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Environmental Research

Introduction of Current Research on Mercury in Korea

JULY 27, 2016



Ministry of
Environment

National Institute of Environmental Research

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Acid precipitation monitoring network



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■ Purpose

- To build basic data to understand the dry/wet deposition of acid air pollutants across the country and establish measures to minimize the damage they cause
- To estimate domestic mercury air pollution based on which mercury management policy will be built (e.g., mercury risk assessment and transboundary mercury management)

■ Management

- As a member of the Acid Deposition Monitoring Network in East Asia (EANET), Korea operates monitoring stations that comply with EANET's QA/QC standards.

Acid precipitation monitoring network

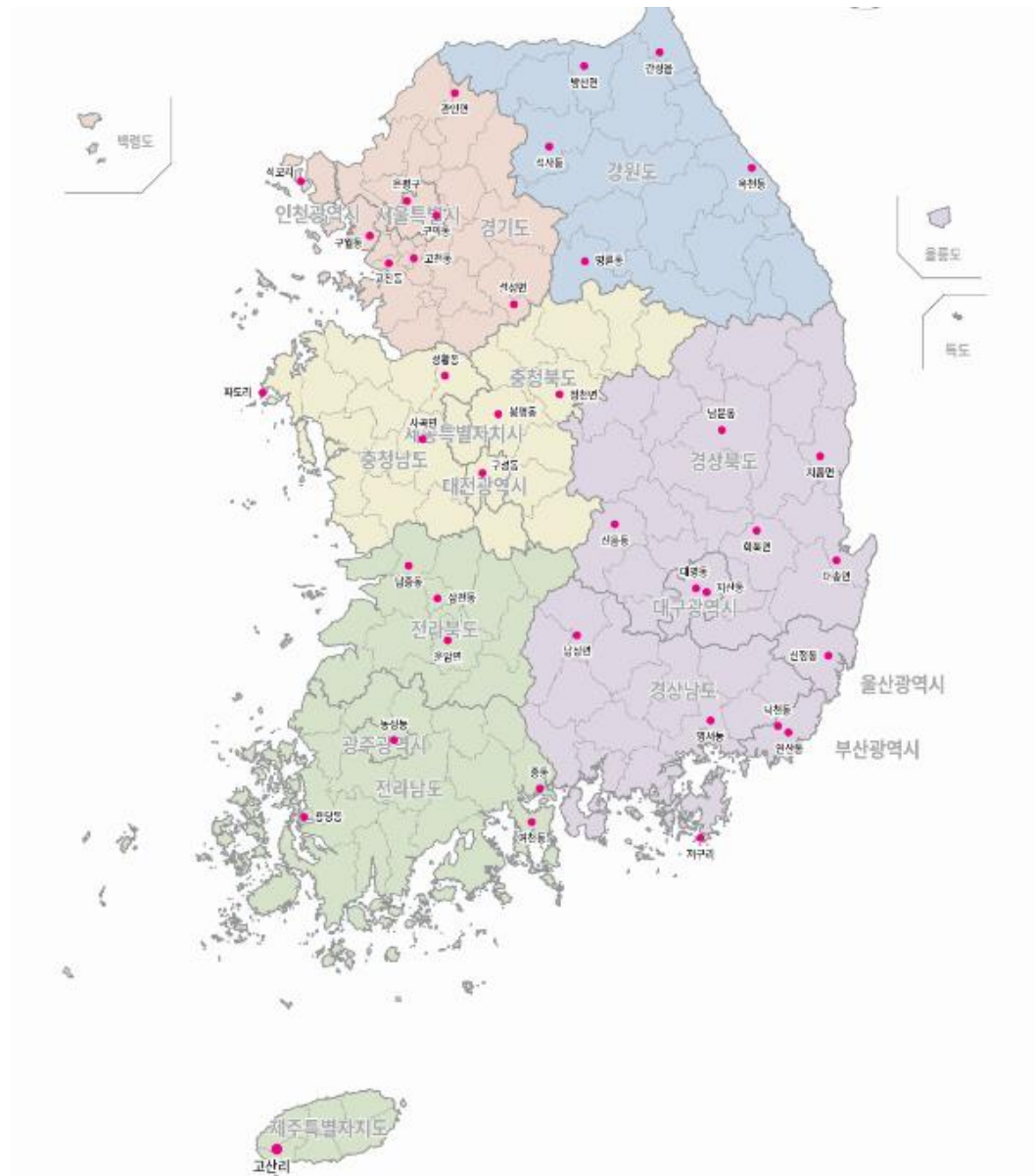


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■ Siting criteria for monitoring stations

- The monitoring stations are included in the APMN to estimate the impact of mercury on the ecosystem by calculating the concentration and wet deposition of mercury.
- The monitoring stations are installed in three area groups:
 - a) background areas to understand the long-range movement of mercury,
 - b) areas to calculate domestic mercury concentrations, and
 - c) lake/river areas where mercury is deposited as methylmercury.

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National Mercury Monitoring Stations in Korea (12 stations, 2016)

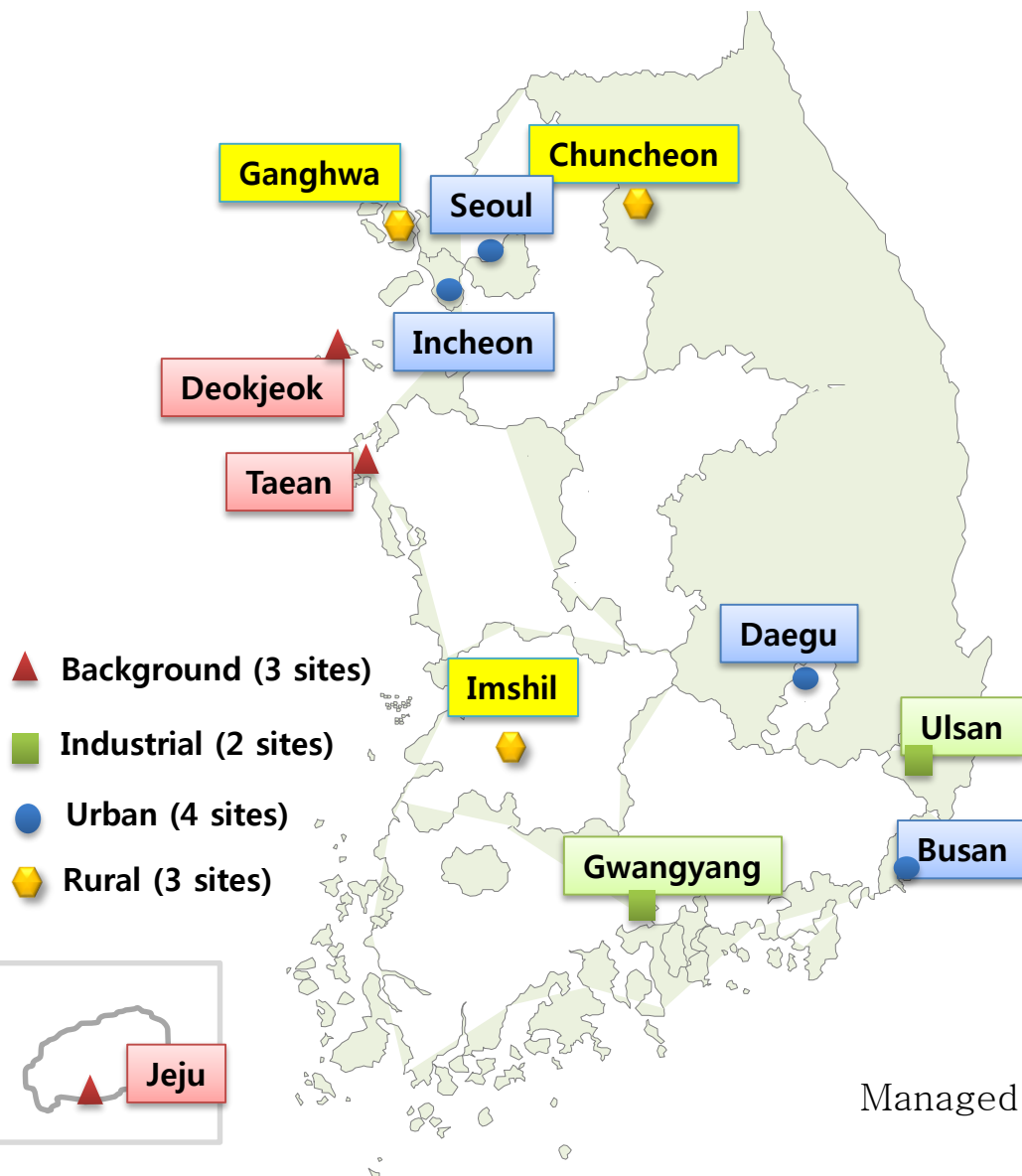
State		2009~2015	2016~2020		
			2016	2017	2018
Mercury Monitoring Stations	Total gaseous mercury	12 stations Deokjeok, Incheon, Seoul, Chuncheon, Taean, Daejeon, Gwangju Gwangyang, Daegu, Busan, Ulsan, Jeju	Daejeon, Gwangju ↓ Imshil, Ganghwa (EANET Site)		
	Hg by chemical specie	-	1 stations Taean	1 stations Jeju	
	Hg in precipitation	2 stations Seoul Incheon	2 stations Taean Jeju	1 stations Chuncheon	

● 습식주은측정소 (5개소)

● 종별수은측정소 (2개소)



Management Plan (Current State and Expansion Plan of Mercury Monitoring Stations)



- Included in the national acid precipitation monitoring system
- Monitoring of TGM in 12 stations
- Mercury wet deposition monitoring sites
(Seoul, Incheon, Taeon, and Jeju in 2016)
(Chuncheon in 2017)
- Monitoring sites for mercury by species
(Taeon and Jeju in 2017)

Management Plan of Mercury Monitoring Stations)



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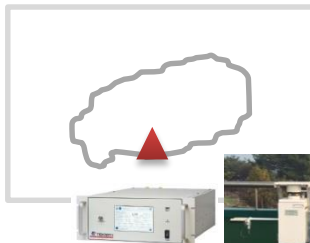


▲ Background

■ Industrial (2 sites)

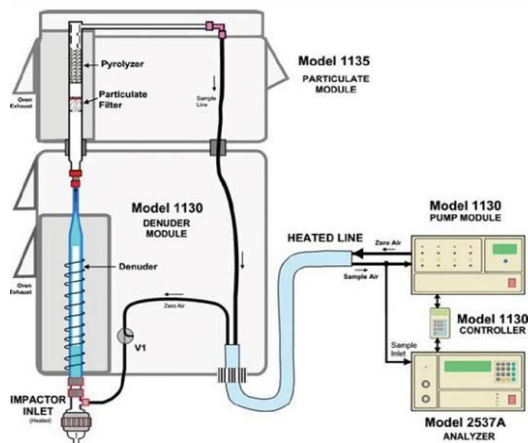
● Urban (4 sites)

◆ Rural (3 sites)



Method of Measurement

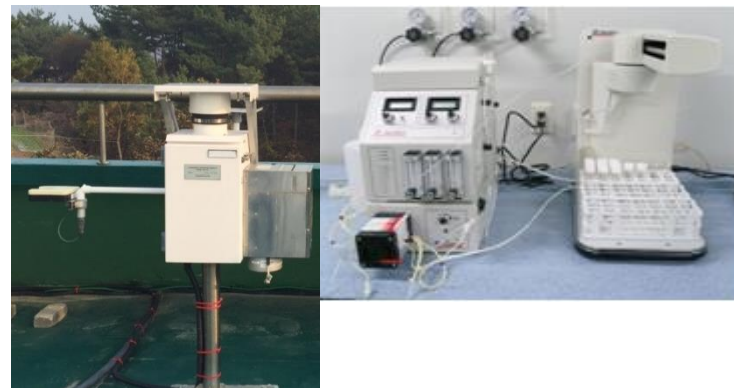
Concentration of atmospheric Hg by chemical specie



Tekran 2537/1130/1135, Canada

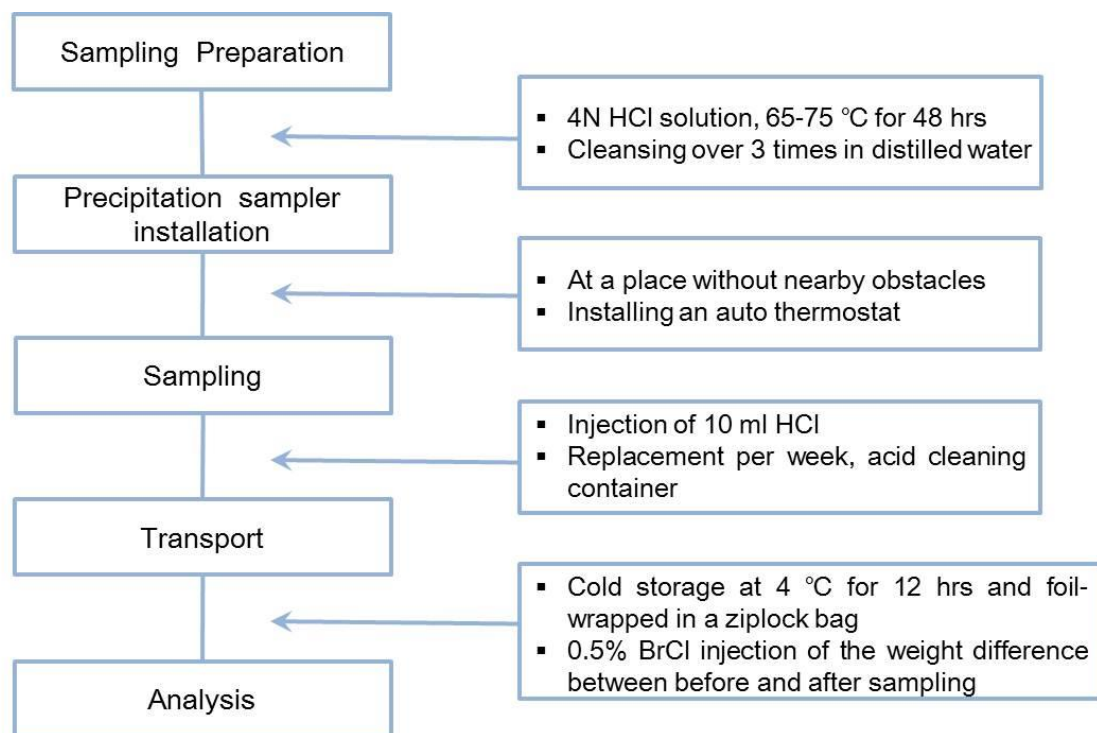
- TGM: 5-minute interval using Tekran 2537
- GOM & PBM: 2-hour interval using Tekran 1130/1135
- QC: accuracy with reference samples using Tekran 2505
 - : reference value adjustment via zero air measurement per 2 min.

Hg concentration in precipitation

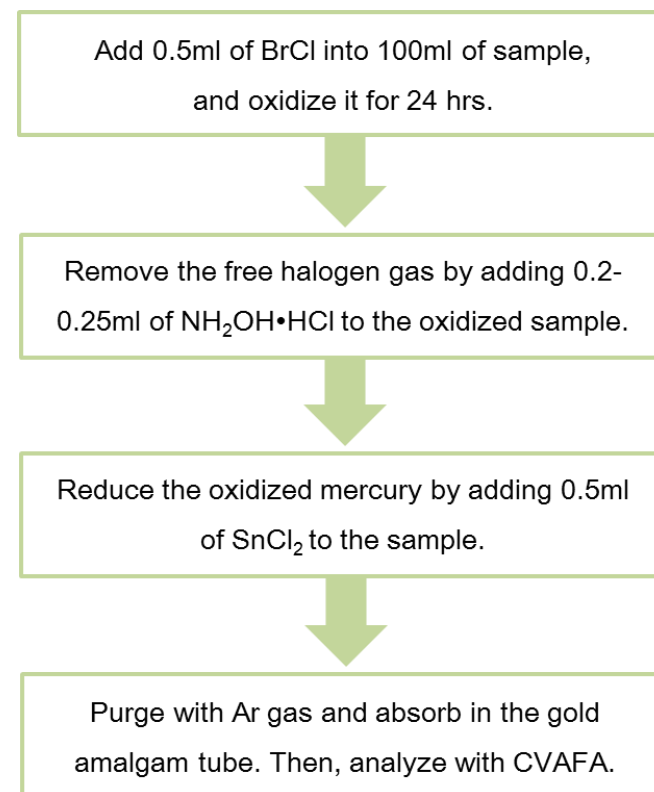


- Cumulative precipitation sampling per week (N-CON, Canada)
- Total Hg analysis using Tekran 2600
- Comparative experiments among labs
 - Subsampling through homogenization and stabilization of the samples
 - APMN, Taiwan Central University, and GIST

Method of Measurement



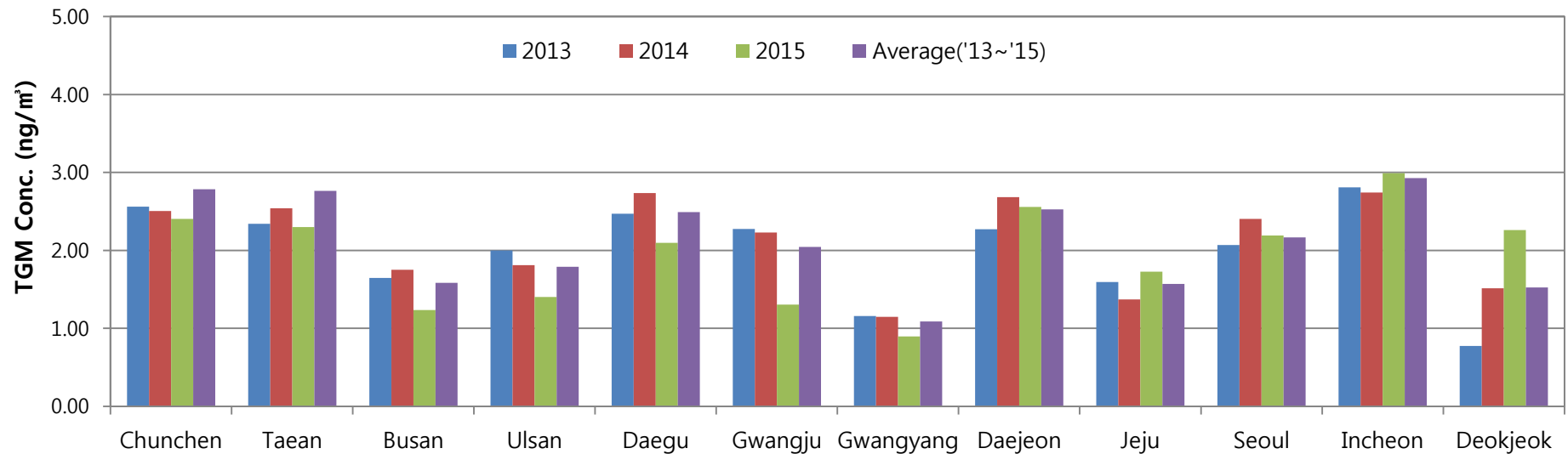
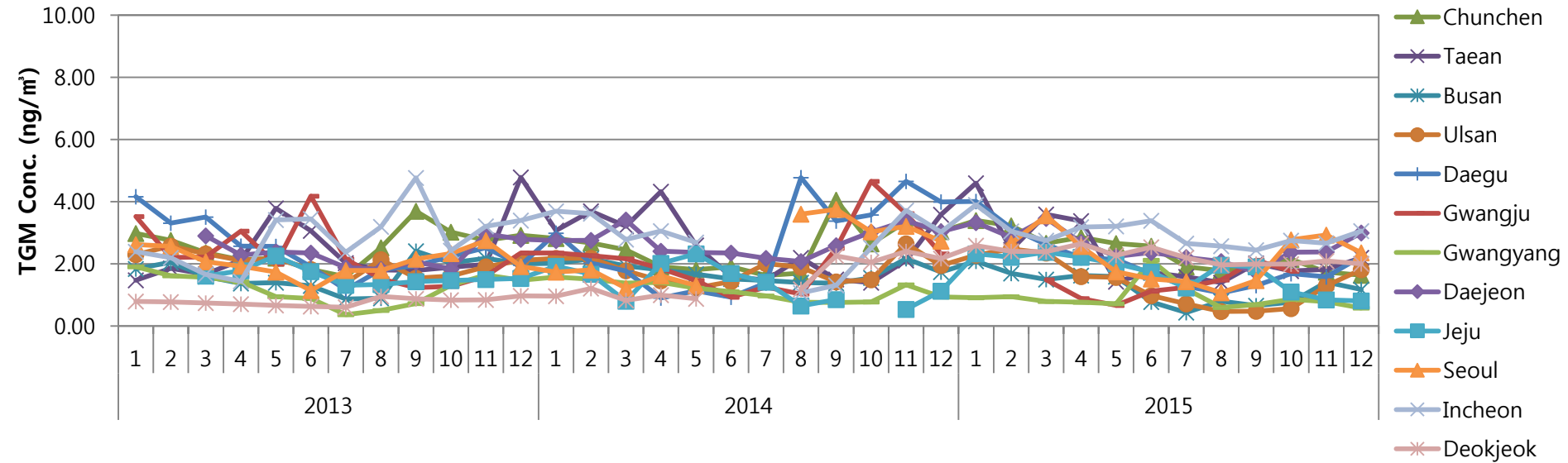
< EPA method 1631 >



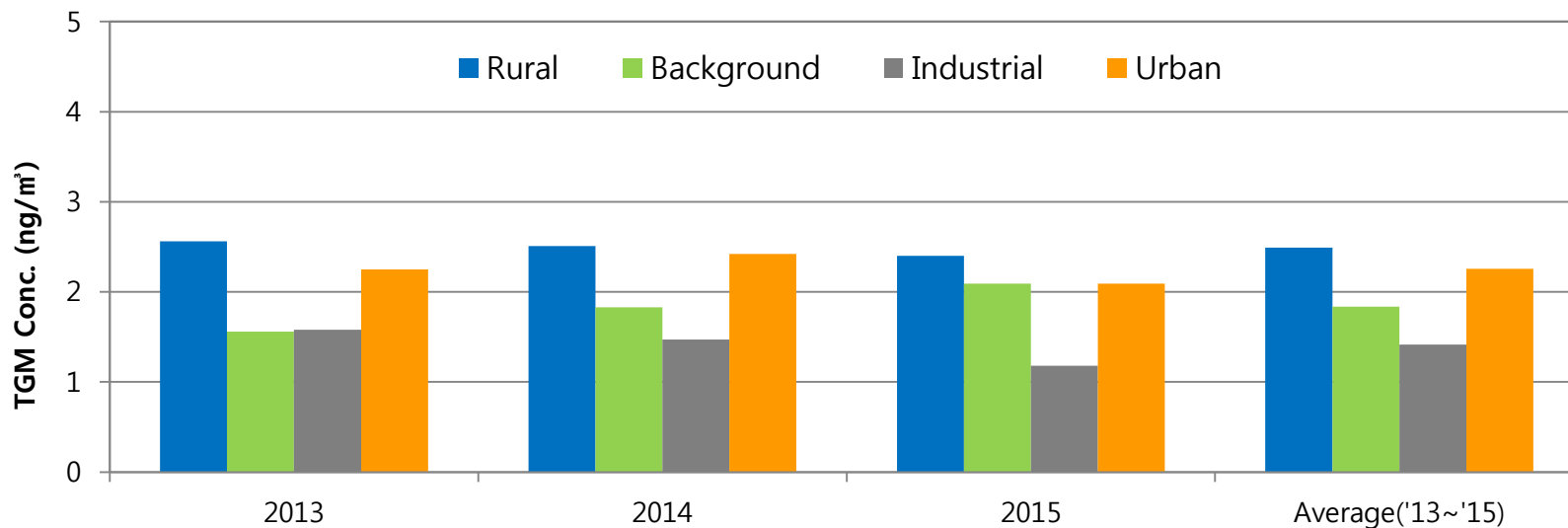
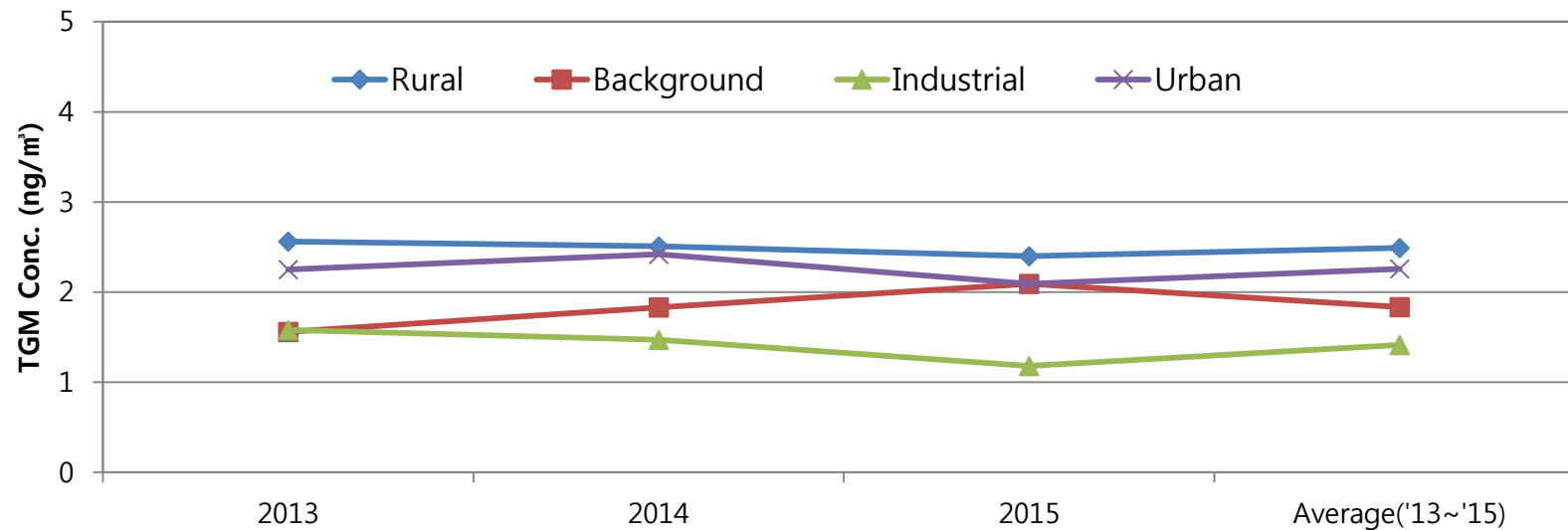
Results of Mercury Monitoring



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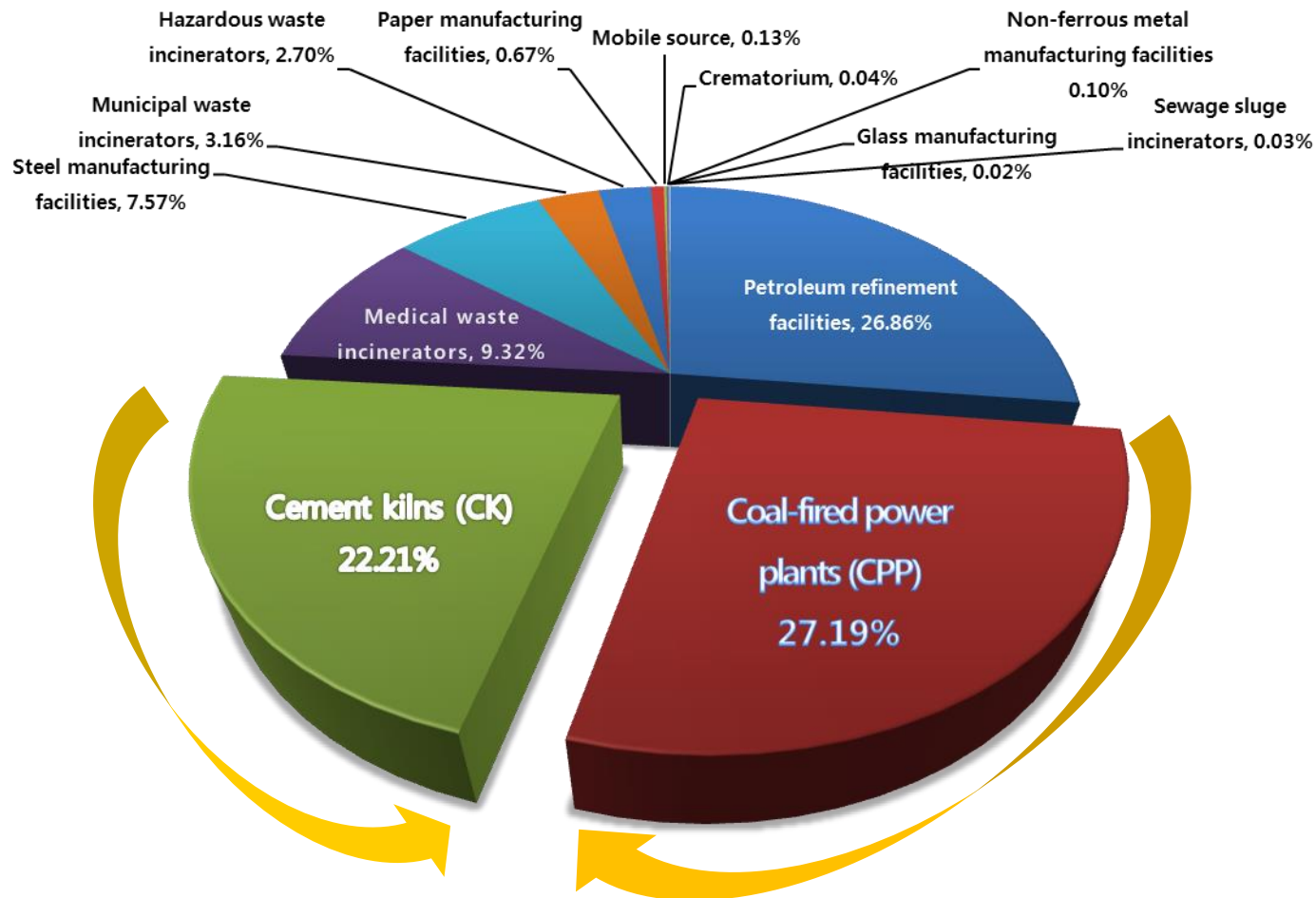
Results of Mercury Monitoring



Tested Emission Sources – multiple mercury emissions (2012)

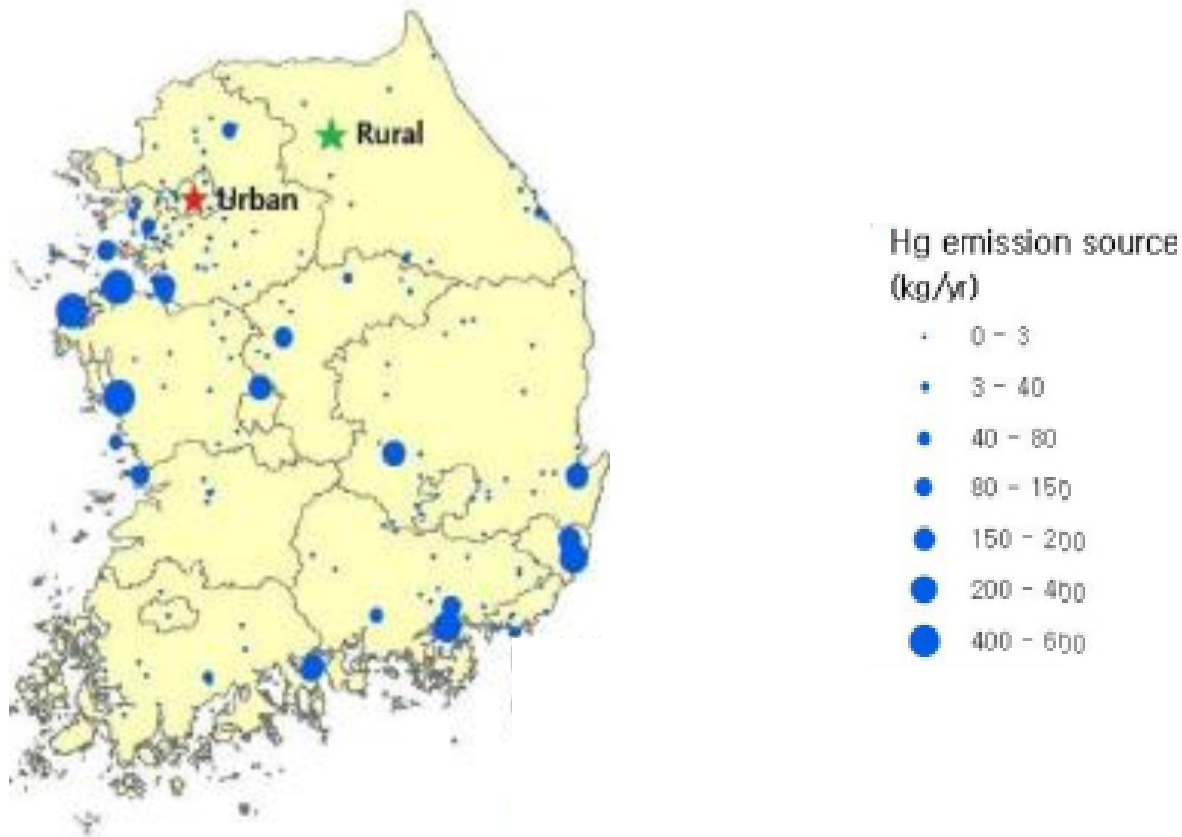


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Emission Sources

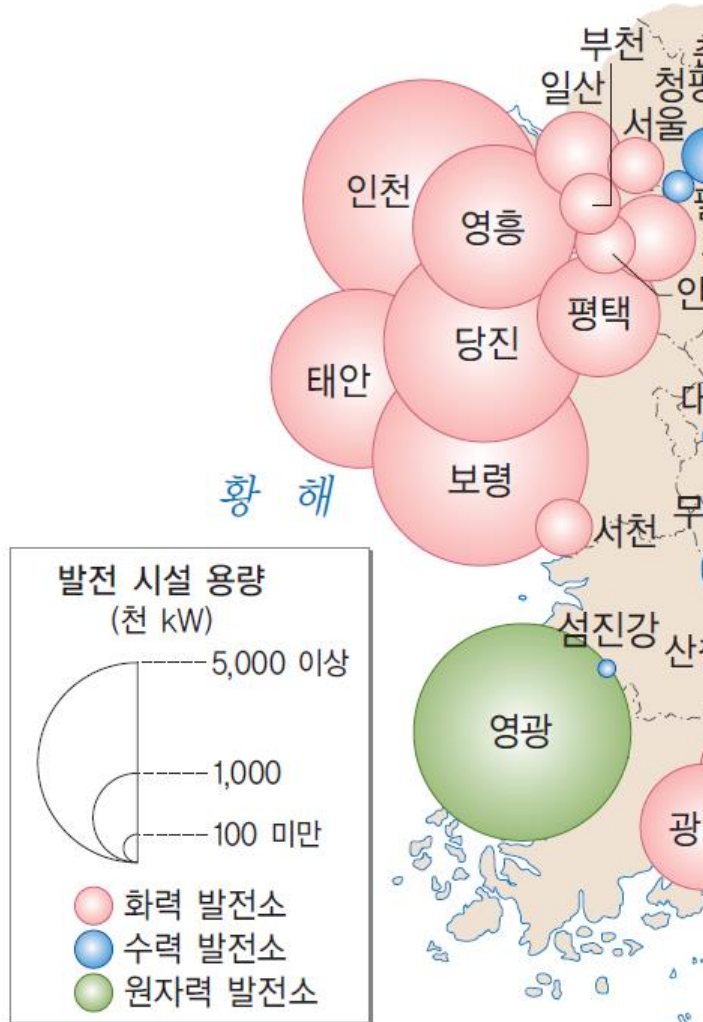
– multiple mercury emissions



(Korea's Hg emission sources Y. Lee, '11)

Emission Sources – Coal fired power plants

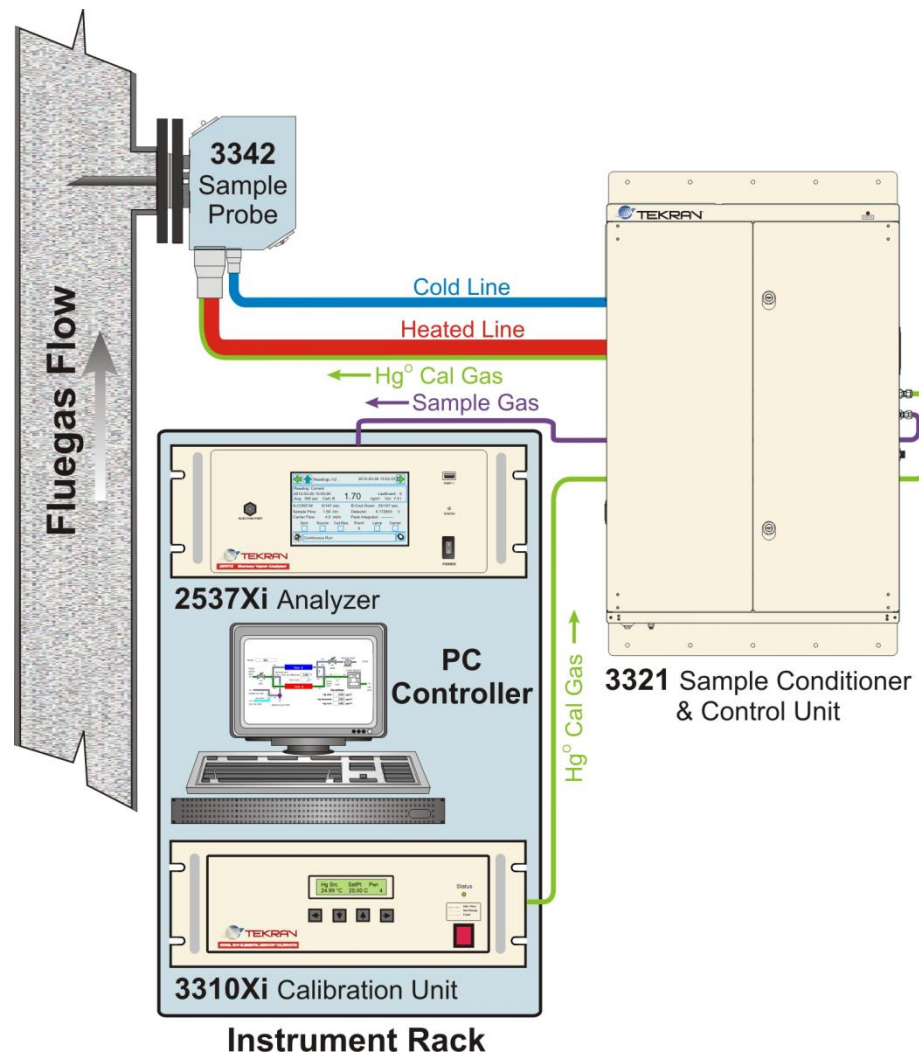
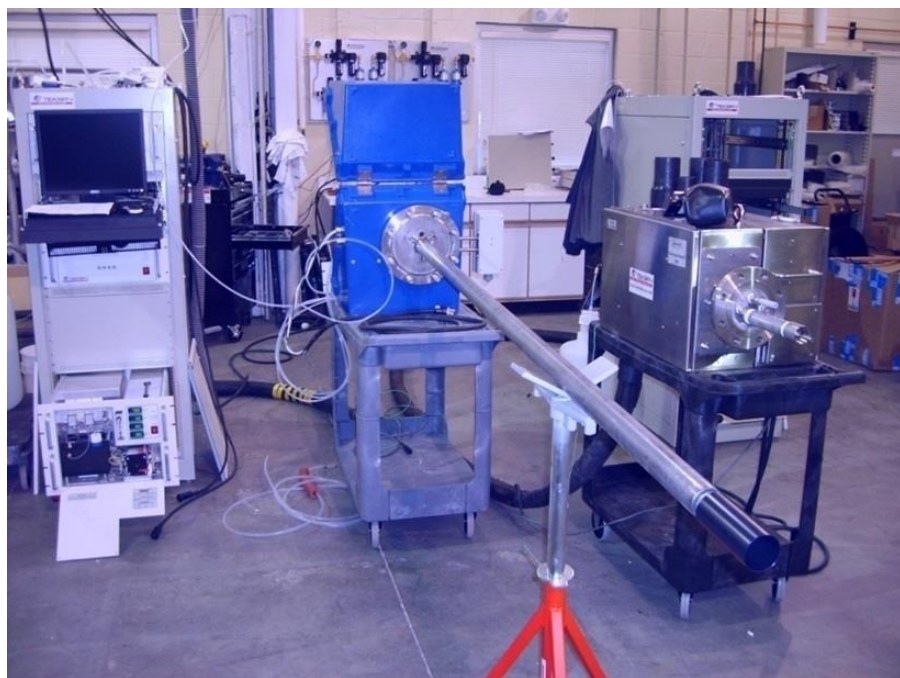
(한국 전력 공사, 2011)



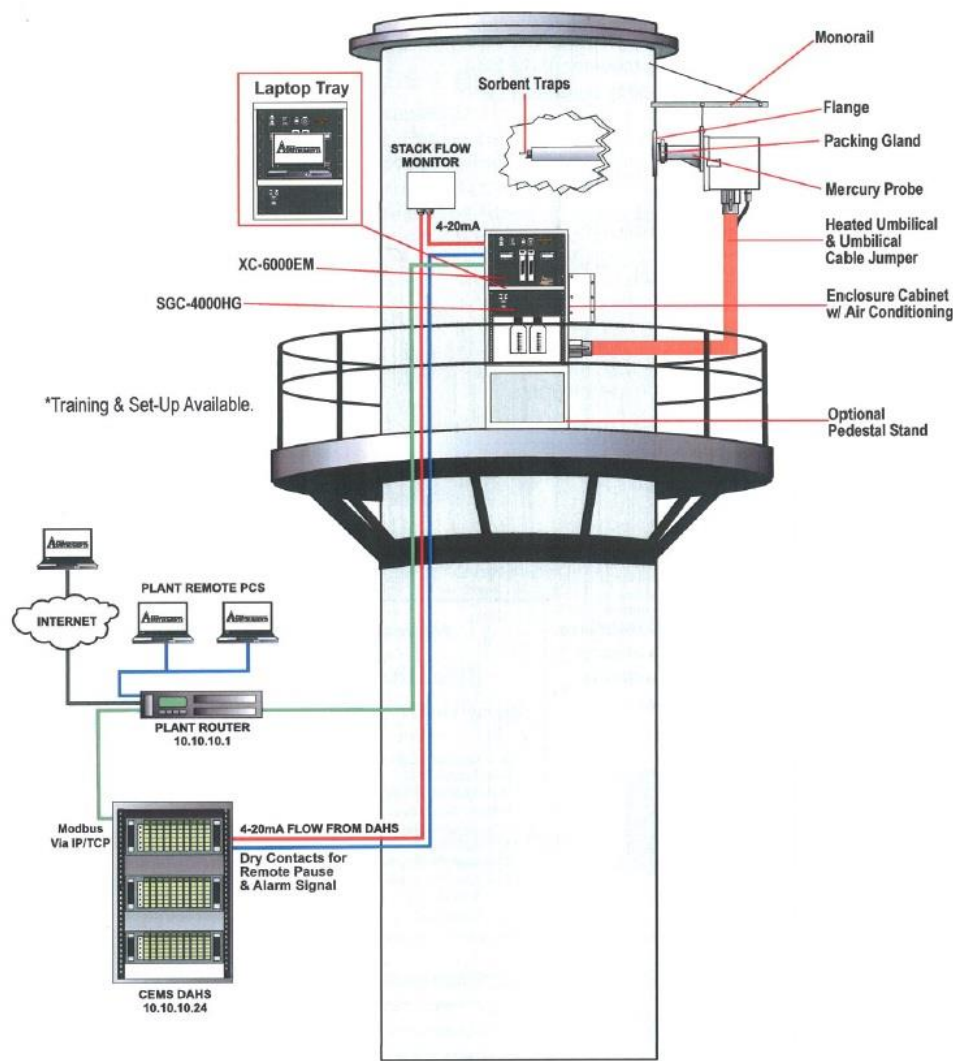
국내 주요 화력발전소 현황



The appearance and general structure of a CEM system



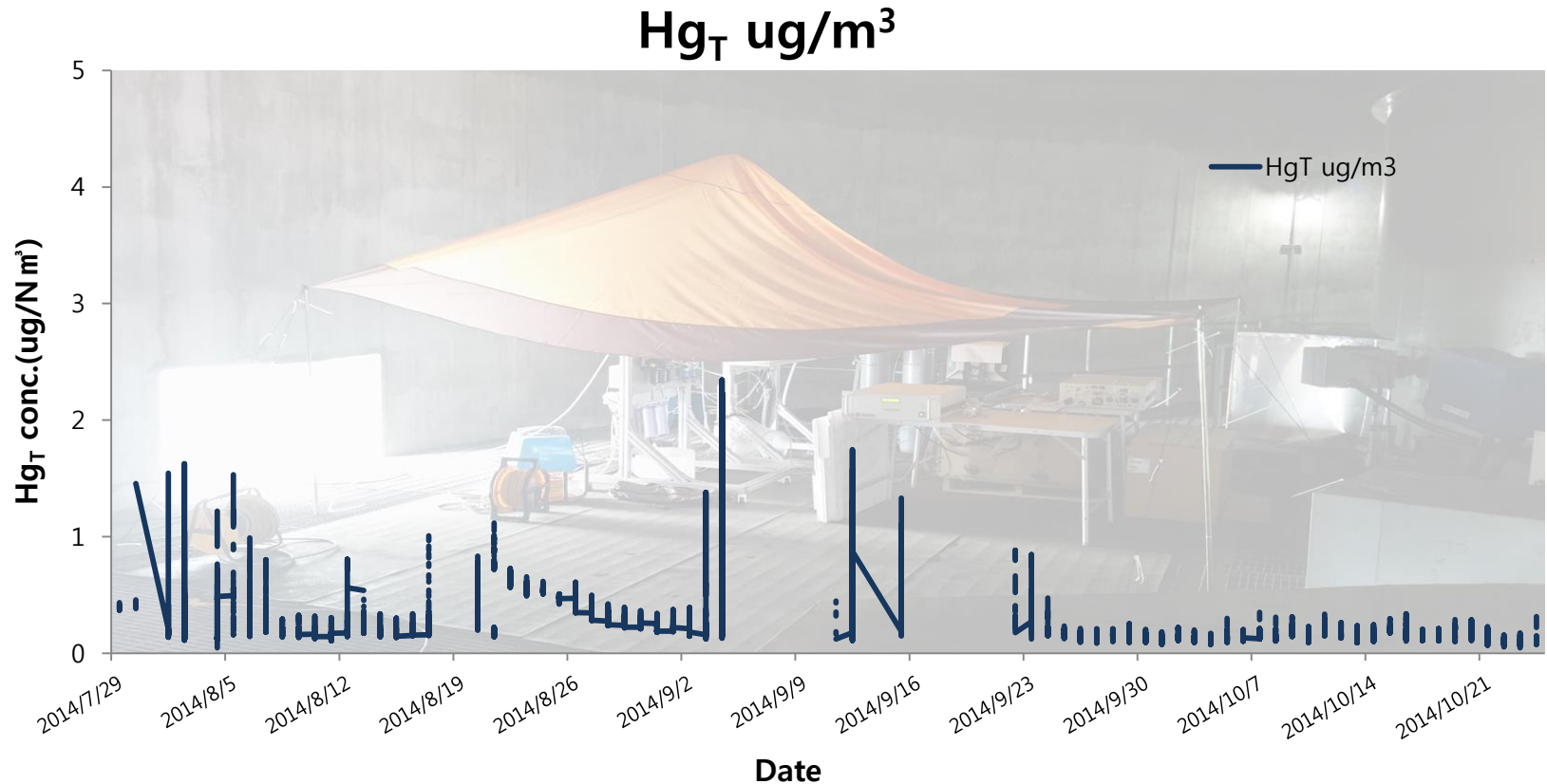
Field Installation of a CEM system



Field Installation of a CEM system



Result of analyzing flue gas through CEM

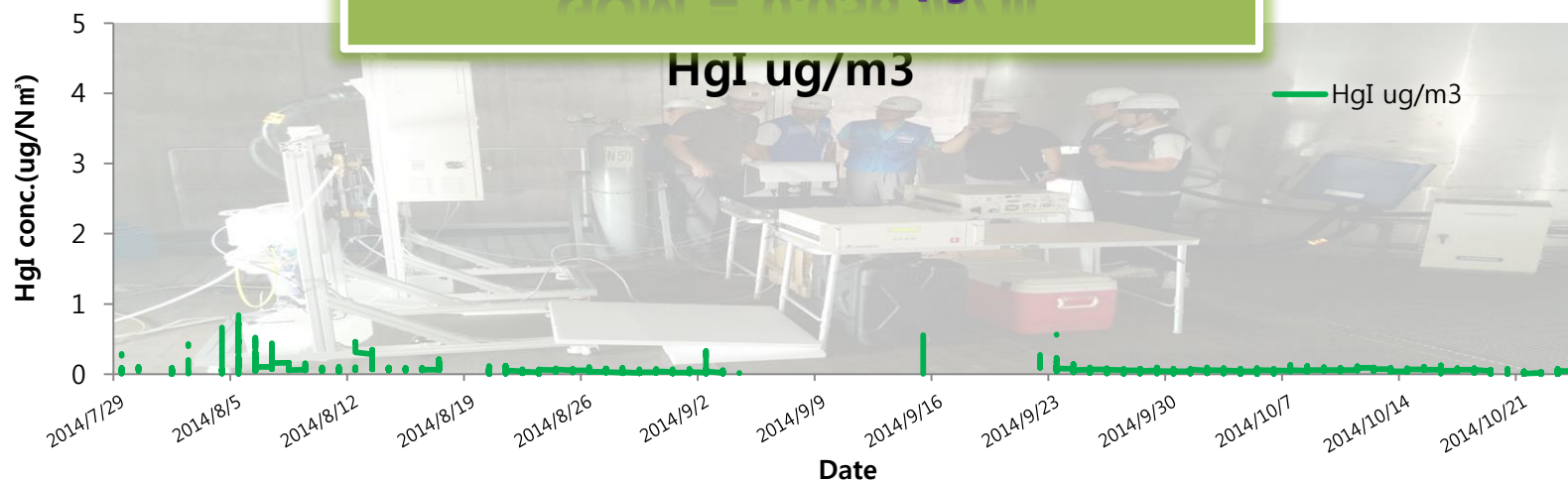
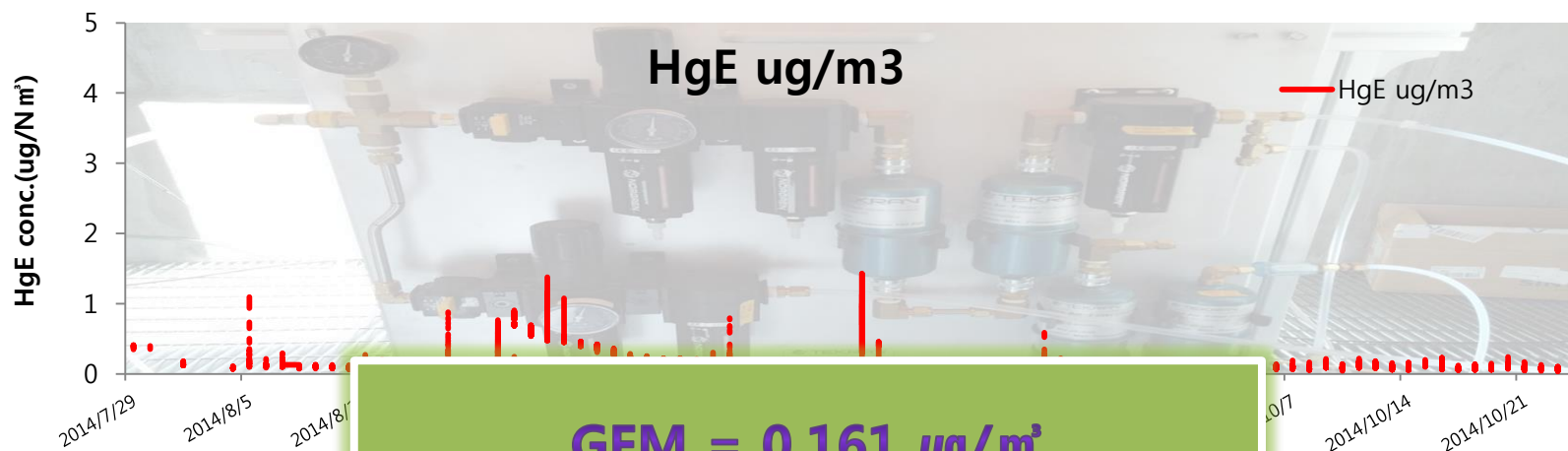


$\text{Hg}_T \text{ Conc. (gaseous mercury)} = 0.217 \text{ } \mu\text{g/m}^3 \text{ (July 29 ~ Oct. 24)}$

Result of analyzing flue gas through CEM

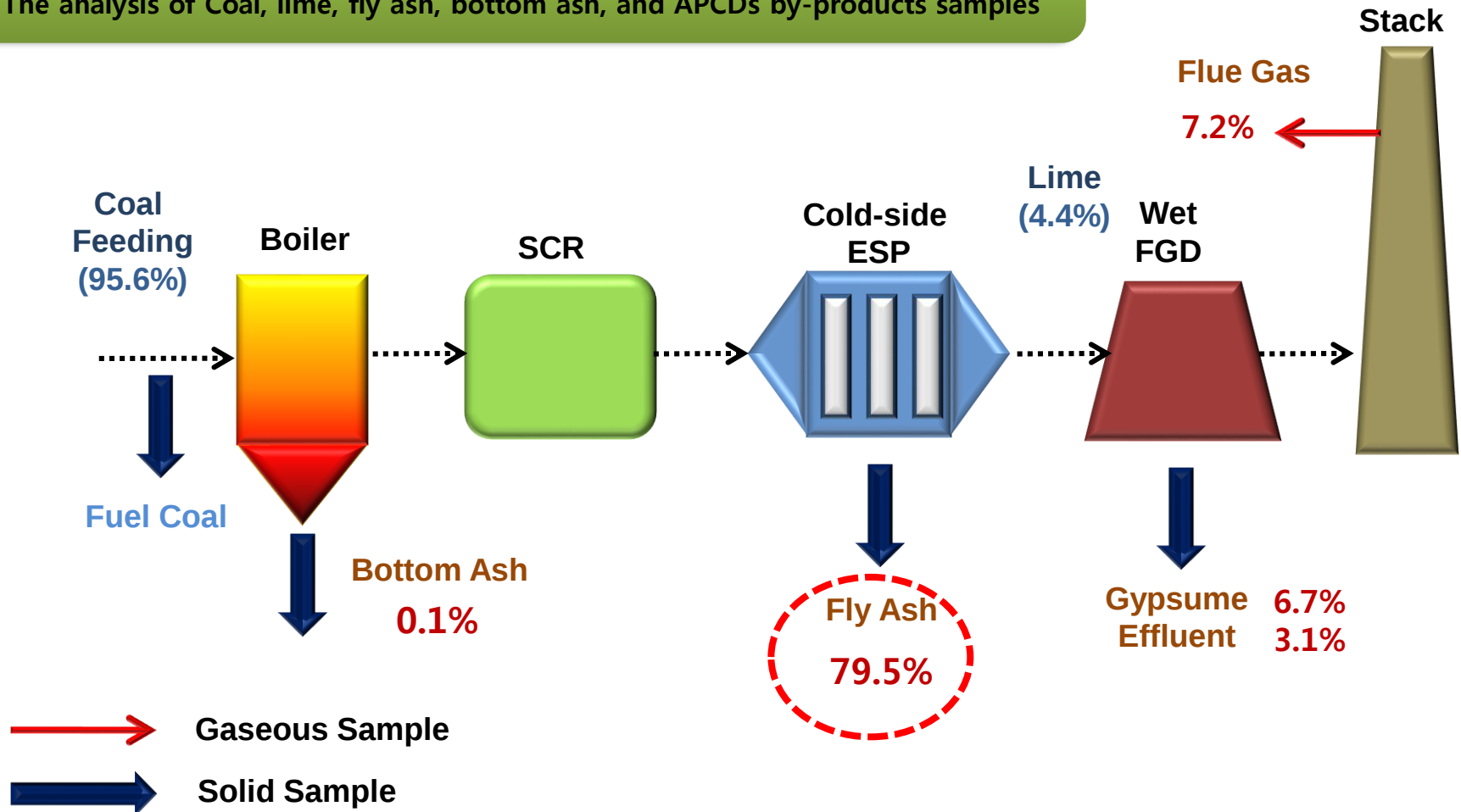


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Hg Mass balance in CPP

- Comparative evaluations of exhaust gases using EPA Method 101A, 30A and 30B
- The analysis of Coal, lime, fly ash, bottom ash, and APCDs by-products samples



Hg Mass balance in CPP



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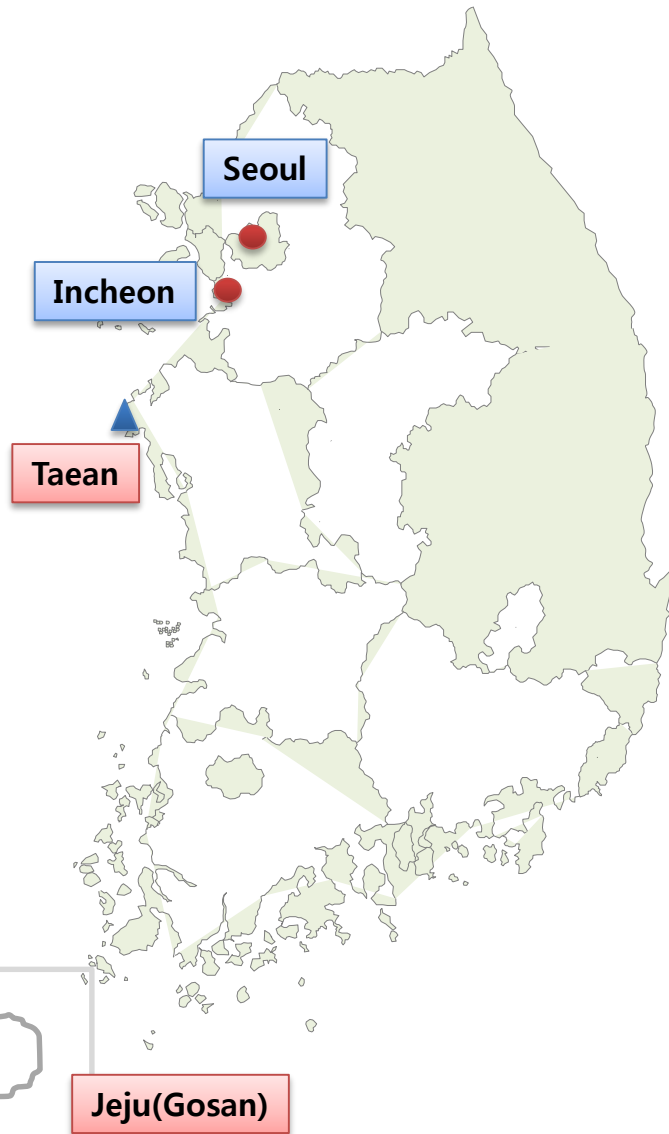
ID	Input			Output					
	Total	Fuel/ Coal	Lime/ Limestone	Total	F/A	B/A	Gypsum	Effluent	Flue gas
Hg mass Flow rate (g/day)	226.8	224.2	2.6	180.7	152.8	0.9	10.9	5.8	10.3
Mass balance (%)	100	98.9	1.1	79.67	67.38	0.41	4.79	2.56	4.52

Coal사용량 = 7915 ton/day, Lime사용량 = 137 ton/day, F/A발생량 = 537 ton/day, B/A발생량 = 95 ton/day,
Gypsum 생산량 = 187 ton/day, Effluent 발생량 = 73 ton/day, 배출가스 유량 = 64,081,903 m³/day

Hg mass Flow rate (g/day)	139.5	133.4	6.1	134.8	110.9	0.08	9.4	4.3	10.1
Mass balance (%)	100	95.6	4.4	96.6	79.5	0.1	6.7	3.1	7.2

Coal사용량 = 7463 ton/day, Lime사용량 = 108 ton/day, F/A발생량 = 495 ton/day, B/A발생량 = 95 ton/day,
Gypsum 생산량 = 242 ton/day, Effluent 발생량 = 63 ton/day, 배출가스 유량 = 63,170,872 m³/day

Characteristics of Atmospheric Total Gaseous Mercury Concentrations



- TGM assessment in bkgd./urban areas (using the AMMS results)
 - Concentration of atmospheric mercury by chemical specie (Taejeon)
 - Mercury wet deposition in bkgd./urban areas
- ↑
- Long-term monitoring data for effectiveness evaluation under the Minamata Convention
 - Participation in the Asia-Pacific Mercury Monitoring Network

Averaged seasonal TGM concentrations at 4 sampling sites (Jan. ~ Dec. 2015)



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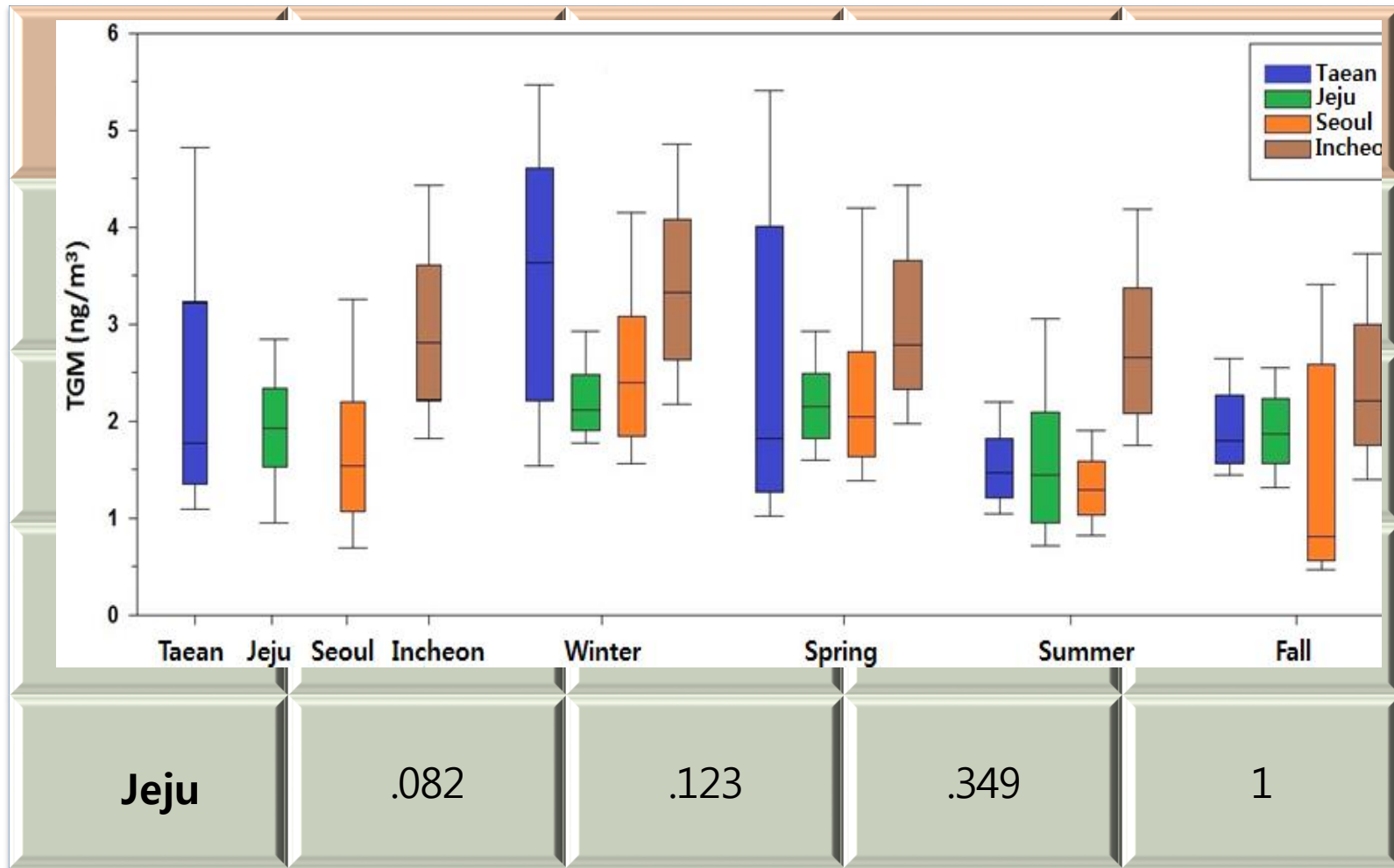
	Seoul	Incheon	Taeon	Jeju
Winter (Dec-Feb)	2.5 ± 1.0	3.3 ± 0.5	3.1 ± 1.5	1.8 ± 0.8
Spring (Mar-May)	2.6 ± 2.2	3.0 ± 0.3	2.8 ± 1.8	2.2 ± 0.05
Summer (Jun-Aug)	1.3 ± 0.5	2.9 ± 0.4	1.6 ± 0.5	1.6 ± 0.9
Fall (Sep-Nov)	2.4 ± 1.5	2.6 ± 0.2	1.9 ± TGM (ng/m ³) 0.7	1.3 ± 0.6
Total (range)	2.19 ± 1.57 (0.29-29.35)	2.97 ± 1.18 (1.01-15.97)	2.32 ± 1.40 (0.69-10.96)	1.73 ± 0.80 (0.40-4.68)

0.71

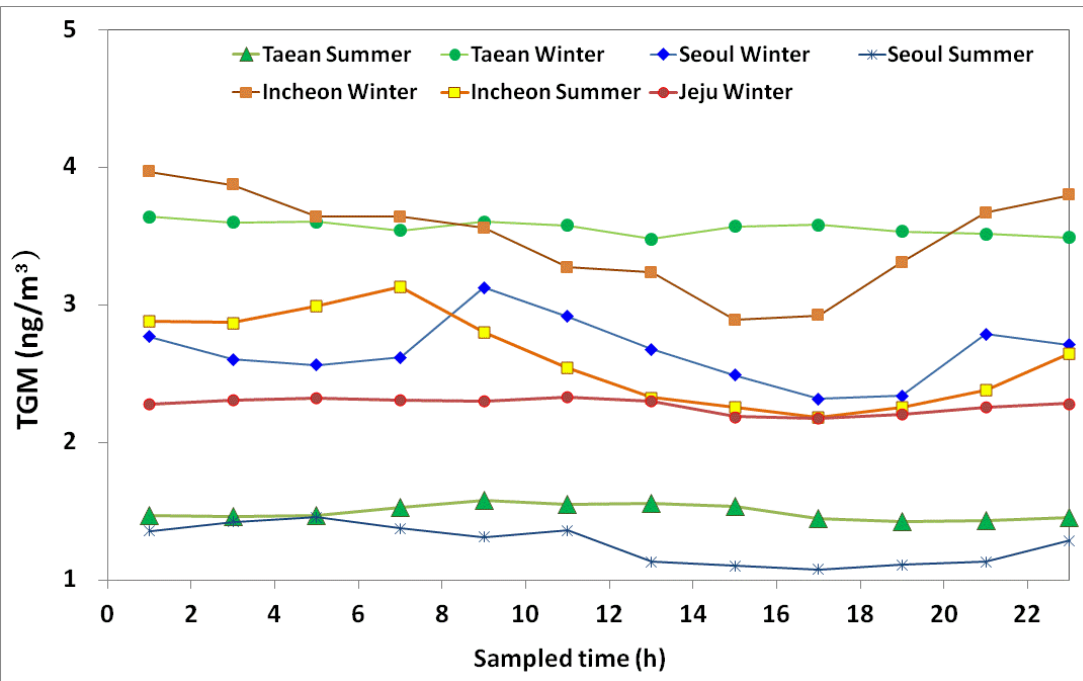
0.61

0.46

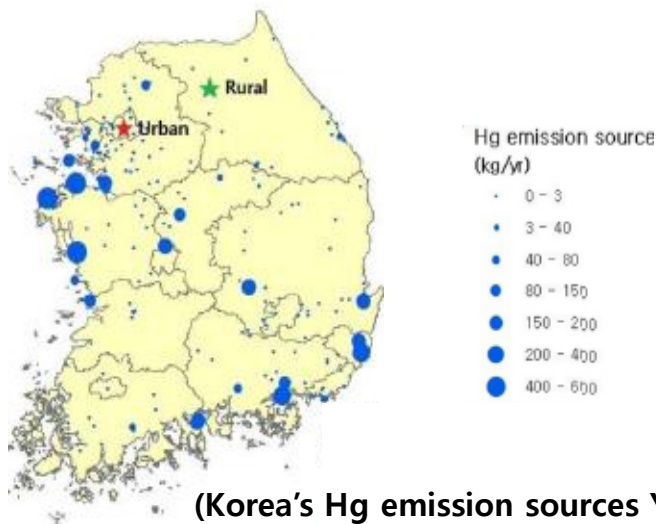
Comparison of seasonal TGM concentrations between sampling sites



Comparison of hourly TGM concentrations



- Little change in Jeju and Taejeon
⇒ Affected by long-range inflow more than local sources
- Changes with time in Incheon
⇒ Local sources
Air diffusion increases continuously (day)
Air stagnation decreases continuously (night)
- High concentration at certain times in Seoul



(Korea's Hg emission sources Y. Lee, '11)



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THANK YOU

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