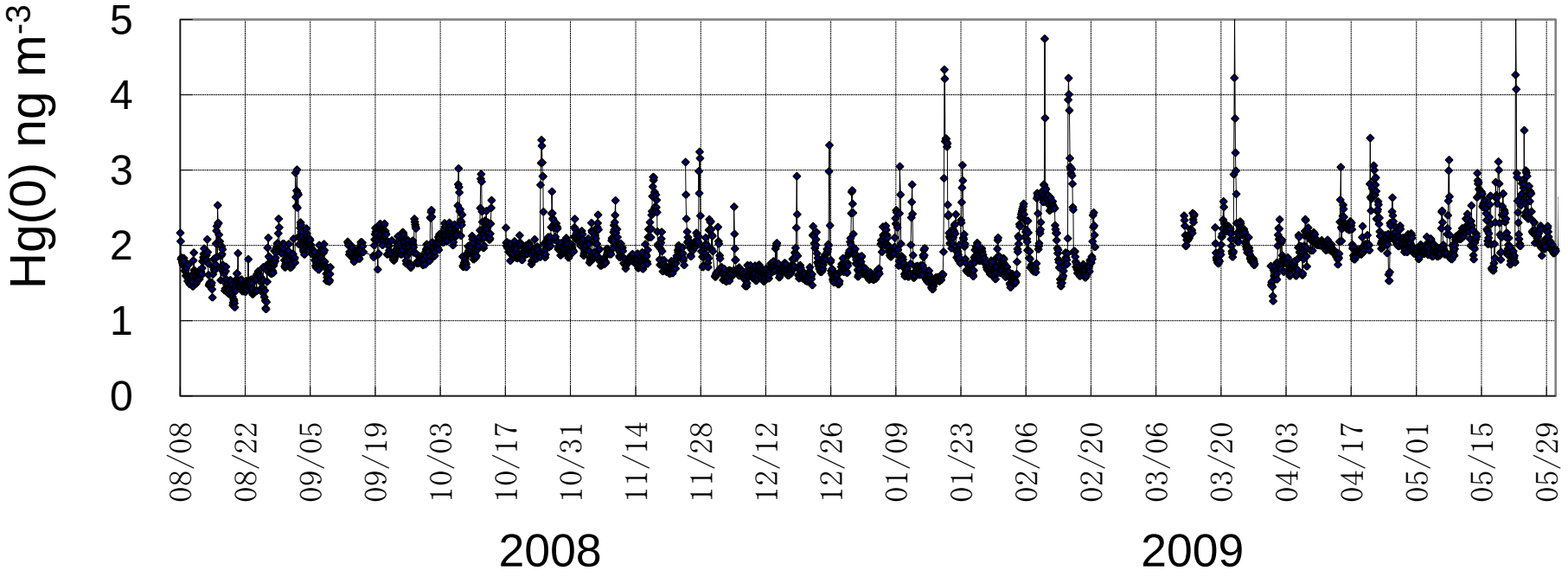
Mar-May'04
2.04
1.37
4.74

Jaffe et al (2005)

Observations of mercury species

Gaseous elemental mercury Hg(0)

Aug. 2008 – May. 2009

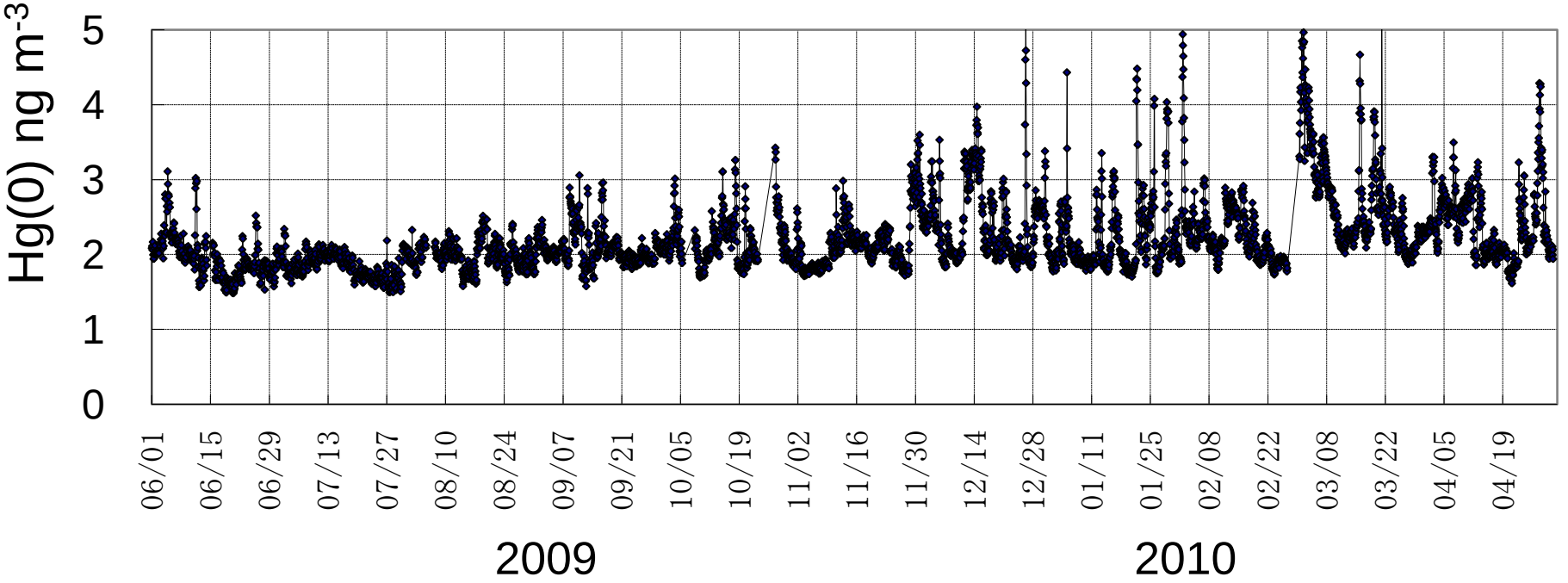


ng m-3	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Mean	1.7	2.0	2.1	2.0	1.7	1.9	2.1	2.1	2.0	2.2
Min	1.1	1.5	1.7	1.6	1.5	1.4	1.4	1.3	1.5	1.7
Max	2.5	3.0	3.4	3.2	3.3	4.3	4.7	5.2	3.4	5.0

Observations of mercury species

Gaseous elemental mercury Hg(0)

Jun. 2009 – Apr. 2010



ng m-3	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Mean	2.0	1.8	2.0	2.1	2.2	2.1	2.4	2.2	2.3	2.5	2.4
Min	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.7	1.7	1.9	1.6
Max	3.1	2.3	2.5	3.1	3.4	3.5	5.2	4.5	4.9	5.1	4.3

Summary of continuous mercury measurement

- Measurement results show good correlation with established MOEJ method.
- Gaseous elemental mercury: Hg(0)

- Monthly mean of observed Hg(0) level was 1.3 to 2.5 ngm^{-3} and hourly mean was 0.8 - 5.2 ngm^{-3}.
- Hg(0) baseline level, as well as frequency and concentration of peak episodes varied with time to time
- Peak episodes of higher Hg(0) concentration increased in winter probably reflecting meteorological conditions

MULTIMEDIA MODELING

Multimedia integrated AQM-MM model by CMAQ/G-CIEMS

CMAQ

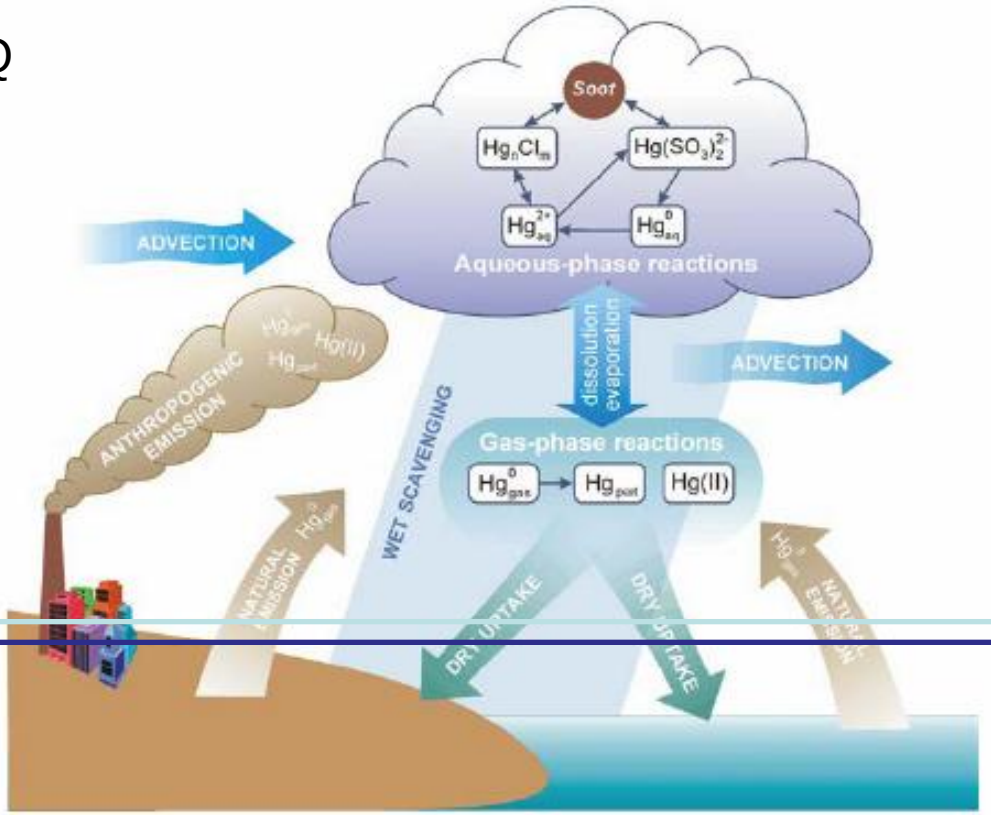
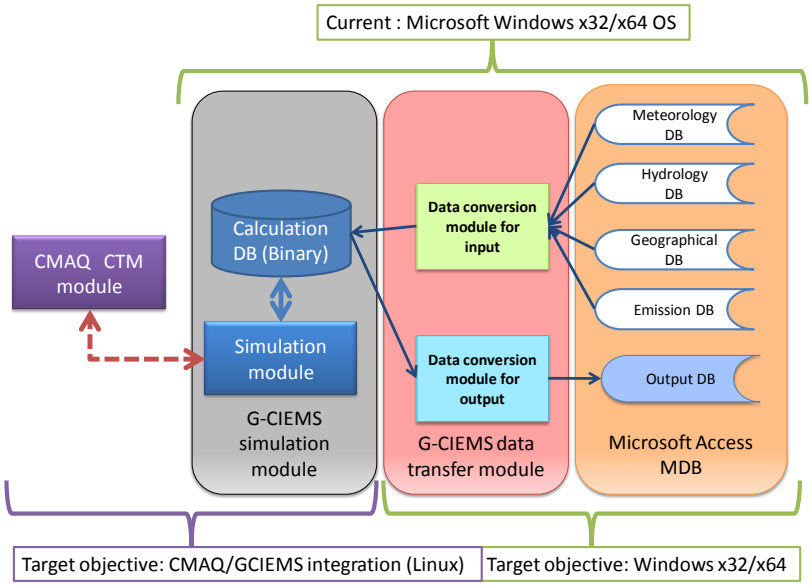


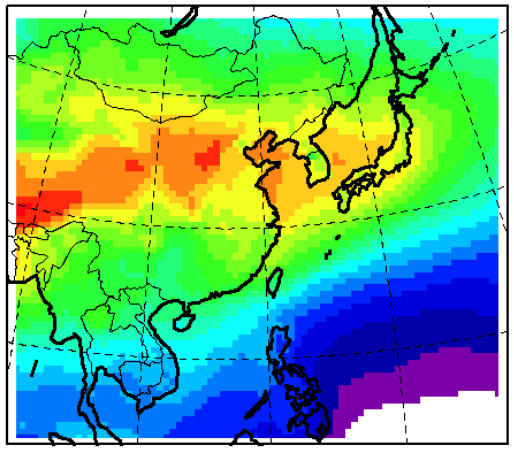
Figure 2.1. *The model scheme of mercury behaviour in the atmosphere*
(Figure from Travnikov, O. and Ryaboshapko, A. MSC-E Technical Report 6/2002)

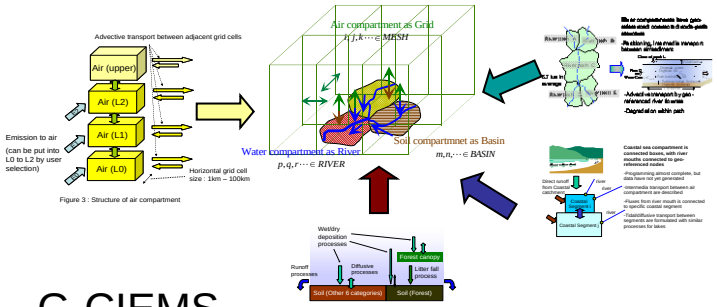
G-CIEMS

Integrated AQM-MM model by CMAQ/G-CIEMS



CMAQ



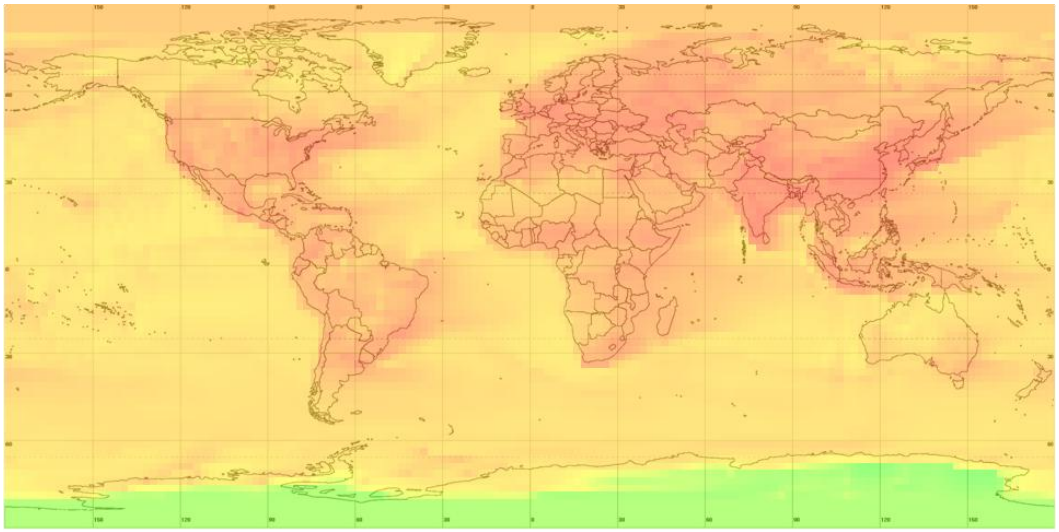


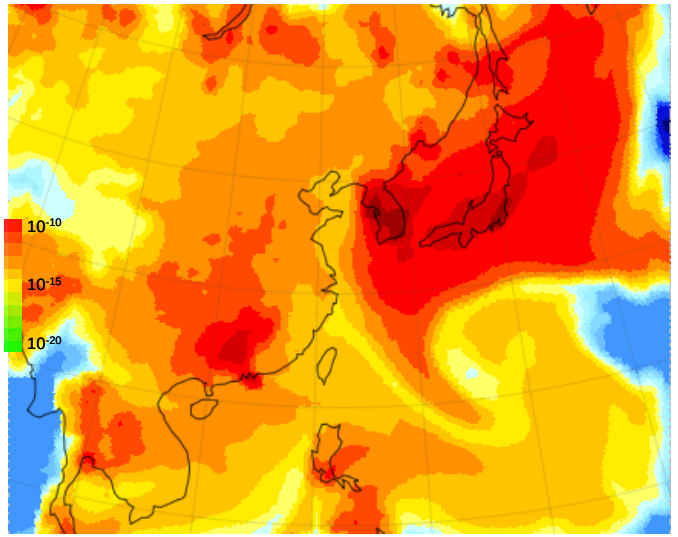
G-CIEMS

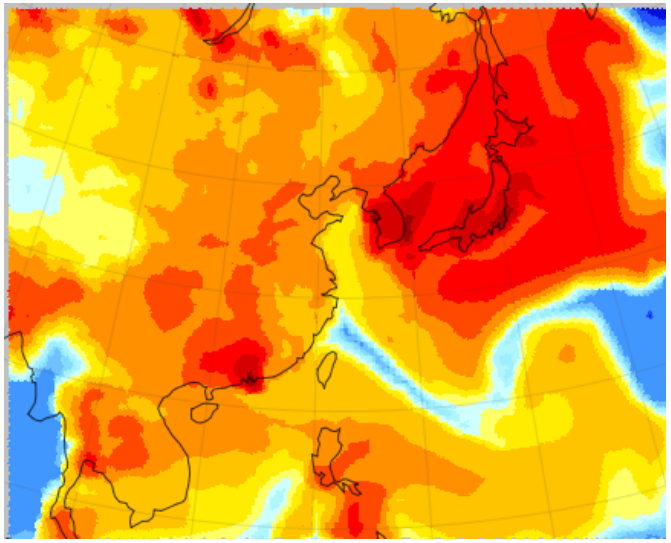
Figure 2. Schematic Diagram of G-CIEMS-Multi model

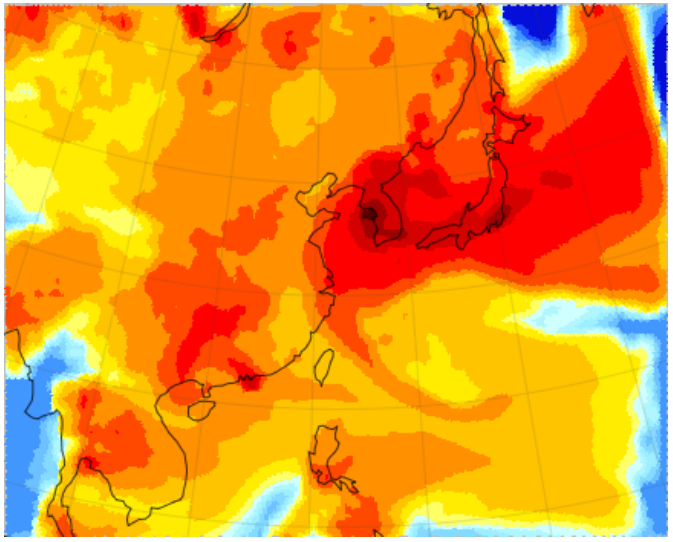
- Atmospheric transport/chemistry of CMAQ and inter-media transport among air, soil, water of G-CIEMS integration
  - CMAQ : atmospheric transport and chemisty
  - G-CIEMS : river, water transports and inter-media transport in multimedia environment

Output of example





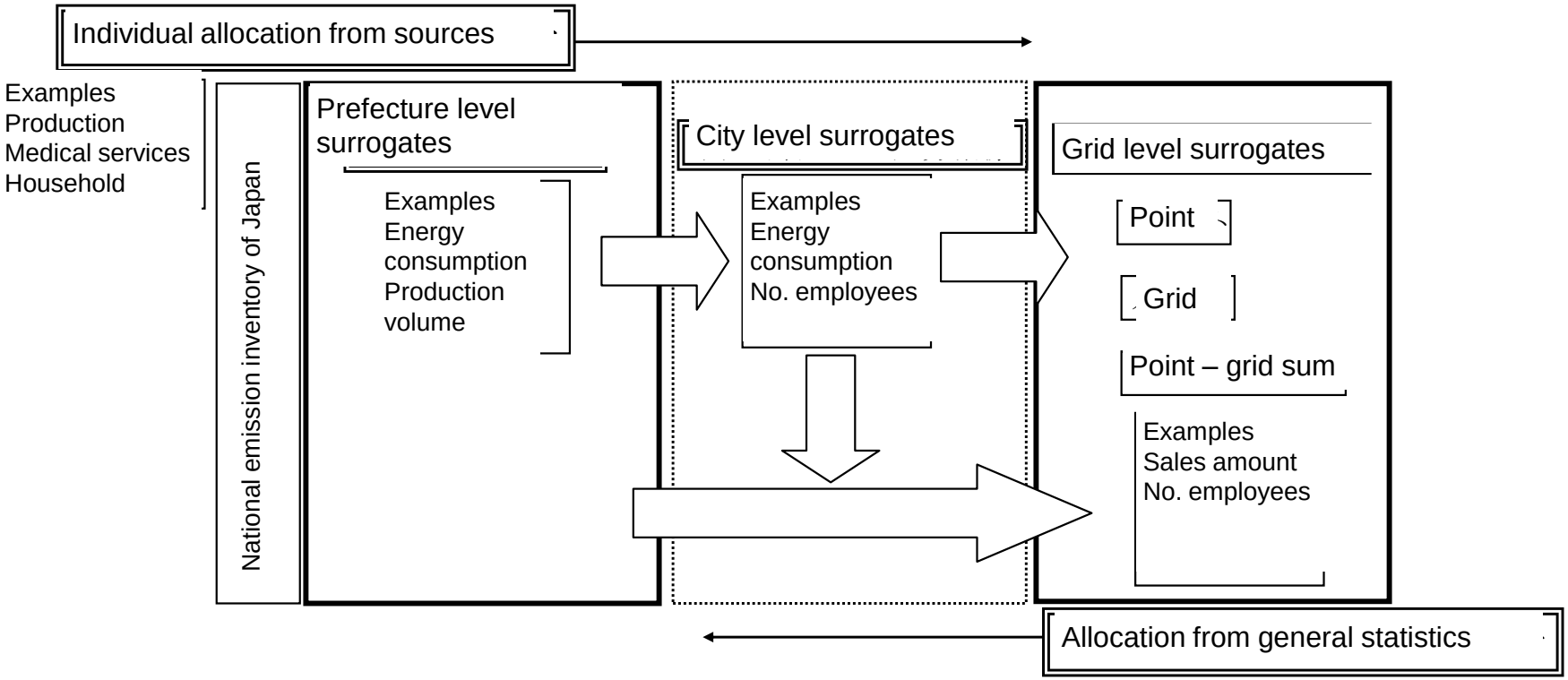




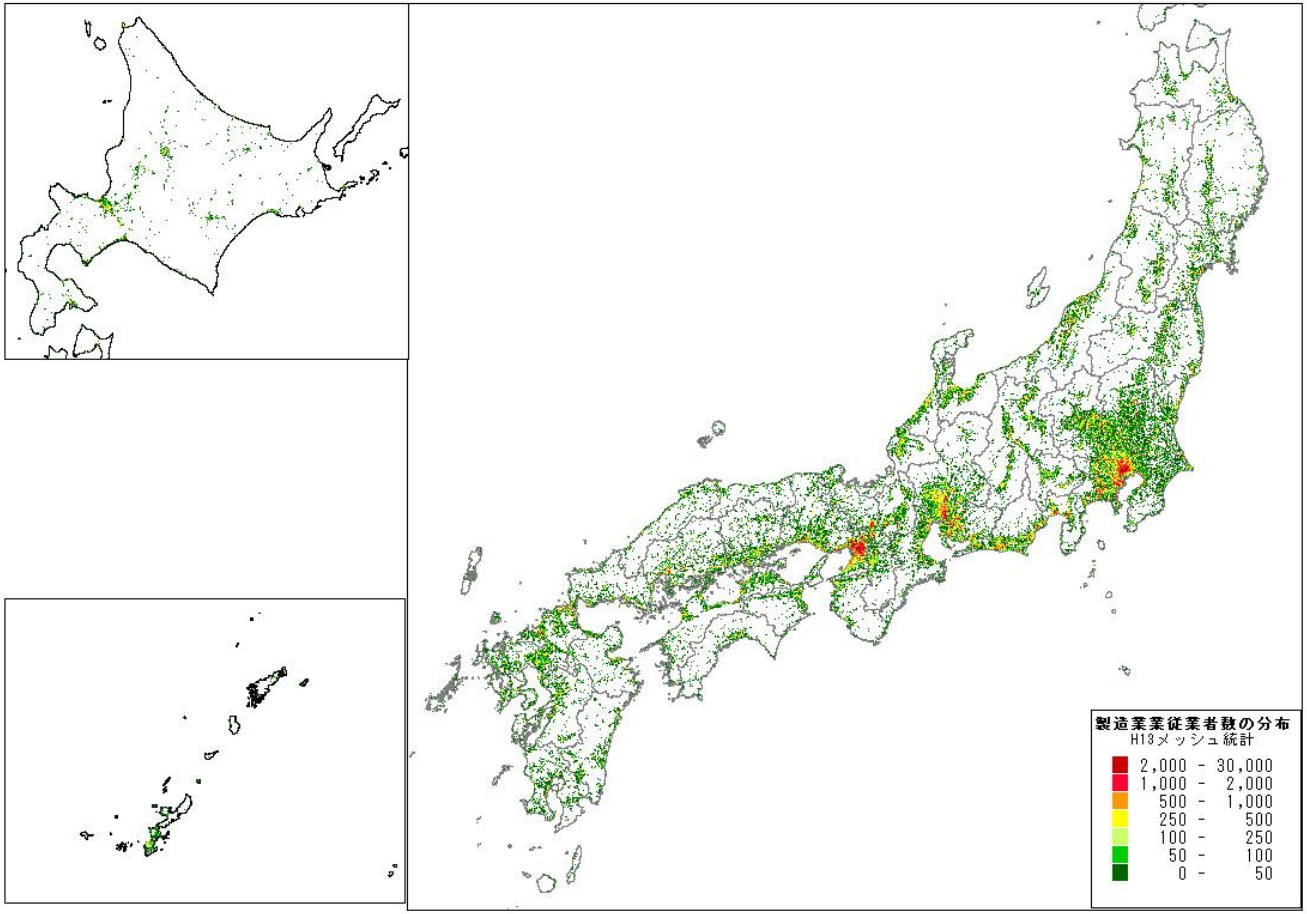
ADDITIONAL TRIALS

- Gridded emission inventory of Japan by 1x1 km resolution – ongoing work

Gridded emission inventory of Japan



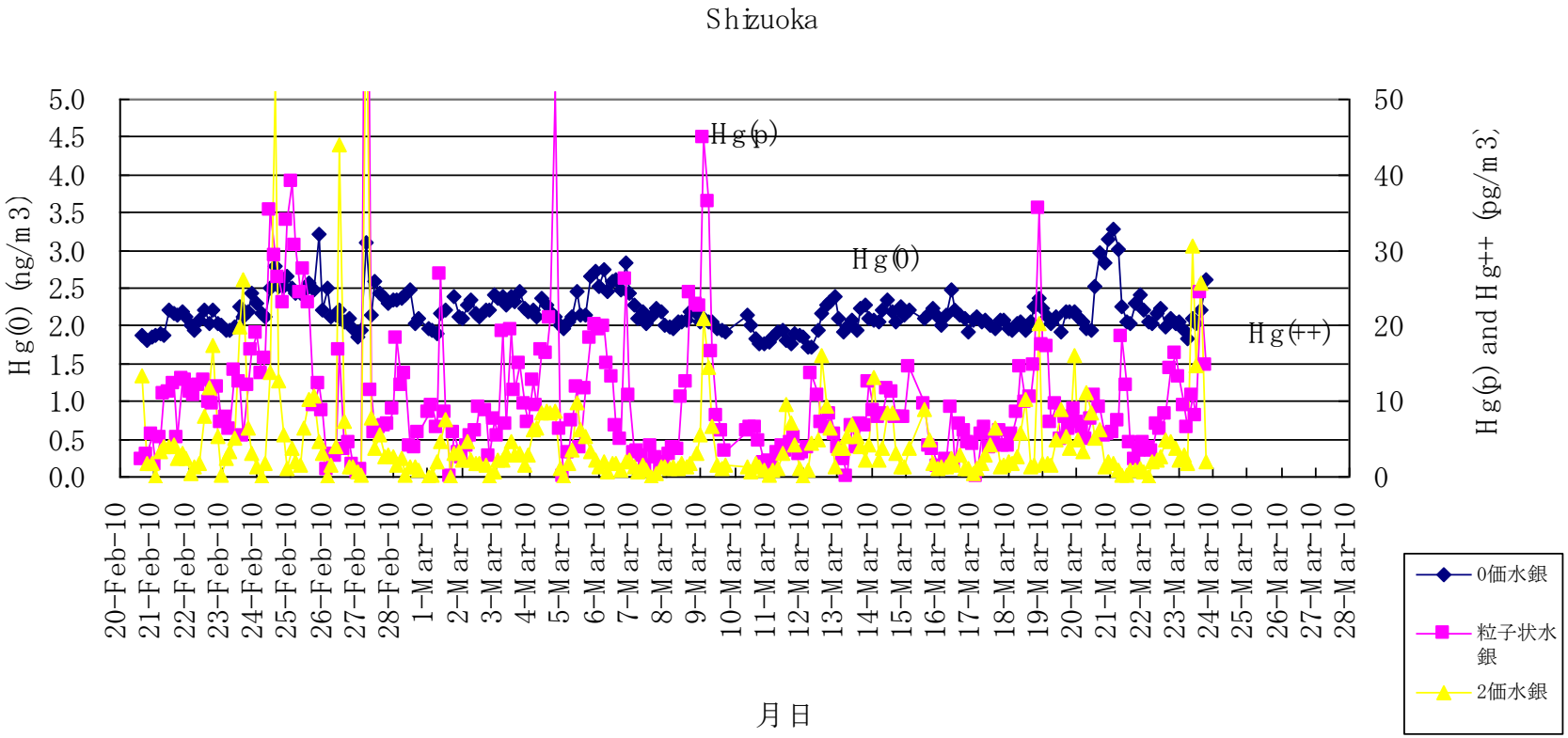
Expected resolution of final output



ADDITIONAL TRIALS

- Trial speciated monitoring at Shizuoka (urban area)

Trial monitoring at Shizuoka



FUTURE DIRECTION

F & T Partnership relating works: Continued and future activities

- Monitoring project at Cape Hedo
- Modeling fate of mercury species in multimedia environment
- Additional trials
  - Gridded emission inventory of Japan by 1x1 km resolution
  - New continuous air monitoring site
    - May continue trial speciated/continuous monitoring at Shizuoka (urban area)
    - May start operation at another site in Minamana

Thank you for your attention!