Trace Metal Biogeochemistry Laboratory TMBL

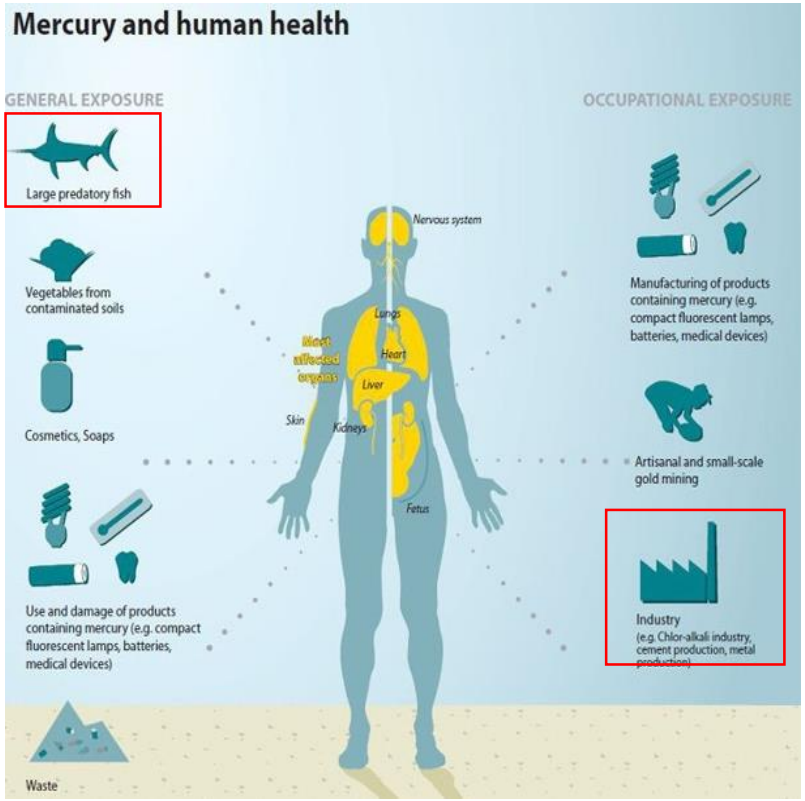
광주과학기술원 Gwangju Institute of Science and Technology

2018 APMMN meeting

National mercury monitoring activities in Korea

Seunghee Han and Eunji Jeong
School of Environmental Sciences and Engineering
Gwangju Institute of Science and Technology (GIST)
Gwangju, Korea

1. Introduction

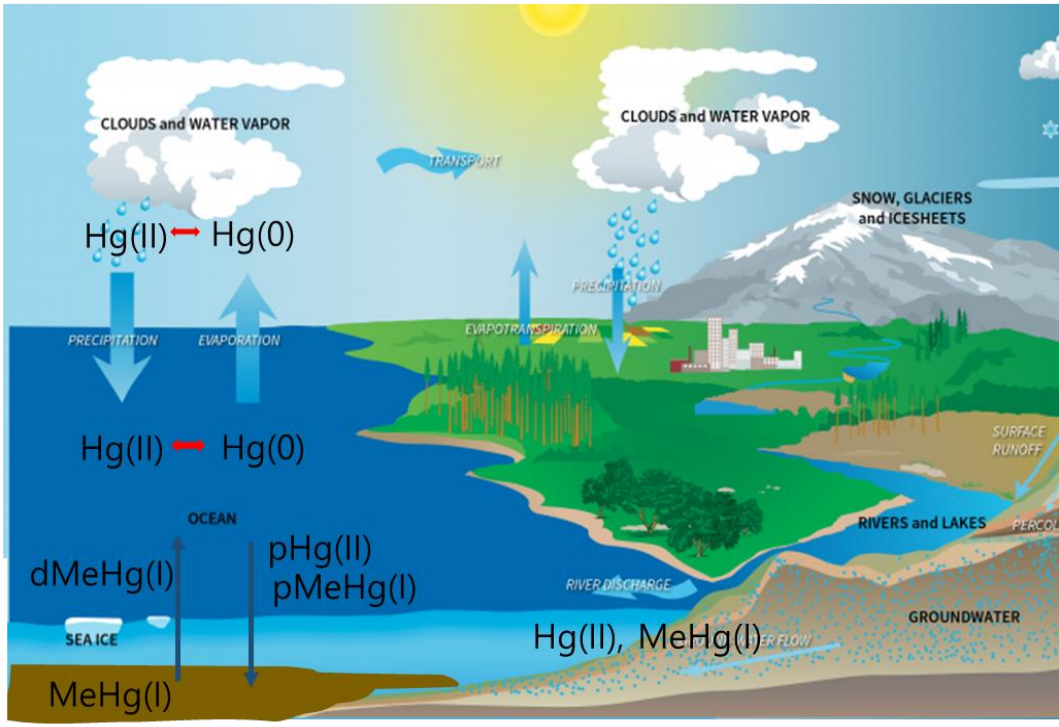


Zero-valent mercury, Hg(0)

- <0.01% bioavailability after ingestion
- After inhalation it easily cross blood-brain barrier
- Disorder of central nervous system
- Nervousness, erethism

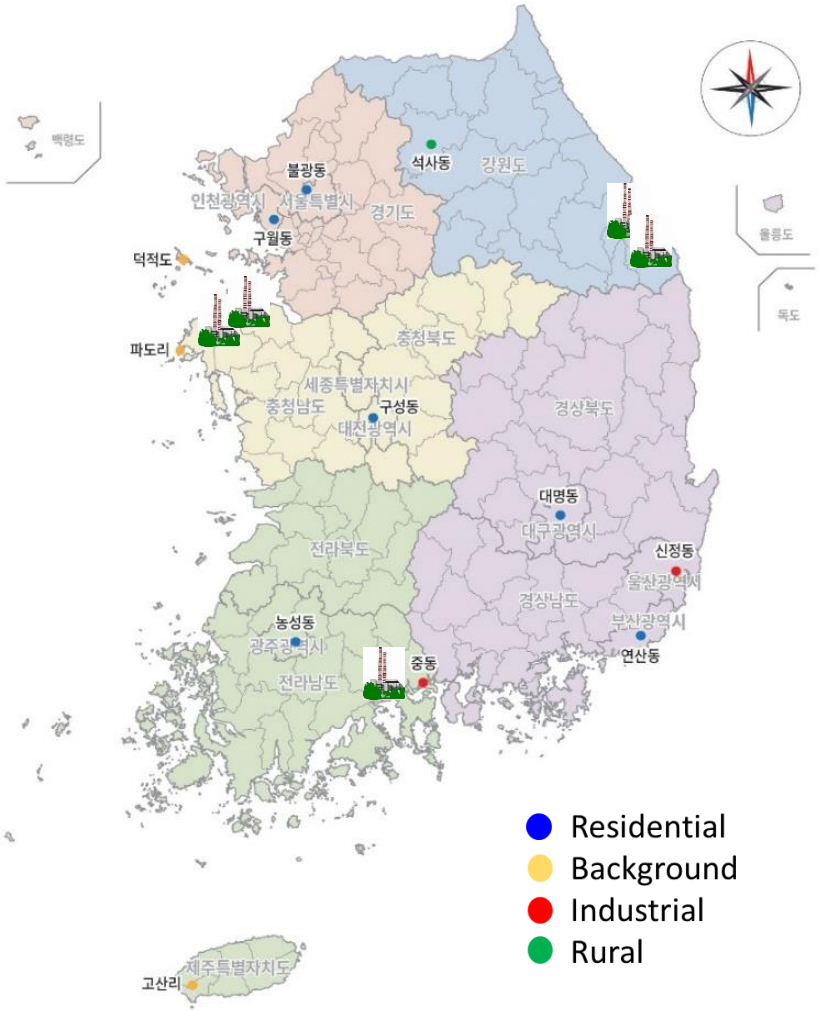
Divalent mercury, Hg(II)

- 7–15% bioavailability after ingestion
- Kidney damage
- Renal tubule damage
- Nephritis

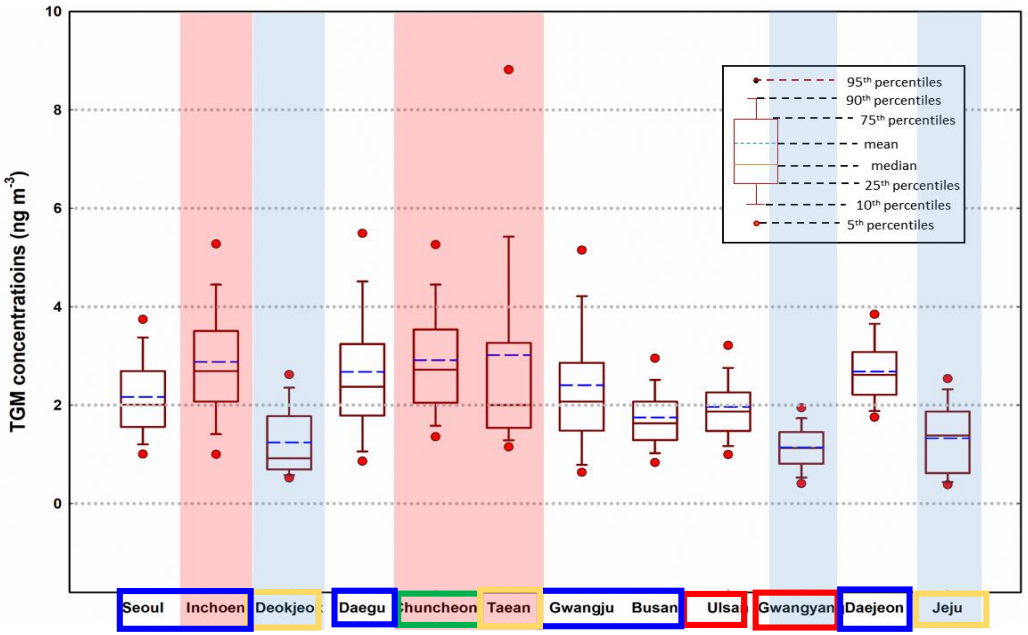


2. National monitoring network for TGM

- TGM has been monitored using CVAFS (Tekran system) at the 12 acid precipitation monitoring sites from 2012 (2 hr mean).



Annual mean TGM (2012-2014)



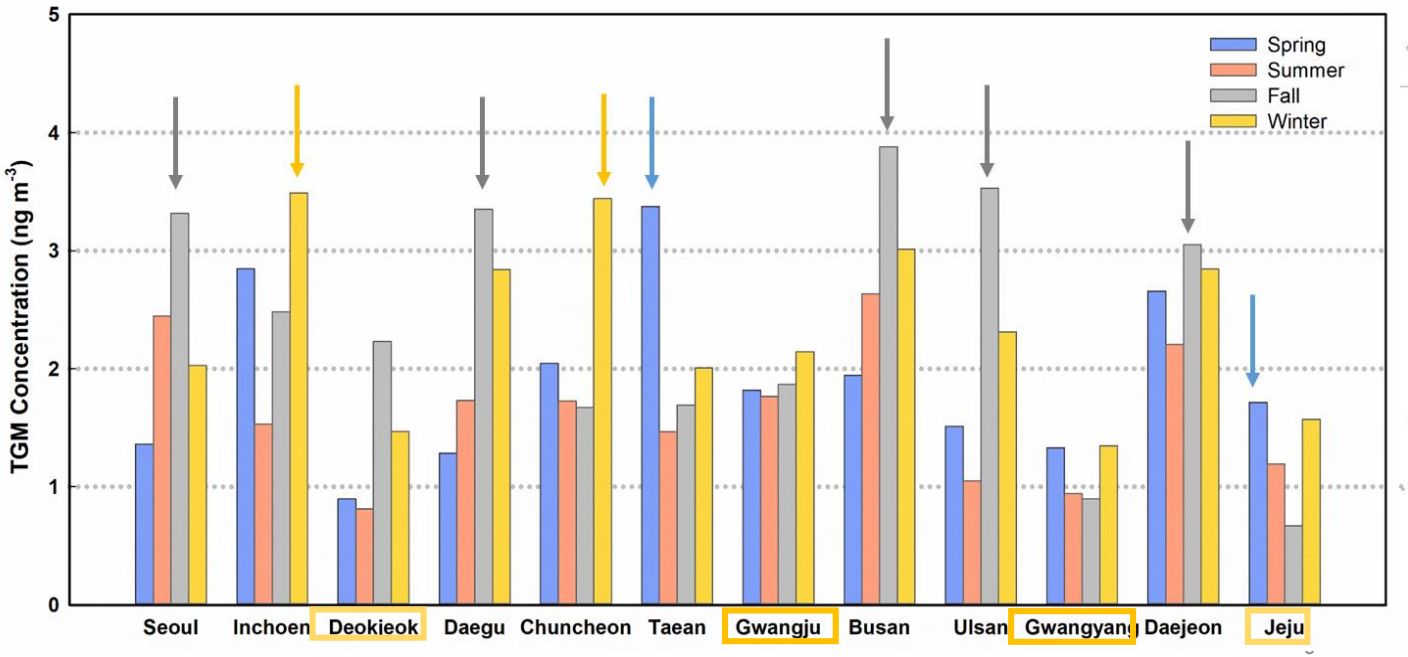
Courtesy of Youngji Han and NIER

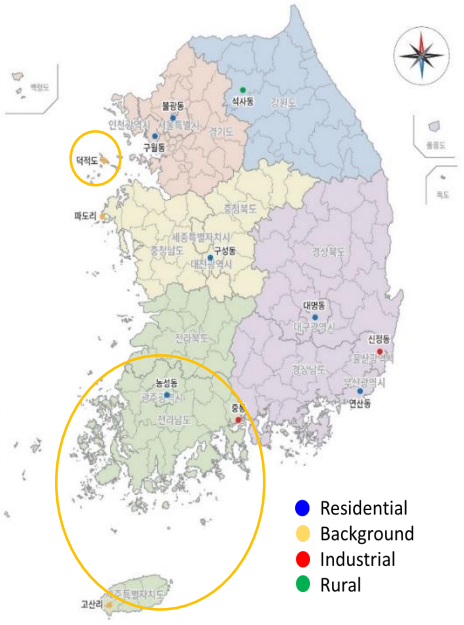
Sources: Air Korea (http://www.airkorea.or.kr)

2. National monitoring network for TGM

- The lowest TGM is found from the southwest area (Jeju, Gwanyang and Gwangju).
- Peak conc is commonly found in fall and winter in the other sites with large seasonal variations.

2014





Courtesy of Youngji Han and NIER

2. National monitoring network for TGM

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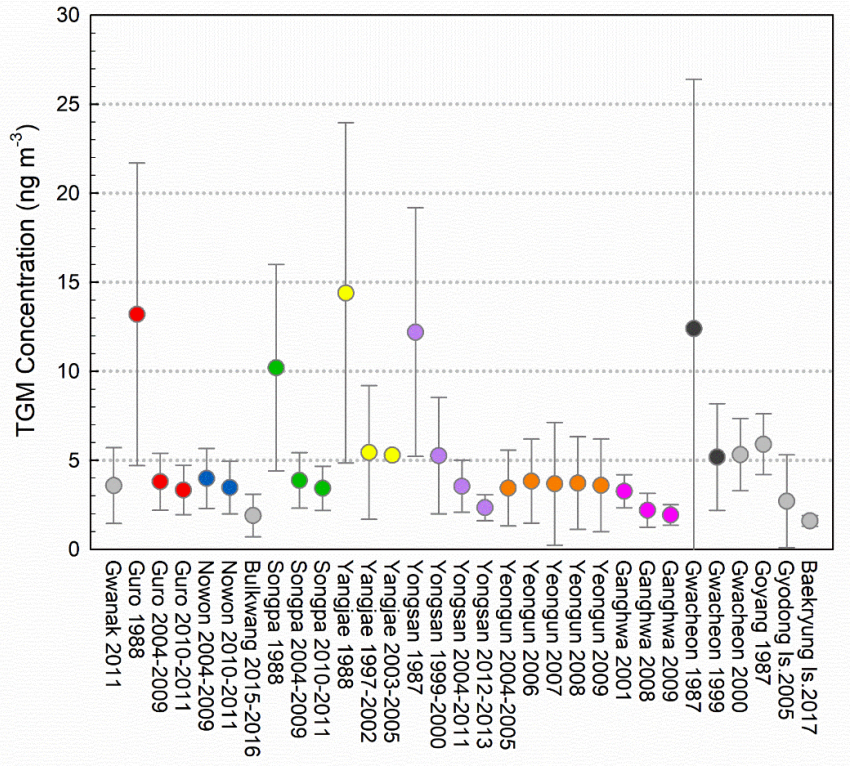
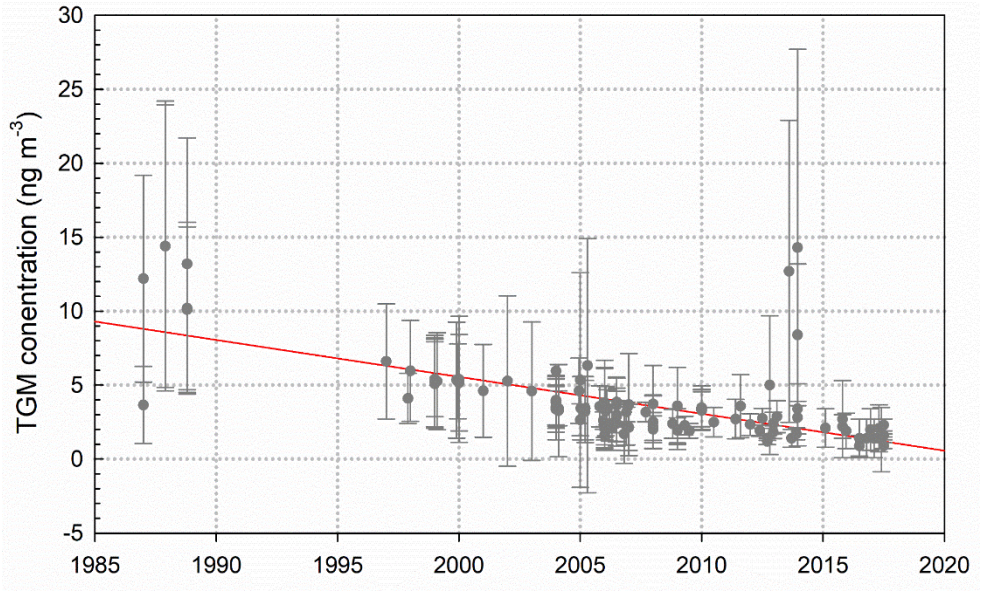
- TGM shows relatively steady trend after 2005.

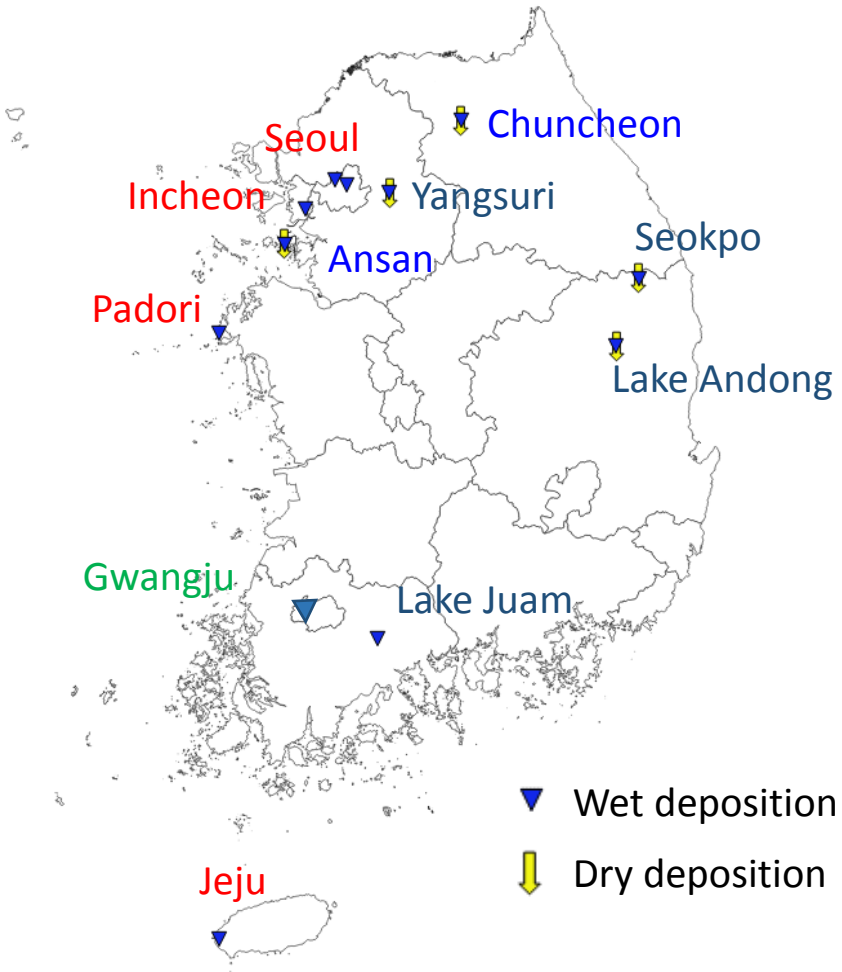




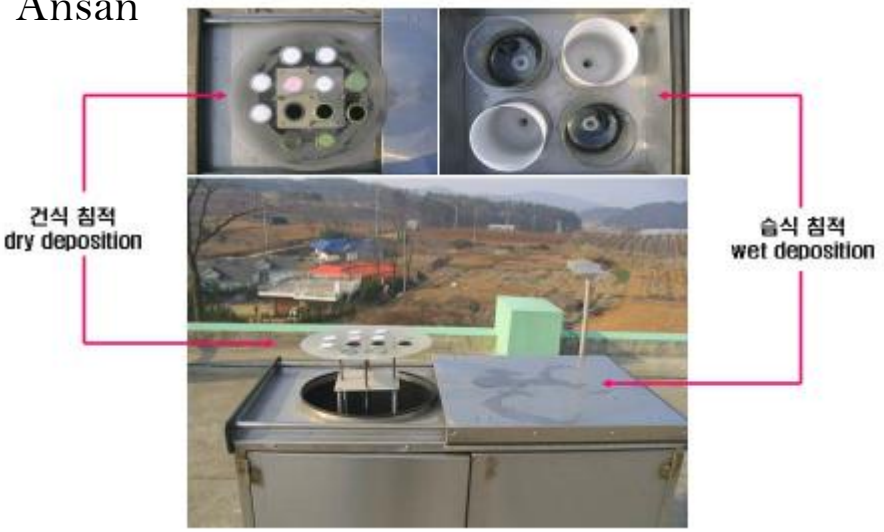
Courtesy of Youngji Han

3. National monitoring network for wet deposition

- Jeju, Padori, Incheon, Seoul: national monitoring, weekly sampling, 2015-present
- Andong, Seokpo: event sampling, 2009-2011
- Ansan, chuncheon: event sampling
- Gwangju: APMMN supported, 2016-present



Ansan

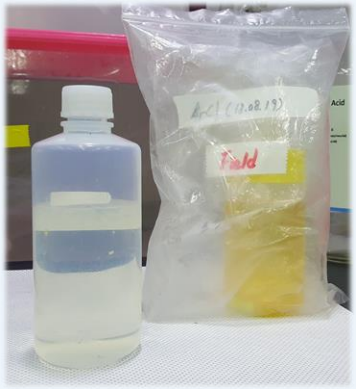


Gwangju

3. National monitoring network for wet deposition

- Gwangju site has been operated from April 2016.
- THg is measured at the Dr Sheu's lab in Taiwan and MeHg at the GIST lab.

THg



BrCl oxidation

Reduction and sorption

CVAFS

MeHg

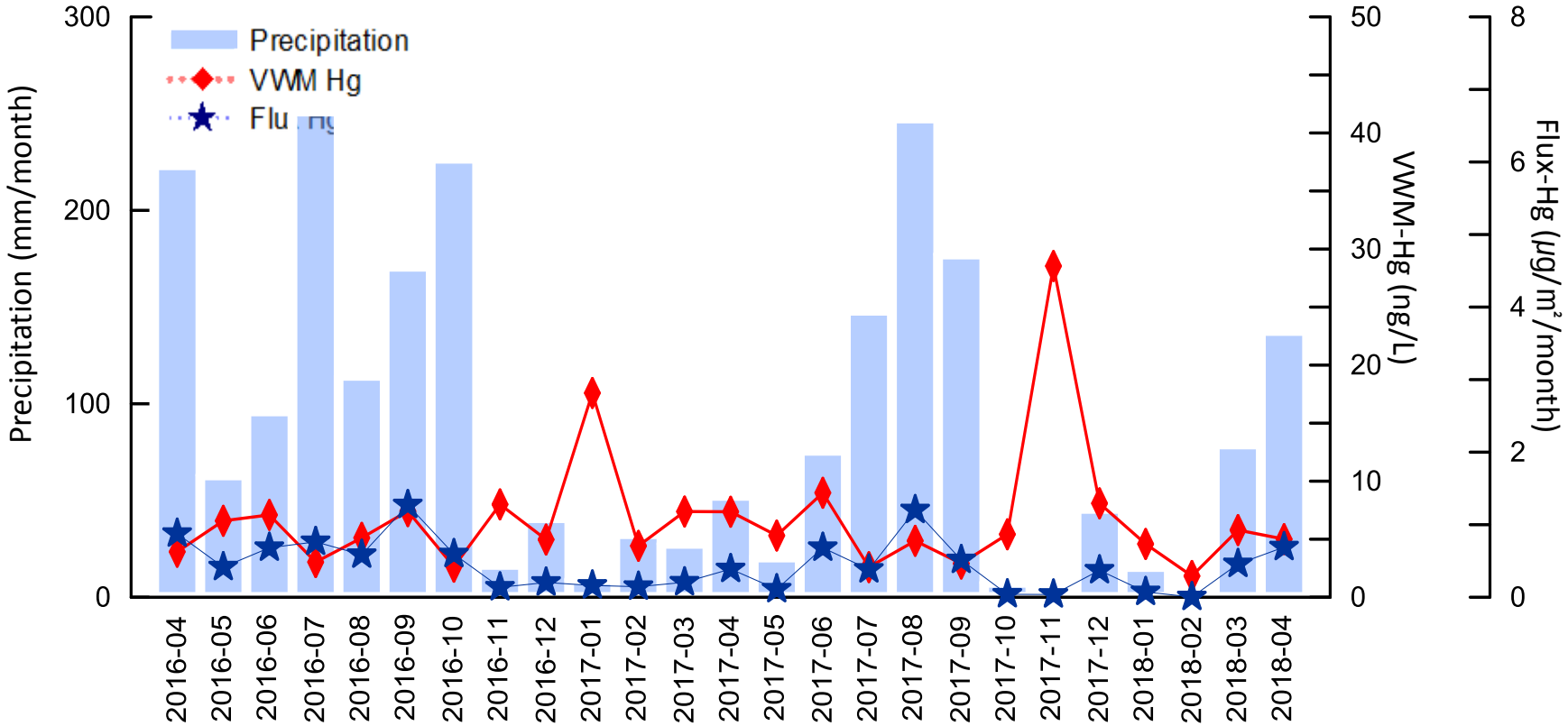
Distillation

Ethylating and sorption

GC-CVAFS

3. National monitoring network for wet deposition

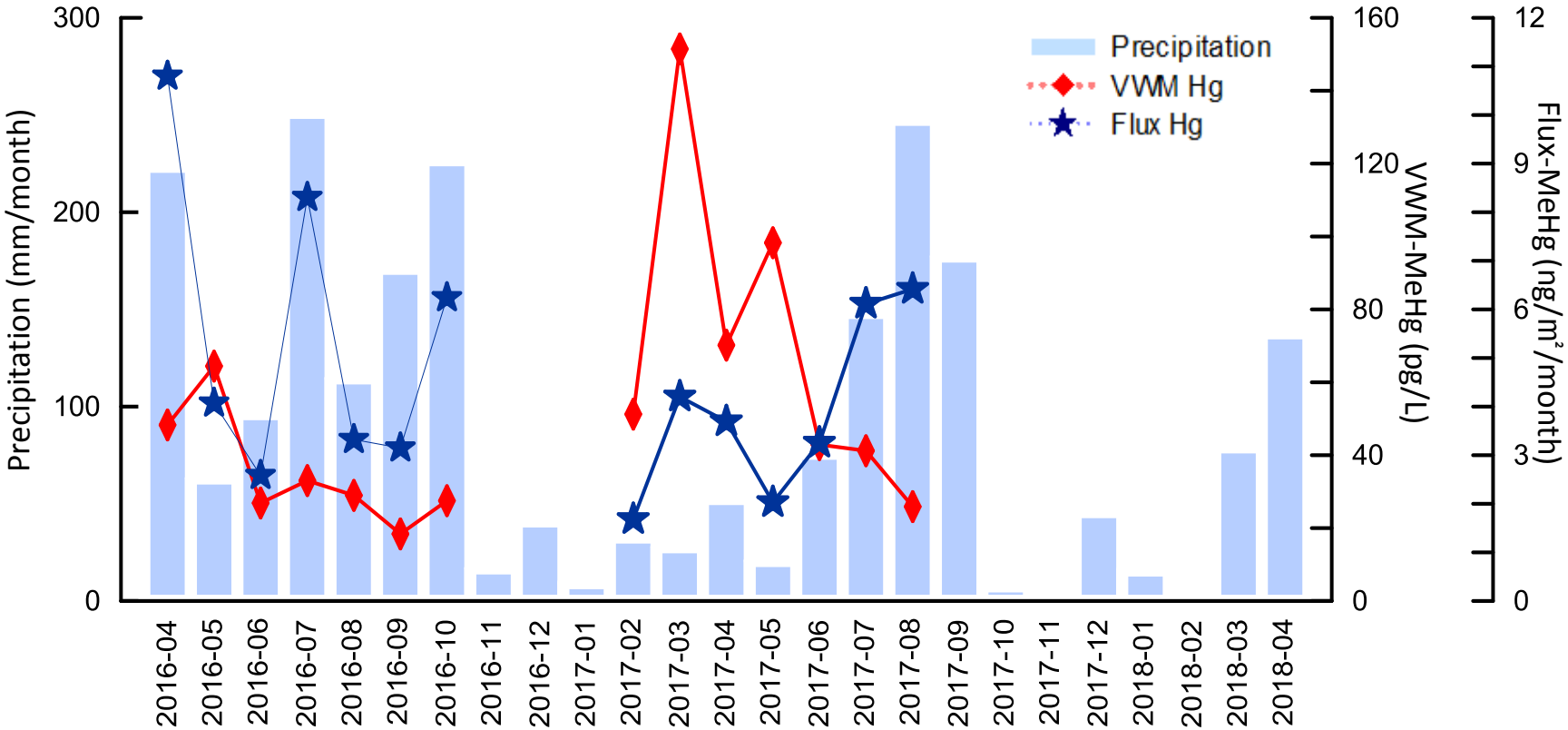
- VWM THg is peaked in winter (November and January) and wet deposition is peaked in summer (August).



April 2016-March 2017, VWM THg: 4.7 ng/L, THg flux: 6.0 μg/m^2/yr
April 2017-March 2018, VWM THg: 4.9 ng/L, THg flux: 4.3 μg/m^2/yr

3. National monitoring network for wet deposition

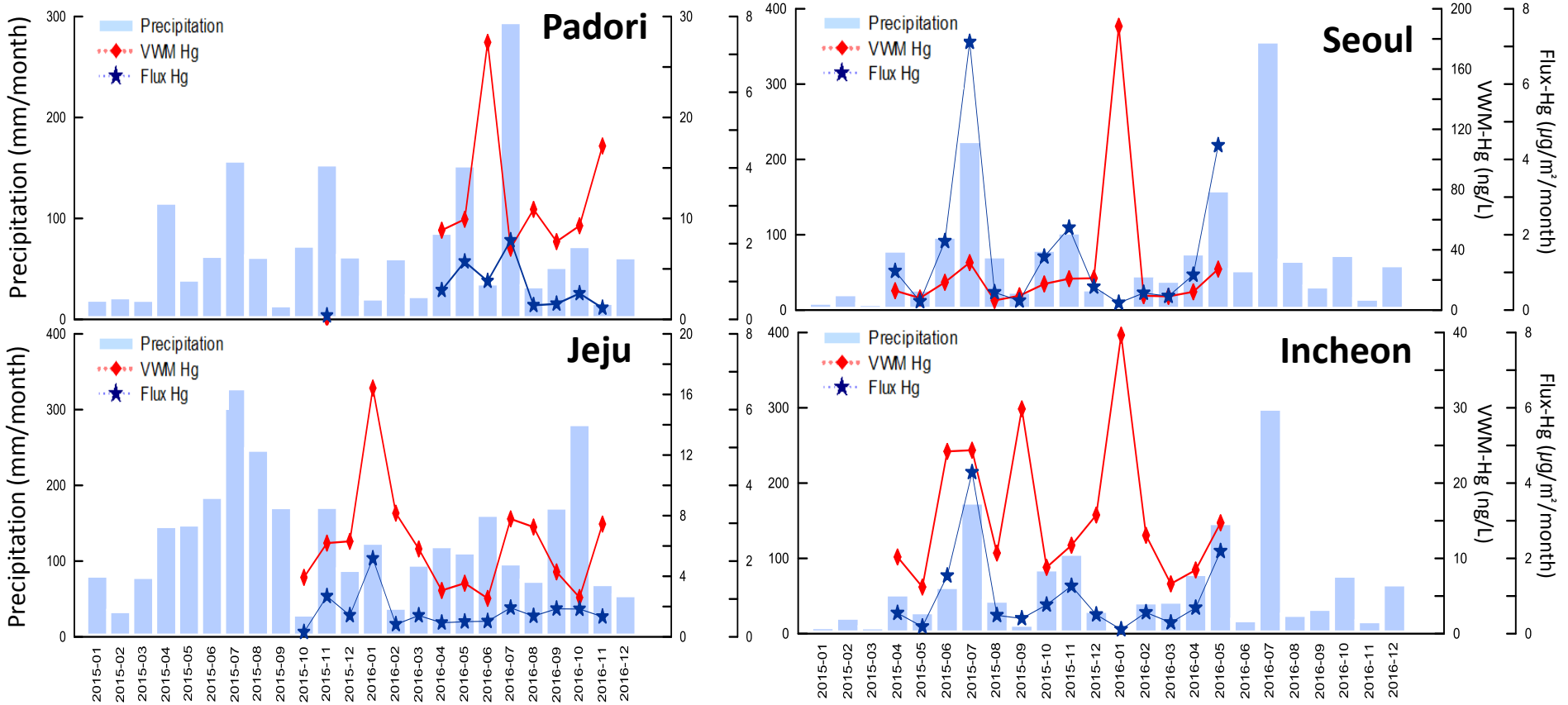
- VWM MeHg is highest in spring (March) and wet deposition follows the precipitation trend.



April 2016-March 2017, VWM MeHg: 31 pg/L, MeHg flux: 40 ng/m^2/yr (0.67% of THg)

3. National monitoring network for wet deposition

- VWM is highest in January and wet deposition is highest in July except Jeju.



Courtesy of Youngji Han and NIER

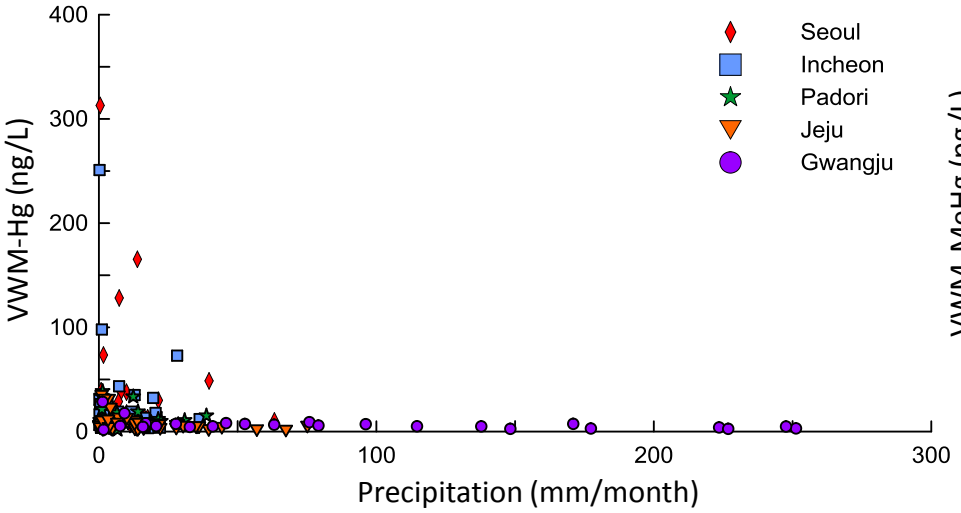
Jeju Oct 2015 – Sep 2016, VWM THg: 4.5 ng/L, THg flux: 8.0 μg/m^2/yr

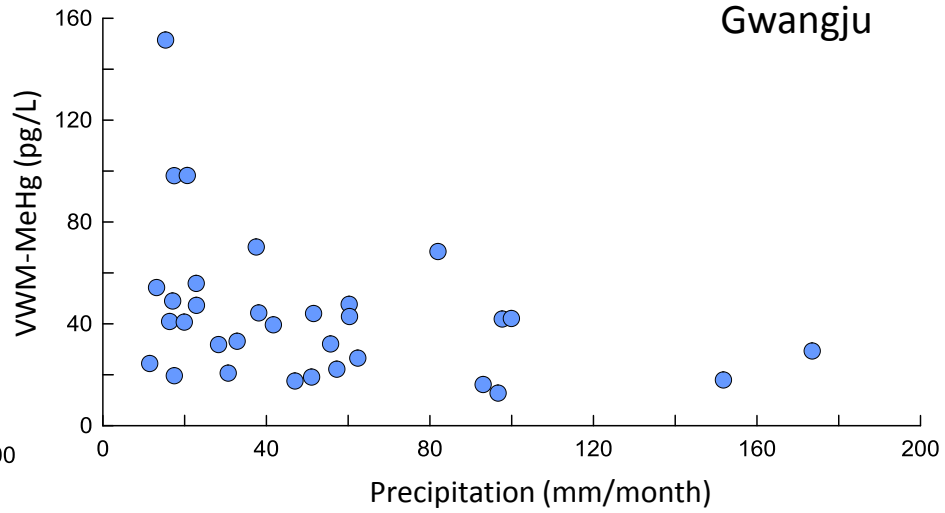
Seoul April 2015 – March 2016, VWM THg: 21.1 ng/L, THg flux: 16.1 μg/m^2/yr

Incheon April 2015 – March 2016, VWM THg: 13.9 ng/L, THg flux: 11.0 μg/m^2/yr

3. National monitoring network for wet deposition

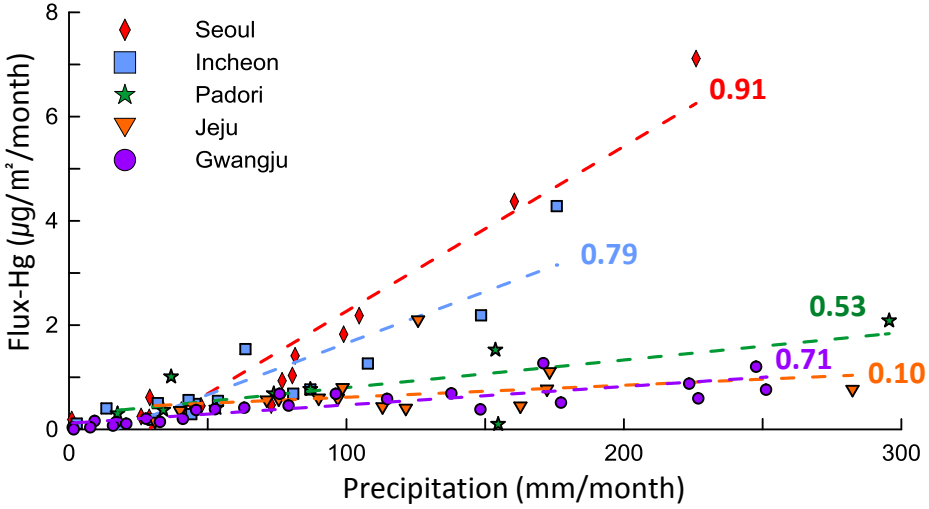
- VWM concentrations of THg and MeHg were negatively correlated to precipitation.

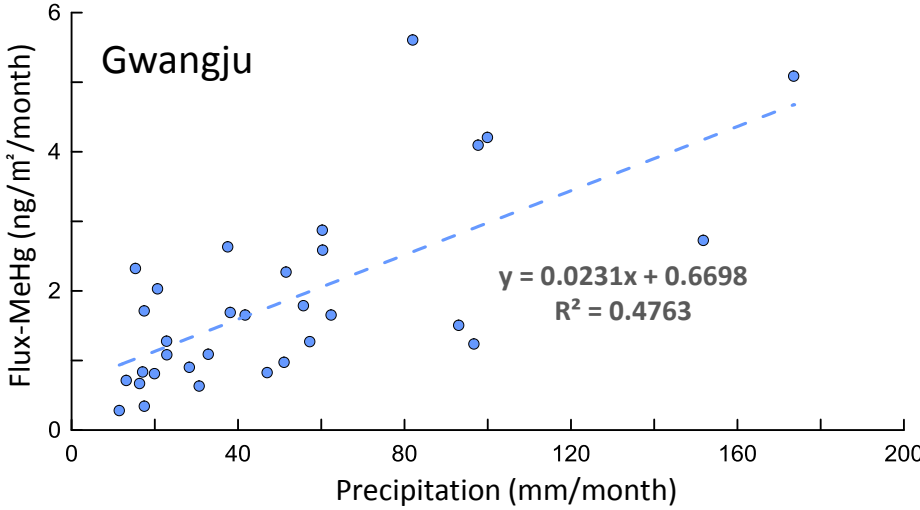


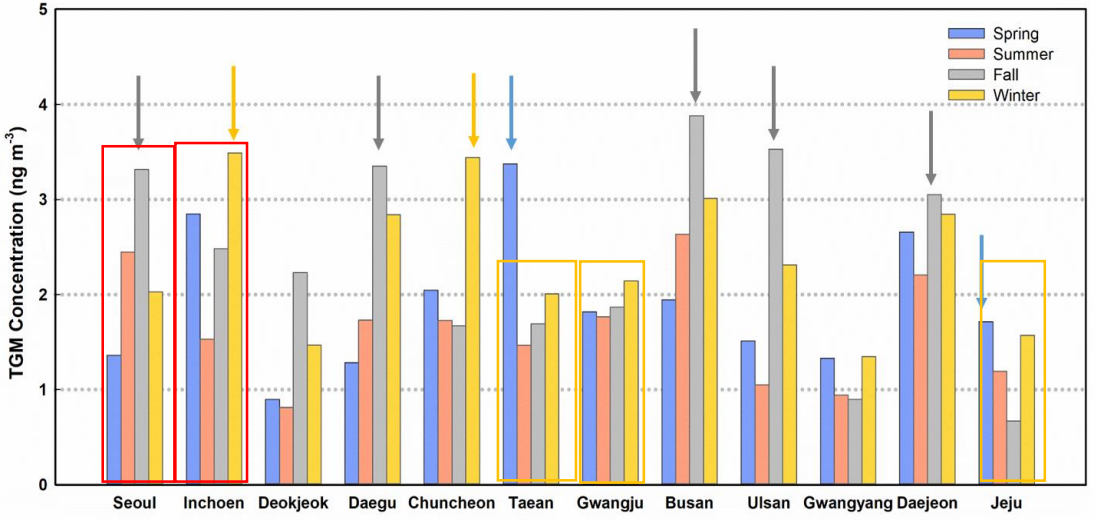


3. National monitoring network for wet deposition

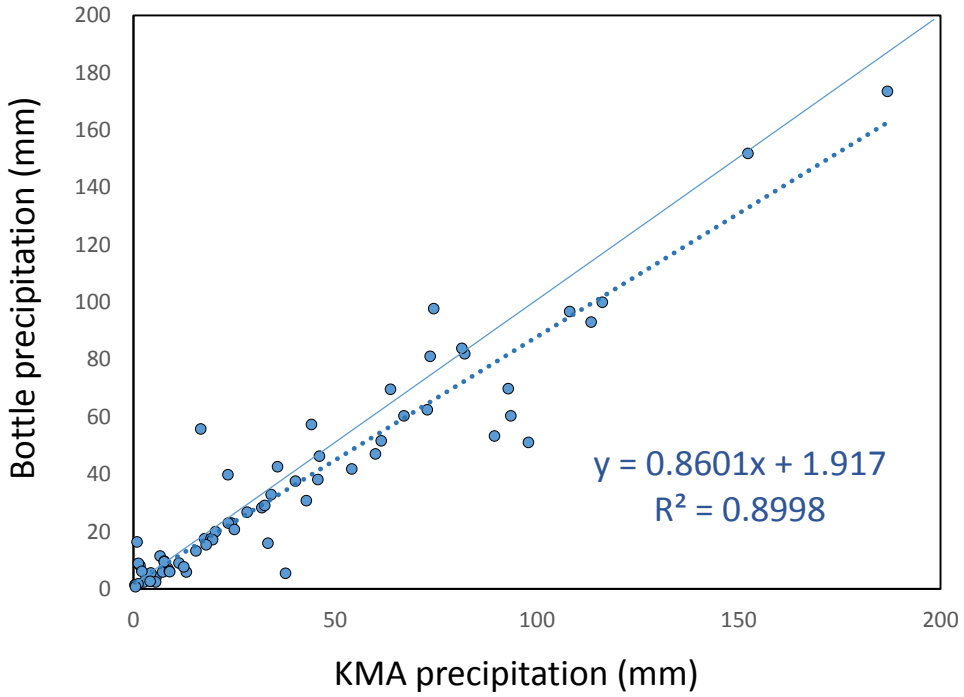
- Wet deposition/precipitation: Seoul > Incheon > Padori > Gwangju, Jeju







3. National monitoring network for wet deposition



- Hg and MeHg deposition fluxes of Gwangju site might be underestimated by ~14%.

3. National monitoring network for wet deposition

Site	Type	Sampling period	Annual prec (mm)	VWM (ng/L)		Wet deposition (μg/m²/yr)		Reference
				THg	MeHg	THg	MeHg	
Chongqing China	Industrial	Dec 2010-Nov 2014	1104.4	34.3	0.48	37.8	0.53	Qin et al., 2016
Chongqing China	Urban	Jul 2010-Jun 2011	921	30.7	0.31	-	-	Wang et al., 2012
Lhasa, Tibetan, China	Urban	Jan-Dec 2009	359	24.8	-	8.2	-	Huang et al., 2013
Seoul Korea	Urban	April 2015-March 2016	766	21.1	-	16.1	-	This study
Three Gorges Reservoir, China	Rural	Nov 2012-Oct 2013	743	18.0	0.23	13.0	0.17	Zhao et al., 2015
Xiamen, China	Suburban	Jun 2012-May2013	1137	12.3	0.053	14.0	0.058	Xu et al., 2014
Pengjiayu Taiwan	Remote	Jan-Dec 2009	1438	8.8	-	10.2	-	Sheu and Lin, 2013
Minamata Bay Japan	Costal	Sep 2009-Aug 2010	-	5.9	0.061	13.7	0.14	Marumoto and Matsuyama, 2014
Gwangju Korea	Urban	April 2016-March 2017	1274	4.7	0.031	6.0	0.040	This study
Tibetan Plateau, China	Alpine	May 2010-Oct 2012	978	4.0	0.11	3.9	0.11	Huang et al., 2015

4. Conclusions

- The median TGM concentration of each monitoring site ranged from 1.0 to 2.8 ng m^{-3} and peak concentrations were found in fall and winter (national network, 2012-2014).

- The concentration range of TGM was low and seasonal variation was small in the southwest part Korea including Jeju island (Seoul, Busan and Incheon) (national network, 2012-2014).

- The wet deposition of THg normalized to precipitation (Seoul > Incheon > Padori > Gwangju, Jeju) follows the trend of TGM (national network 2015-2016 and Gwangju 2016-2017).

- VWM of THg and MeHg was highest in winter and spring, respectively. MeHg production and scavenging should be better understood with extensive data collection (Gwangju, 2016-2017).

5. What happens after deposition?

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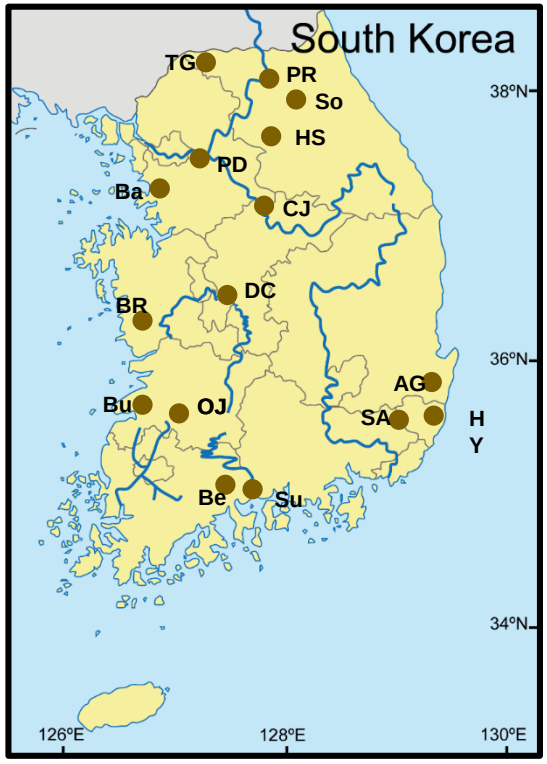
Pilot project for the comprehensive mercury monitoring network in Korea

(1) Preliminary study (2013-2015)

(2) Pilot project (2016-2020)

(3) Operation of the national monitoring network (2021-)



							
DC (1981)	So (1973)	PR (1944)	OJ (1965)	BR (1996)	TG (1976)	Bu (1996)	HY (1986)
Forest: 66% Agricul:15% Urban:17%	Forest: 80% Agricul:4.1% Urban:14%	Forest: 79% Agricul:8.0% Urban:9.9%	Forest: 64% Agricul:13% Urban:23%	Forest: 80% Agricul:11% Urban:6.6%	Forest: 42% Agricul:39% Urban:15%	Forest: 89% Agricul:2.8% Urban:6.8%	Forest: 67% Agricul:19% Urban:8.7%
							
Su (1978)	Ba (1957)	Be (1967)	PD (1973)	CJ (1985)	AG (1971)	SA (1962)	HS (2000)
Forest: 87% Agricul:8.0% Urban:3.2%	Forest: 18% Agricul: 43% Urban: 39%	Forest: 8.2% Agricul:86% Urban:5.3%	Forest: 25% Agricul:60% Urban:15%	Forest: 10% Agricul:81% Urban:9.0%	Forest: 18% Agricul:57% Urban:25%	Forest: 7.5% Agricul:53% Urban:39%	Forest: 12% Agricul:80% Urban:8.0%

Preliminary study sites (2013 - 2015)

5. What happens after deposition?

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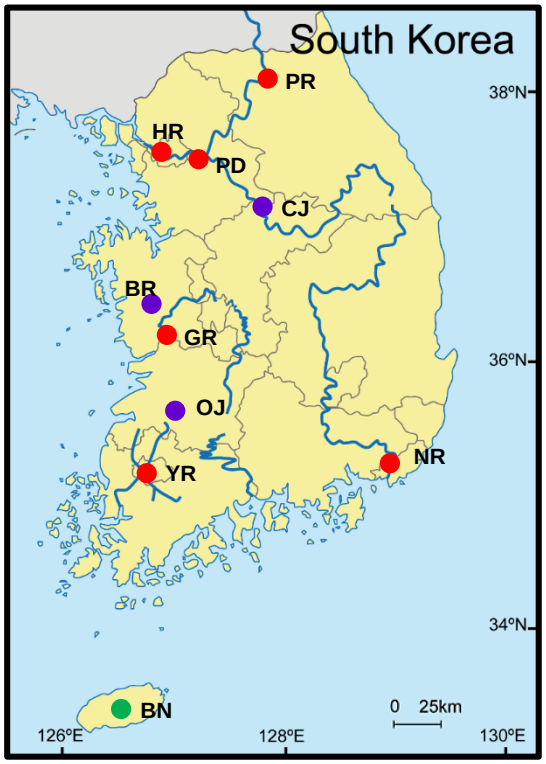
Pilot project (2016 - 2020)



- Background sites
- Fate evaluation
- Concentration evaluation

5. What happens after deposition?

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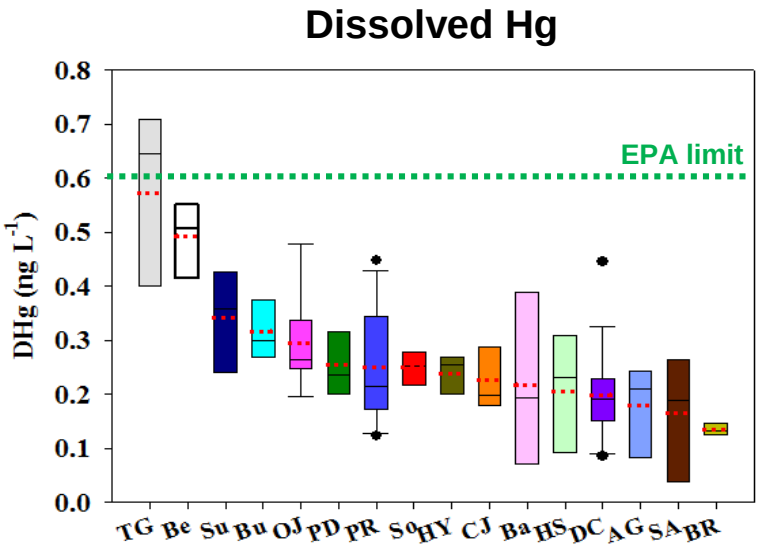
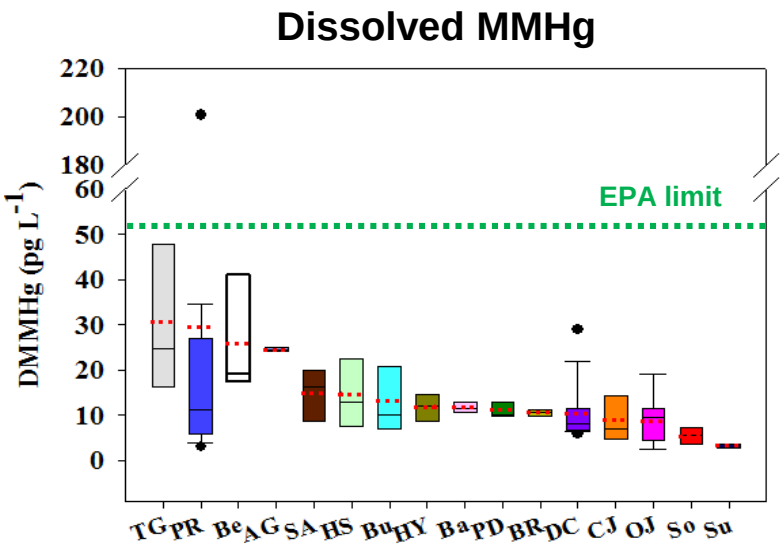
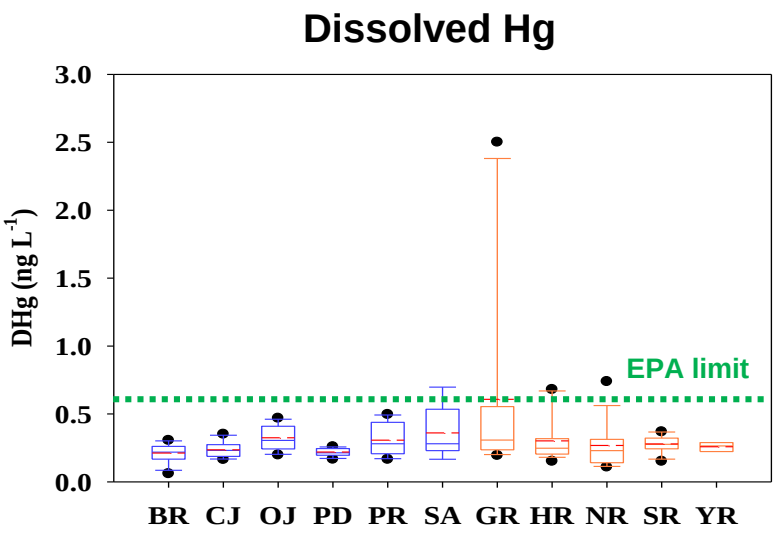
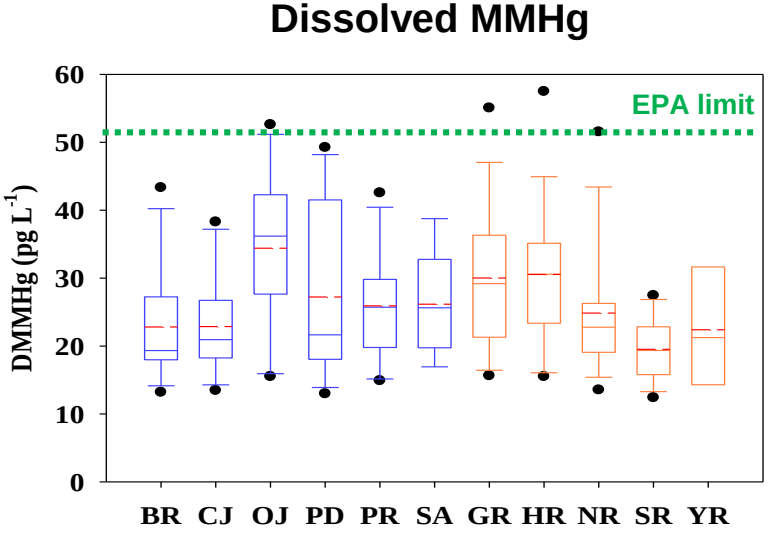
Preliminary study (2013 - 2015)





Pilot project (2016 - 2020)





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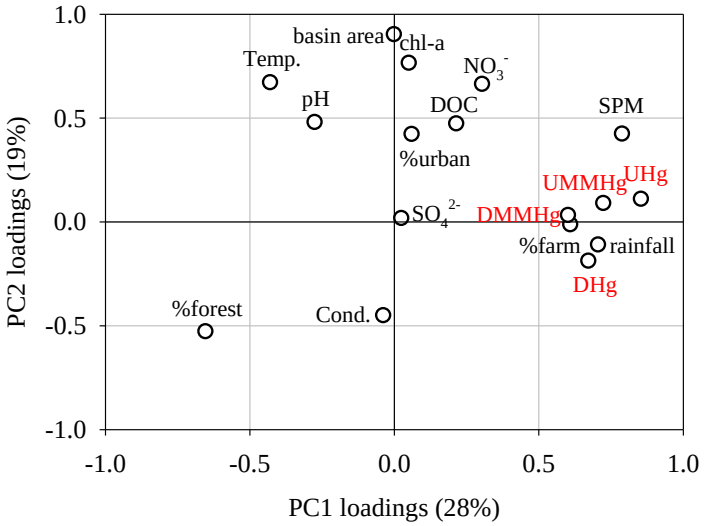
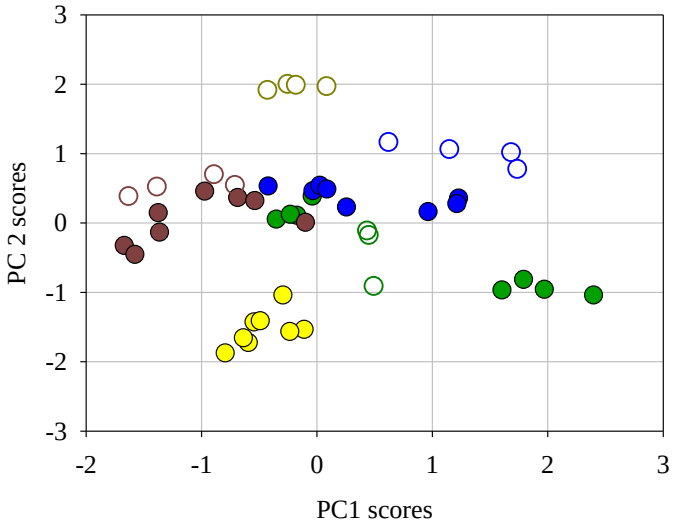
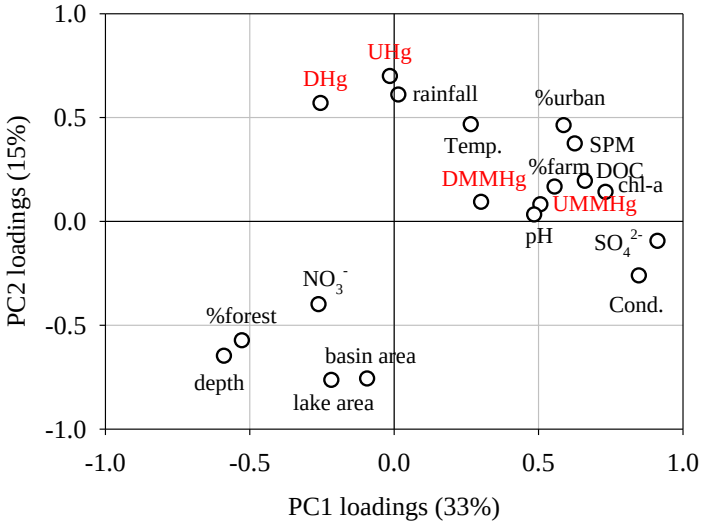
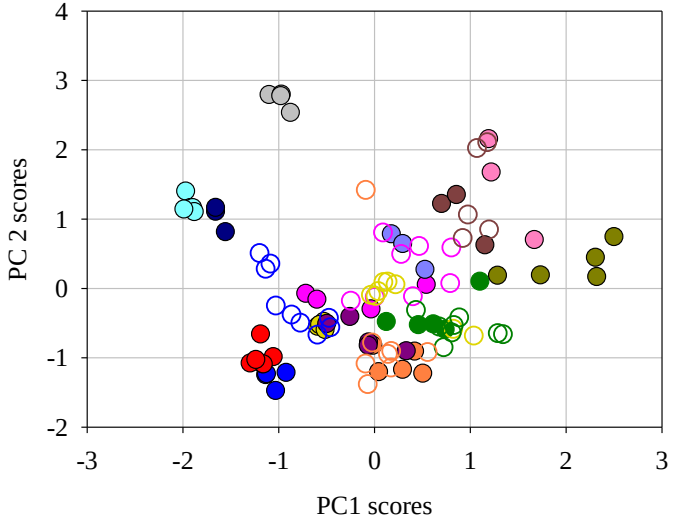




2016-2017 rivers
(excluding winter, n=48)

- 16 GR
- 16 HR
- 16 NR
- 16 SR
- 17 GR
- 17 HR
- 17 NR
- 17 YR



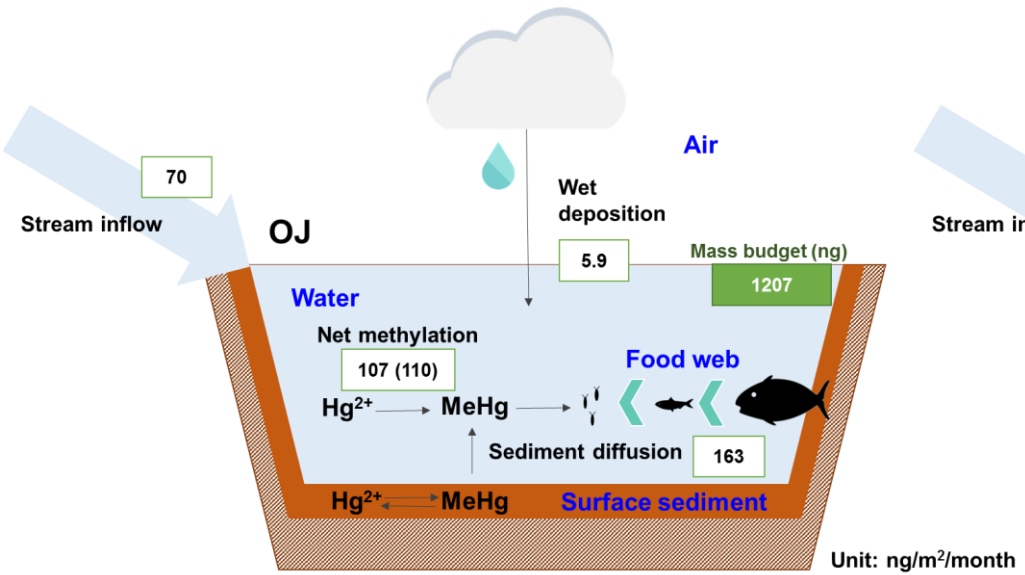


2013-2017 lakes
(excluding winter, n=112)

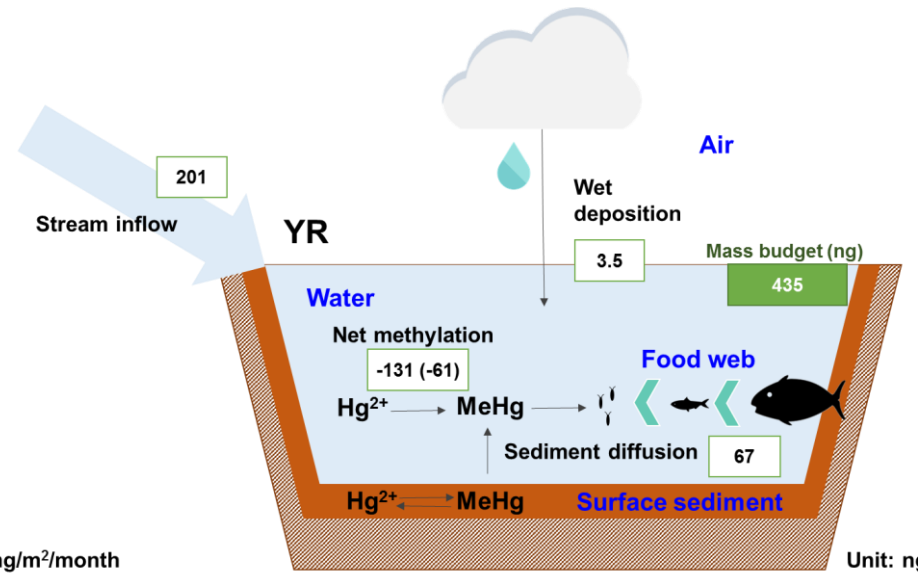
- 13-15 So
- 13-15 DC
- 13-15 TG
- 13-15 Su
- 13-15 Bu
- 13-15 HY
- 13-15 Ba
- 13-15 AG
- 13-15 OJ
- 13-15 PR
- 13-15 BR
- 13-15 PD
- 13-15 CJ
- 13-15 SA
- 16-17 OJ
- 16-17 PR
- 16-17 BR
- 16-17 PD
- 16-17 CJ
- 16 SA

5. What happens after deposition?

Okjeong Lake



Yeongsan River



Okjeong Lake: sediment diffusion > in-situ methylation > stream

Yeongsan River: stream > sediment diffusion > wet deposition

Acknowledgements

국립환경과학원

환경부