

13th APMMN meeting (Sep 3 - 6, 2024)

Wet Deposition of Mercury in South Korea

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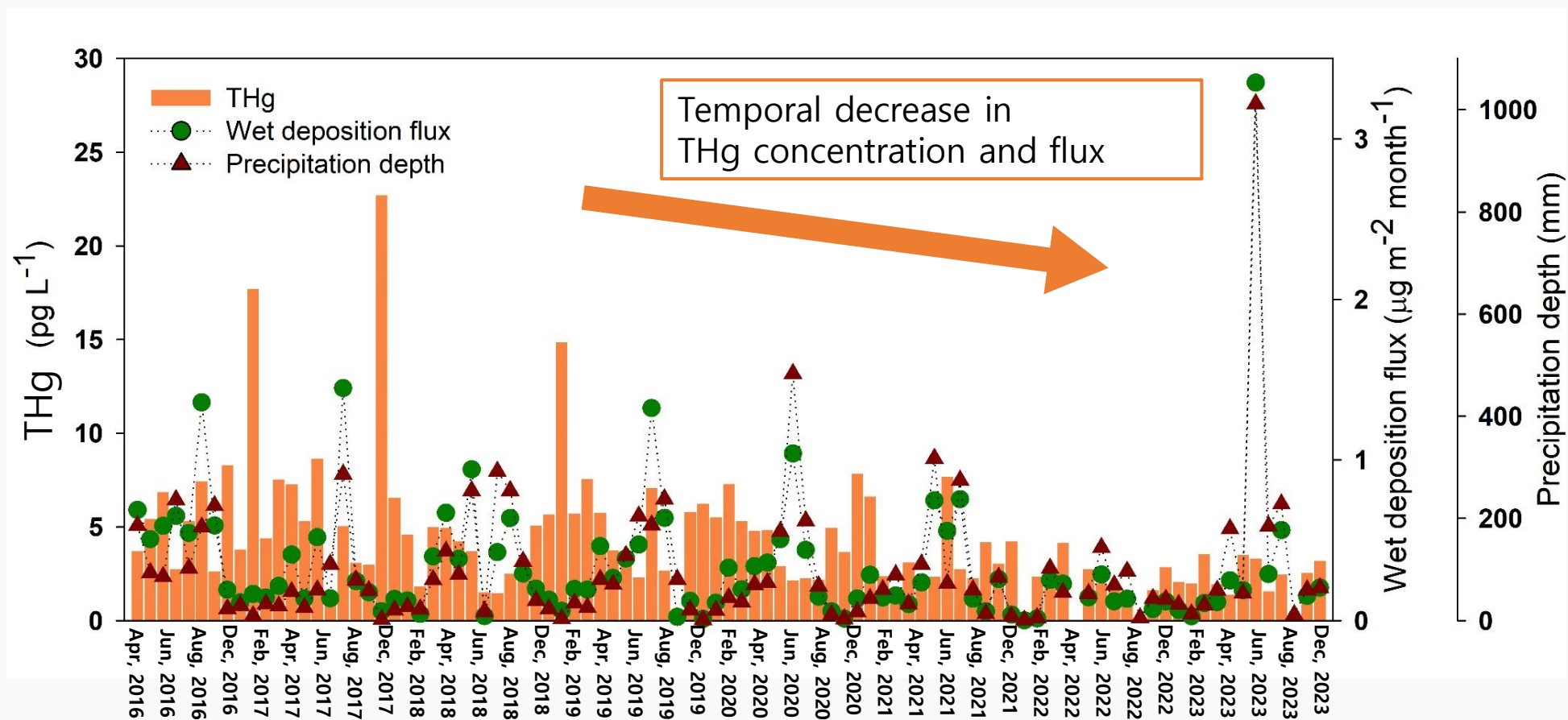
Gwangju Institute of Science and Technology (GIST)
Gwangju, Republic of Korea

Gwangju: APMMN-affiliated site in South Korea (2016-present)



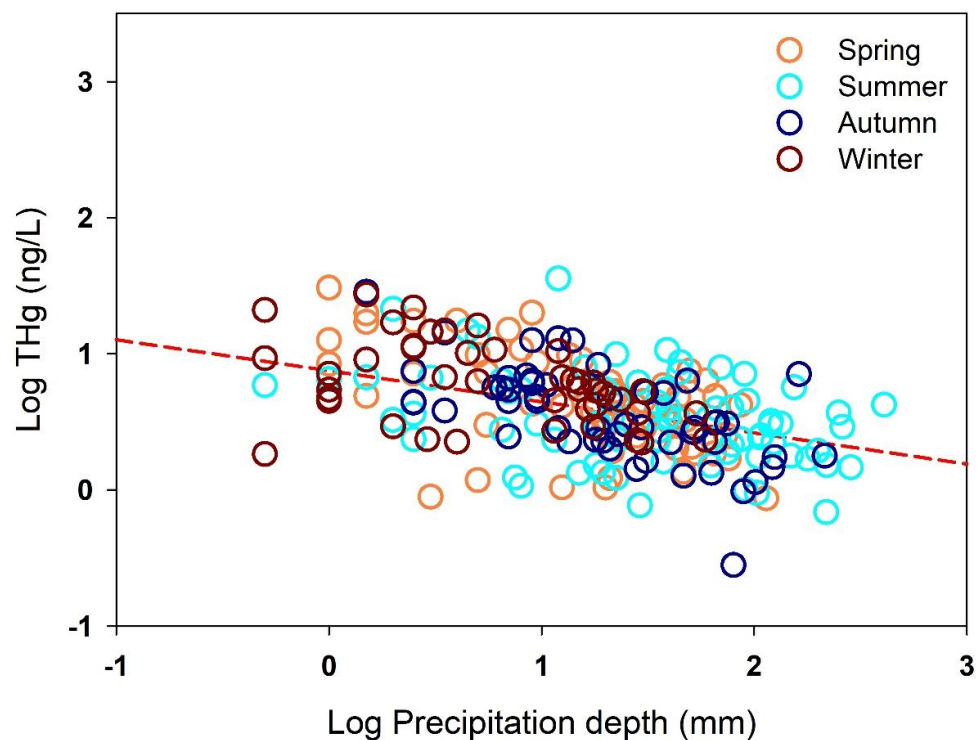
	Site	Operator	Population
Rural	Jeju	NIER	669,771
	Gwangju	GIST	1,459,024
Urban	Incheon	NIER	2,957,024
	Seoul	NIER	9,757,144



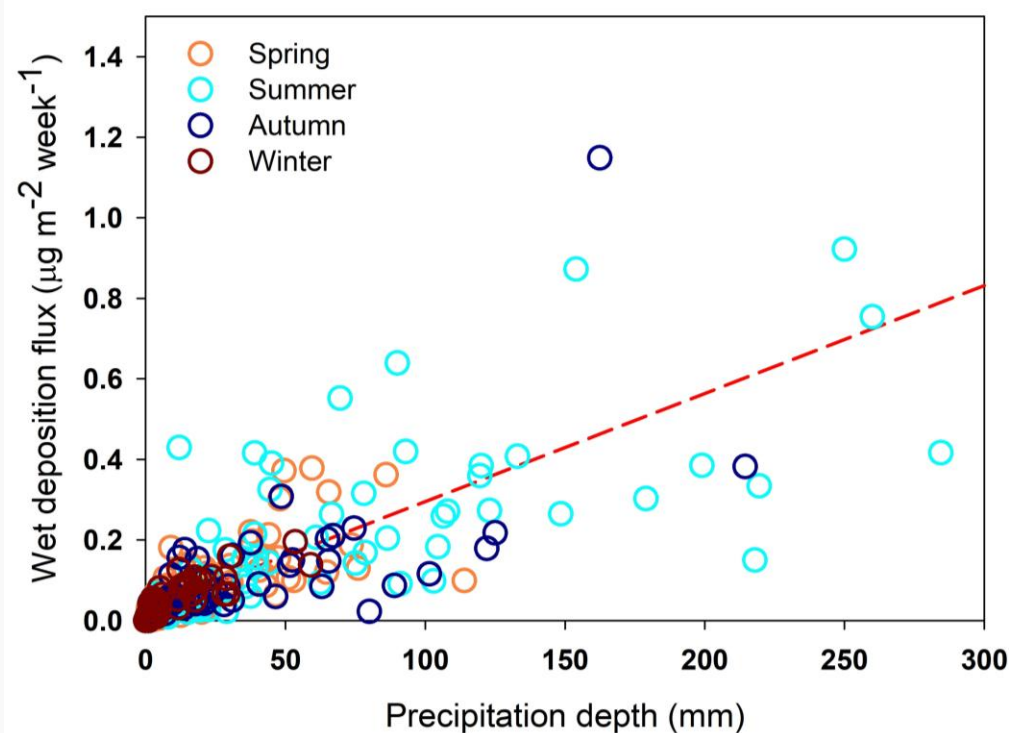


Site	Rainfall	VWM THg	Wet deposition of THg
	mm yr^{-1}	ng L^{-1}	$\mu\text{g m}^{-2} \text{ yr}^{-1}$
Gwangju	1198	4.42	4.1

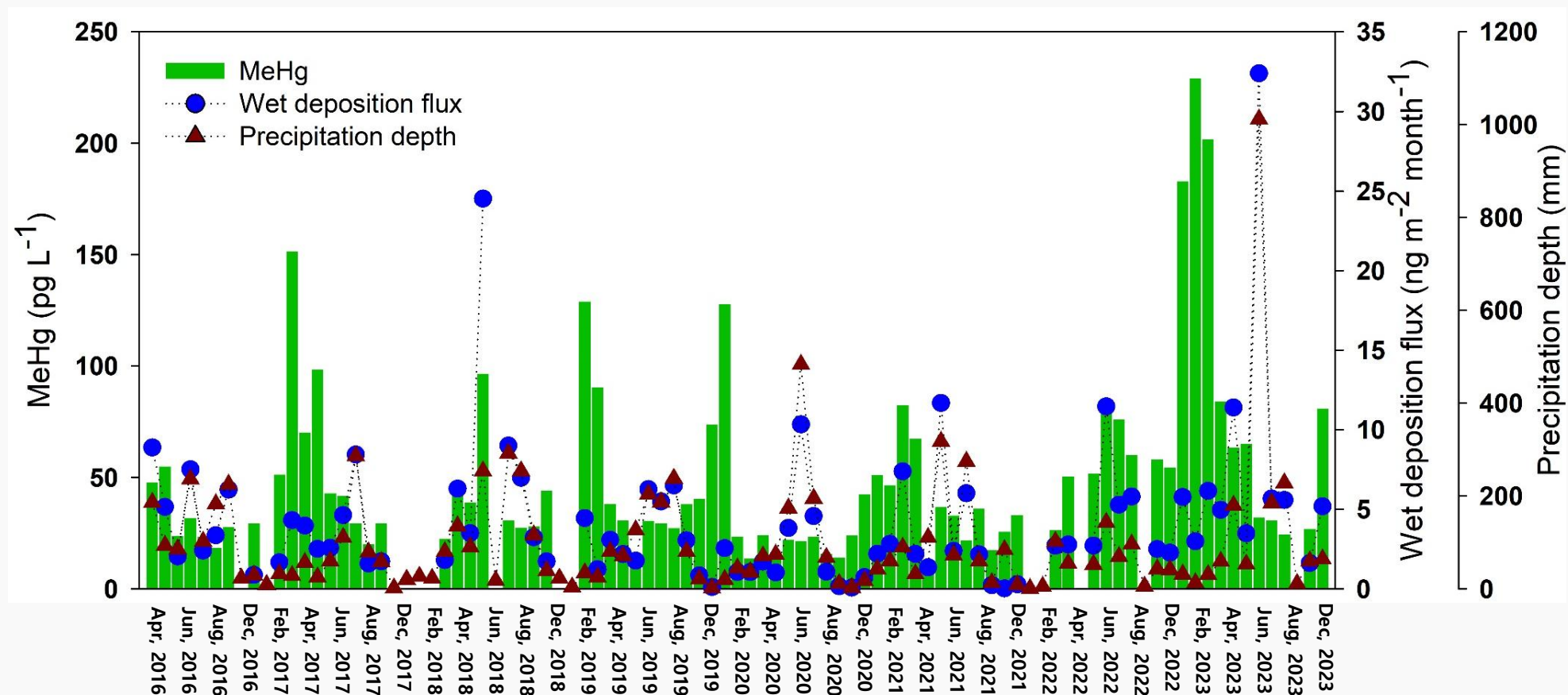
$$y = -0.23x + 0.88 (p < 0.0001)$$



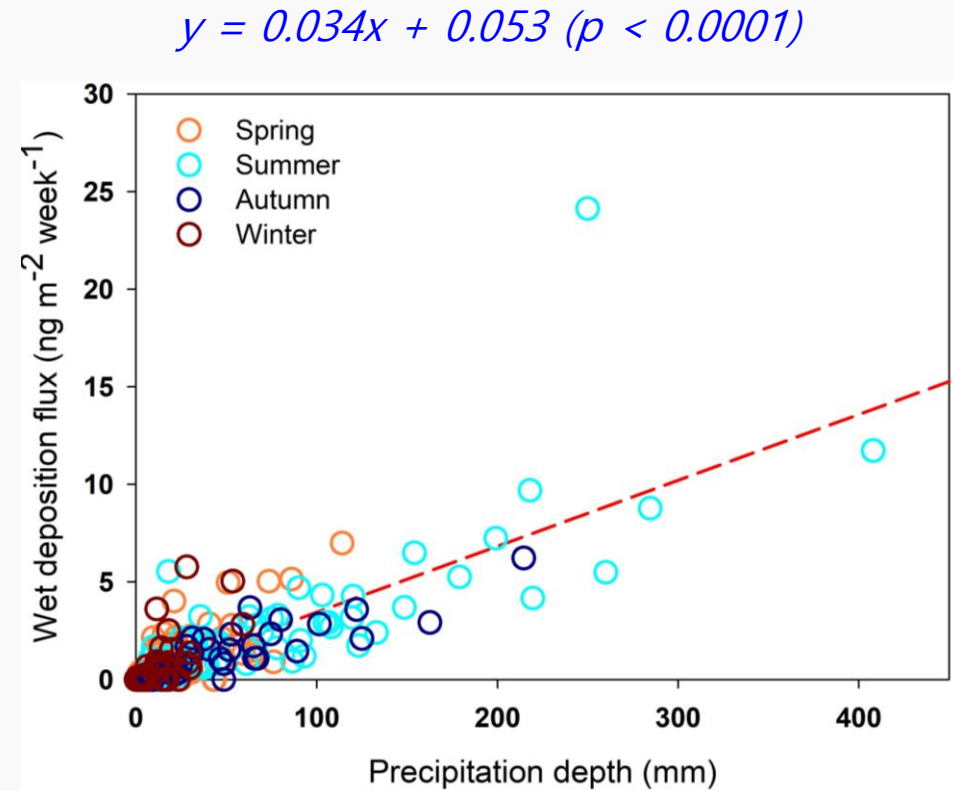
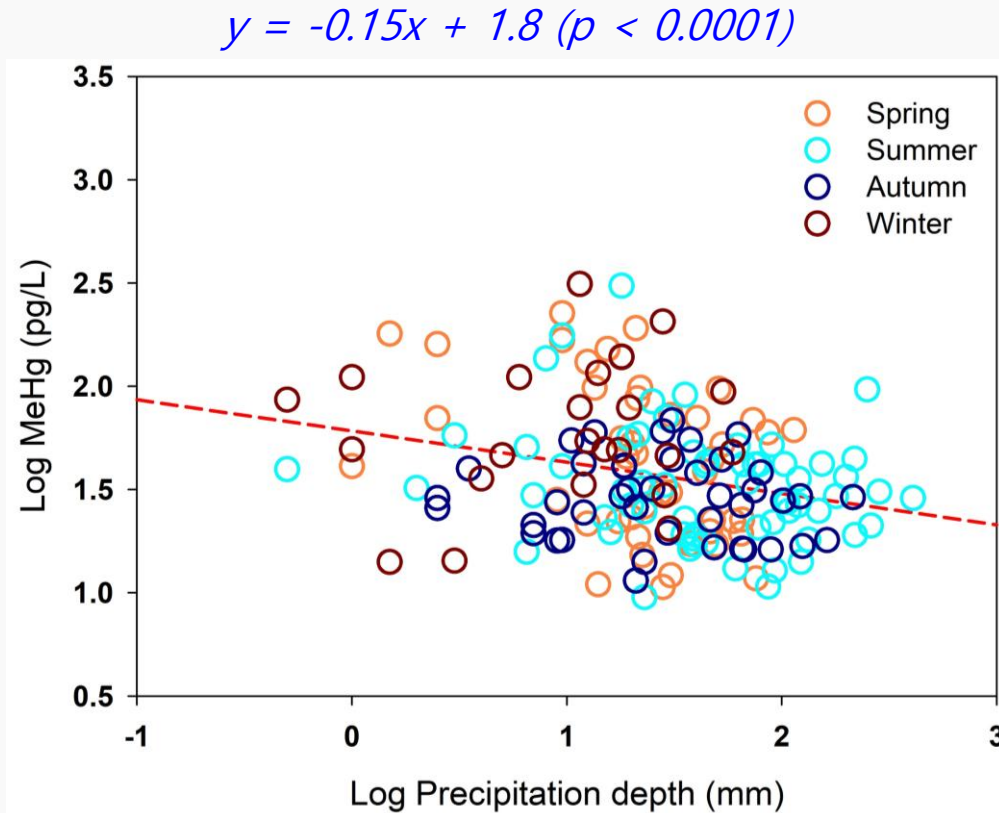
$$y = 0.0024x + 0.042 (p < 0.0001)$$



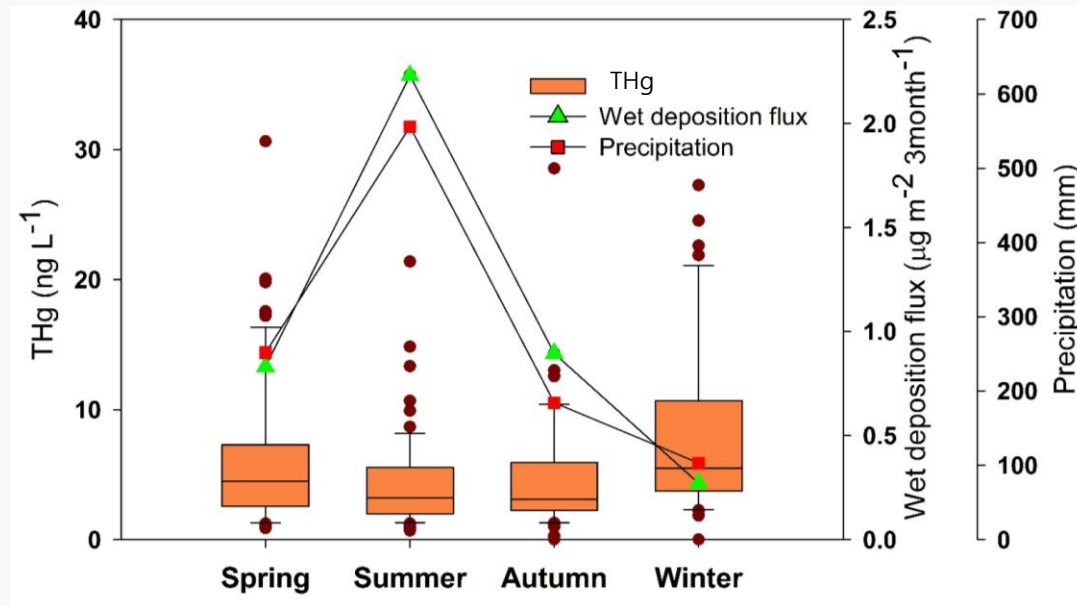
- THg conc showed a negative correlation with precipitation depth (washout effect)
- Wet deposition of THg increased with precipitation depth



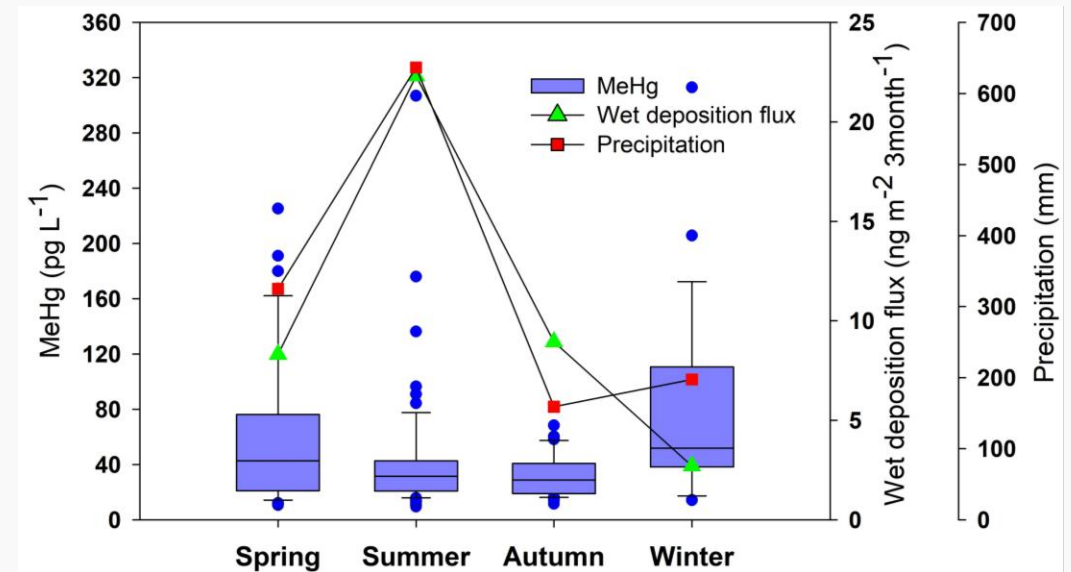
Site	Rainfall	VWM MeHg	MeHg/THg	Wet deposition flux of MeHg
	mm yr ⁻¹	pg L ⁻¹	%	ng m ⁻² yr ⁻¹
Gwangju	1198	41	1.77	45



- MeHg showed a negative correlation with precipitation depth (washout effect)
- Wet deposition of MeHg increased with precipitation depth



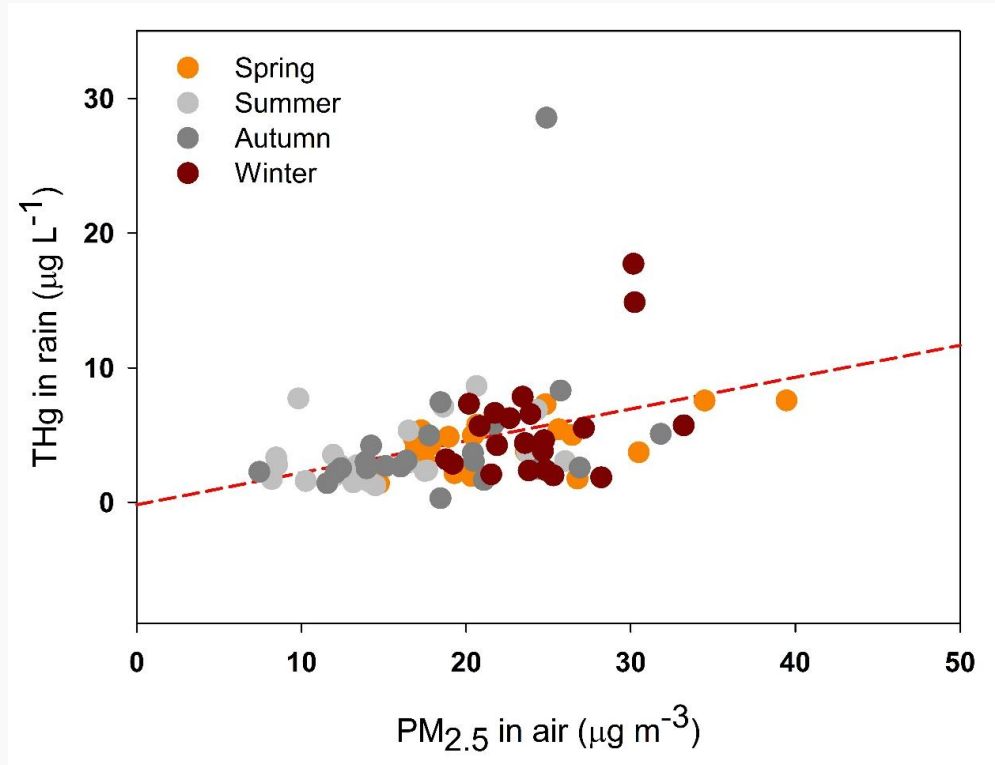
THg (ng L ⁻¹)	Ave.	Std.	Post-Hoc (Scheffe)
Spring	4.36	1.76	Winter > Spring, Summer, Autumn
Summer	3.50	2.13	
Autumn	4.55	5.56	
Winter	5.60	3.93	



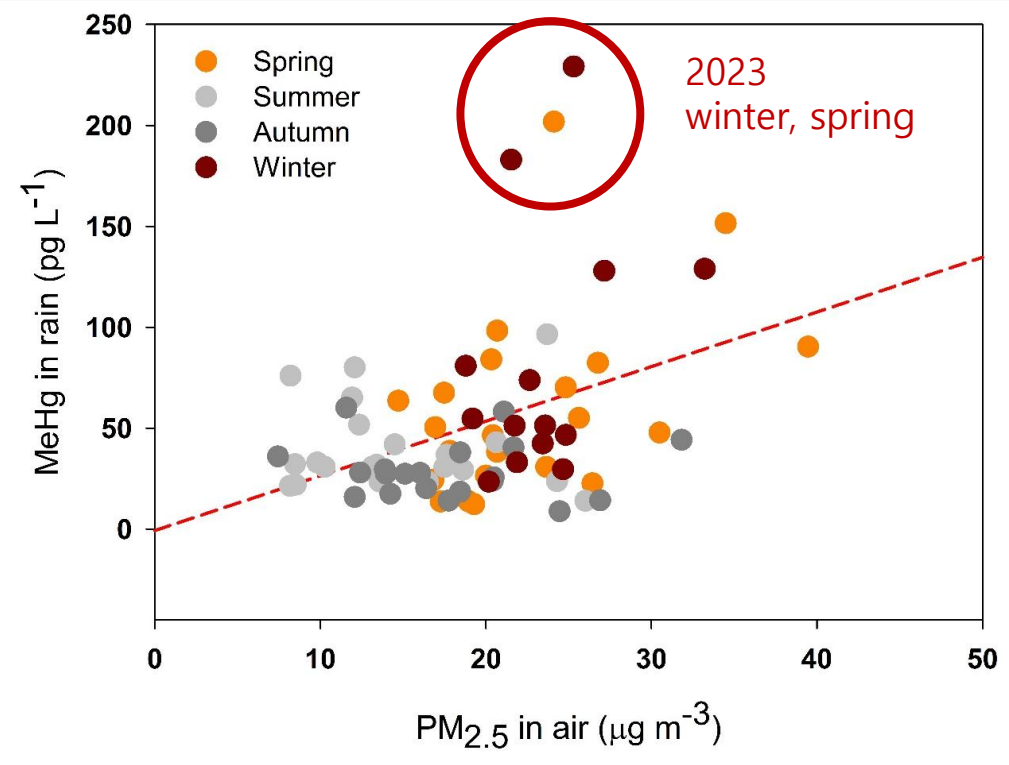
MeHg (pg L ⁻¹)	Ave.	Std.	Post-Hoc (Scheffe)
Spring	60.4	45.1	Winter > Spring > Summer, Autumn,
Summer	38.6	20.1	
Autumn	30.1	12.4	
Winter	82.5	59.9	

- THg concentrations in **winter** were higher than other seasons
- MeHg concentrations in **spring and winter** were higher than those in summer and autumn

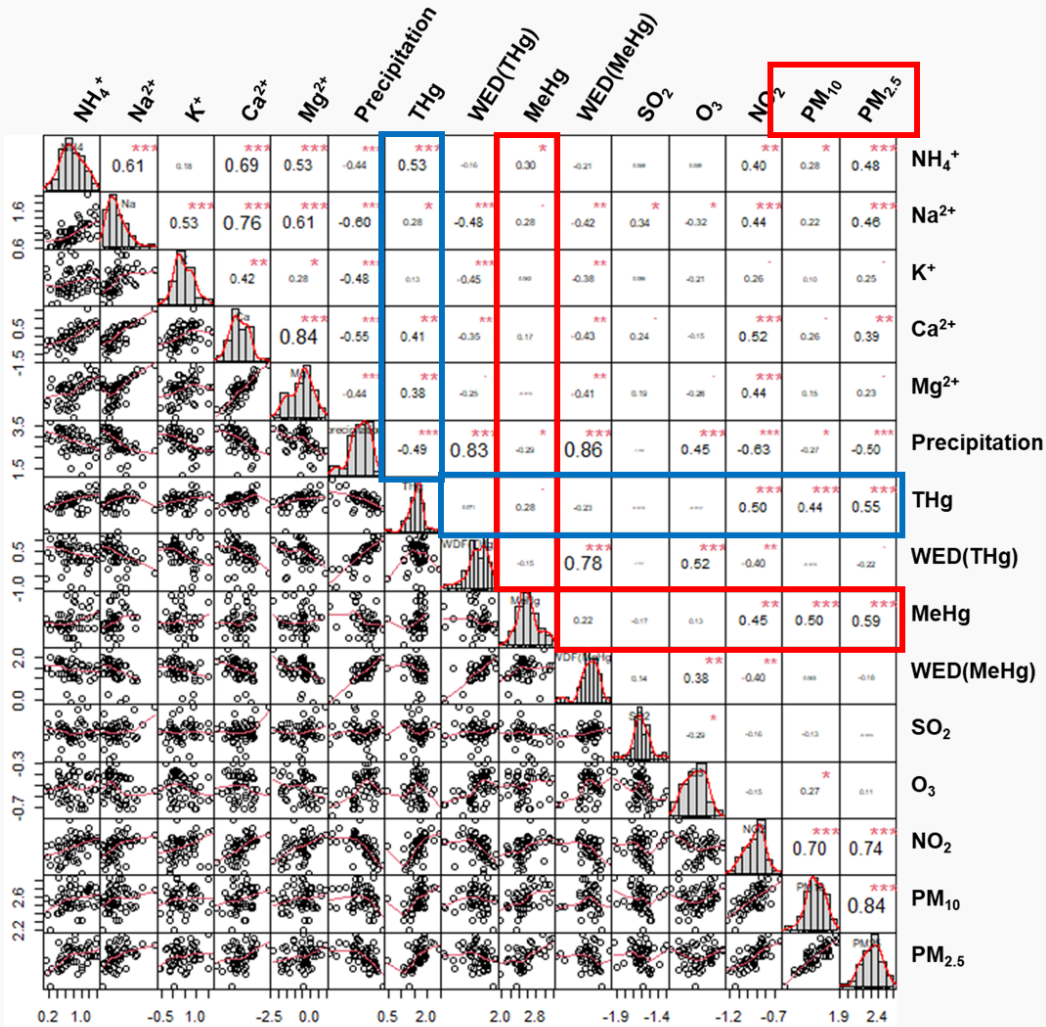
$$y = 0.24x + 0.19 (p < 0.0001, R_{sqr} = 0.171)$$



$$y = 2.71x - 0.73 (p < 0.0001, R_{sqr} = 0.174)$$



- For THg, the correlation with PM_{2.5} was weak and the trend was similar in all seasons.
- For MeHg, the correlation with PM_{2.5} was weak a positive correlation is clearer in winter and spring than summer and autumn



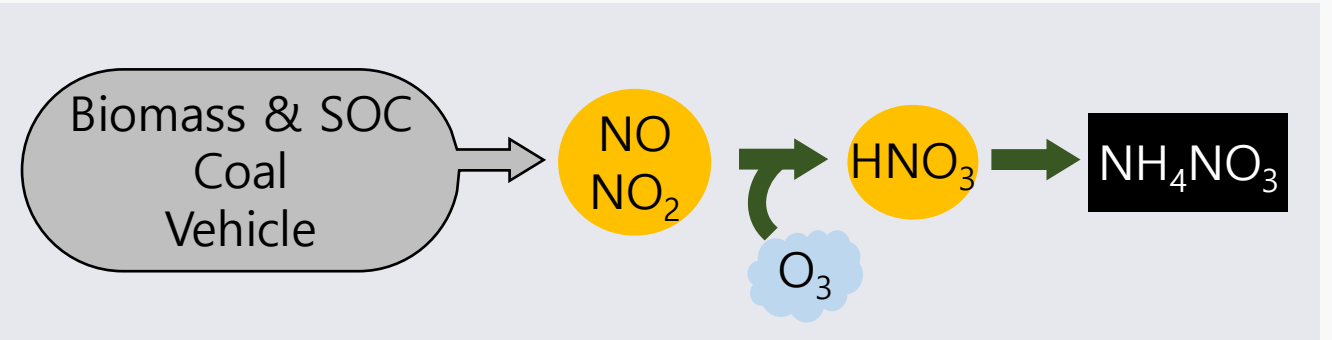
THg vs PM_{2.5} ($r = 0.55$)

THg vs PM₁₀ ($r = 0.44$)

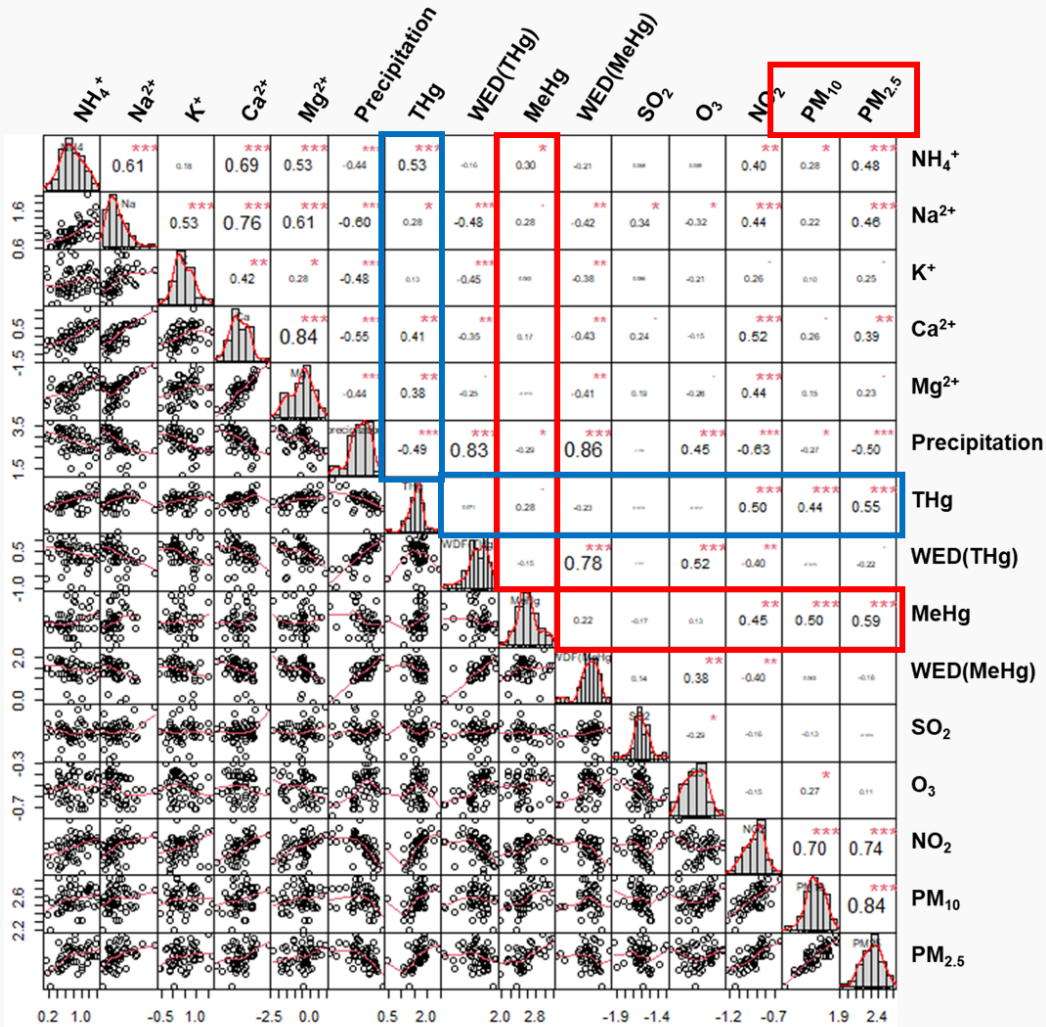
THg vs NH₄ ($r = 0.53$)

THg vs NO₂ ($r = 0.50$)

: Coal combustion sources ($\text{NO}, \text{NO}_2 + \text{O}_3 \rightarrow \text{HNO}_3$
 $\rightarrow \text{NH}_4\text{NO}_3 \rightarrow$ secondary fine dust)



- 2016. 04 - 2021. 04, monthly data
- SO₂, O₃, NO₂, PM₁₀, PM_{2.5}: AIRKOREA
- NH₄⁺, Na⁺, K⁺, Ca²⁺, Mg²⁺ in rain: NIER
- Precipitation: KMA



MeHg vs PM_{2.5} ($r = 0.59$)

MeHg vs PM₁₀ ($r = 0.50$)

MeHg vs NH₄ ($r = 0.30$)

MeHg vs NO₂ ($r = 0.45$)

> THg vs PM_{2.5} ($r = 0.55$)

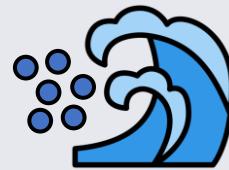
> THg vs PM₁₀ ($r = 0.44$)

< THg vs NH₄ ($r = 0.53$)

< THg vs NO₂ ($r = 0.50$)

MeHg vs K⁺, Ca²⁺, Mg²⁺ (Low r value)

: Higher contribution of natural aerosol sources



Sea spray

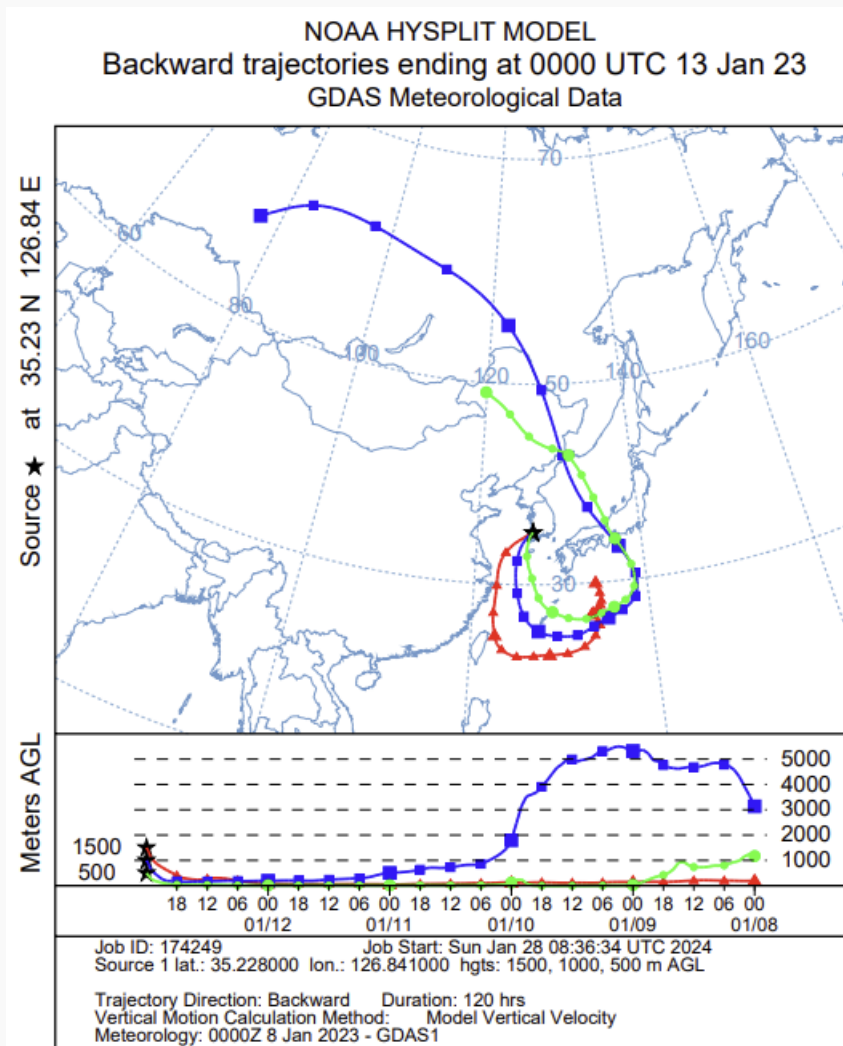


Mineral dust



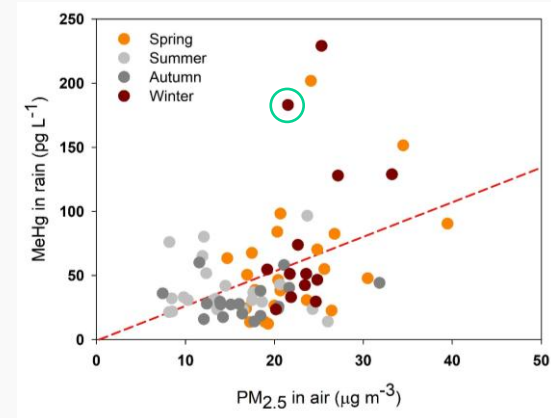
Wildfire

- 2016. 04 - 2021. 04, monthly data
- SO₂, O₃, NO₂, PM₁₀, PM_{2.5}: AIRKOREA
- NH₄⁺, Na⁺, K⁺, Ca²⁺, Mg²⁺ in rain: NIER
- Precipitation: KMA

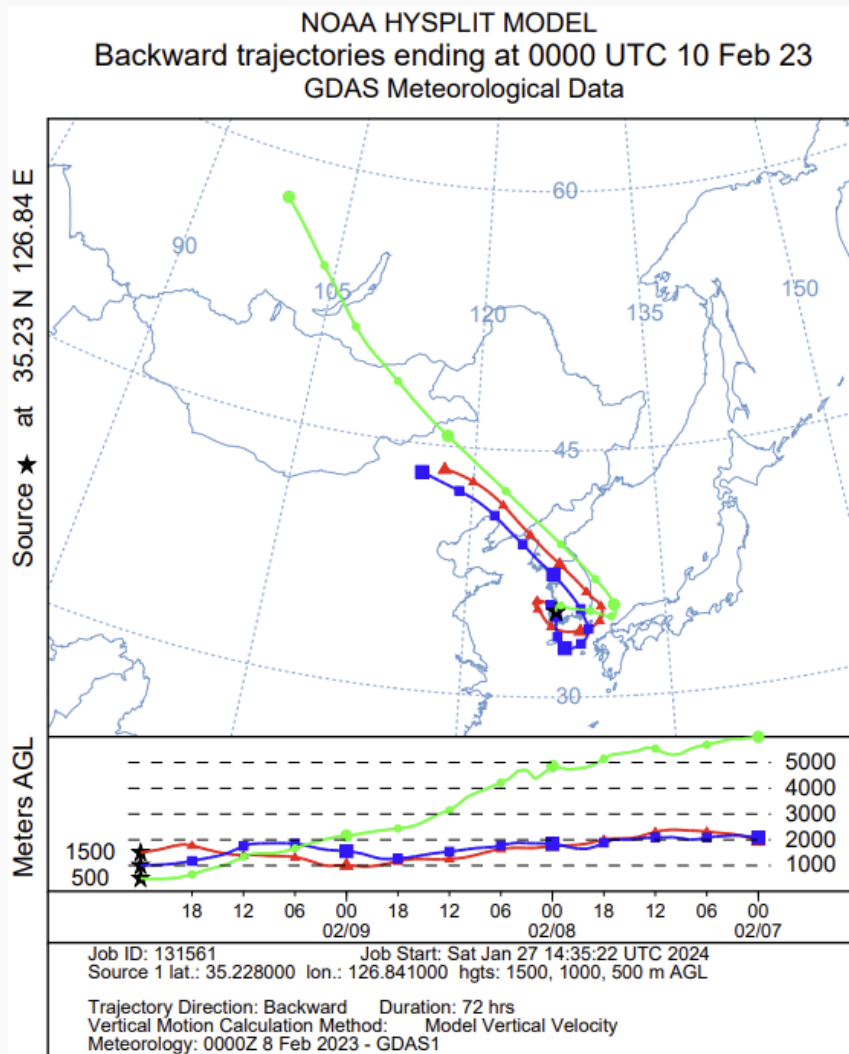


2023.01.13

- MeHg = 183 pg/L
- Precipitation depth = 33.5 mm
- Yellow dust occurred (2023.01.08)
- As the Arctic Oscillation approaches zero, the descending air current stops and the temperature rises
- Increased concentration of fine dust

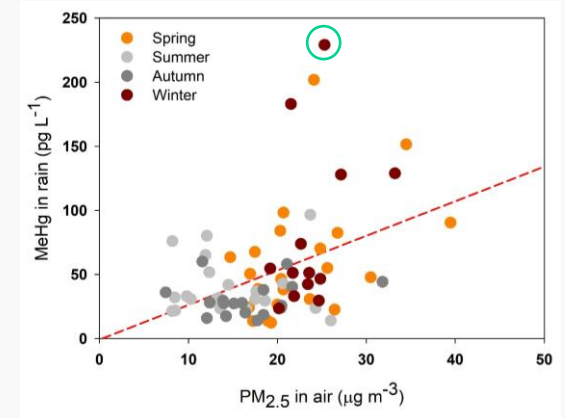
PM_{2.5}

9	23/01/13
20	23/01/12
30	23/01/11
29	23/01/10
30	23/01/09
32	23/01/08



2023.02.10

- MeHg = 229 pg/L
- Precipitation depth = 10.5 mm

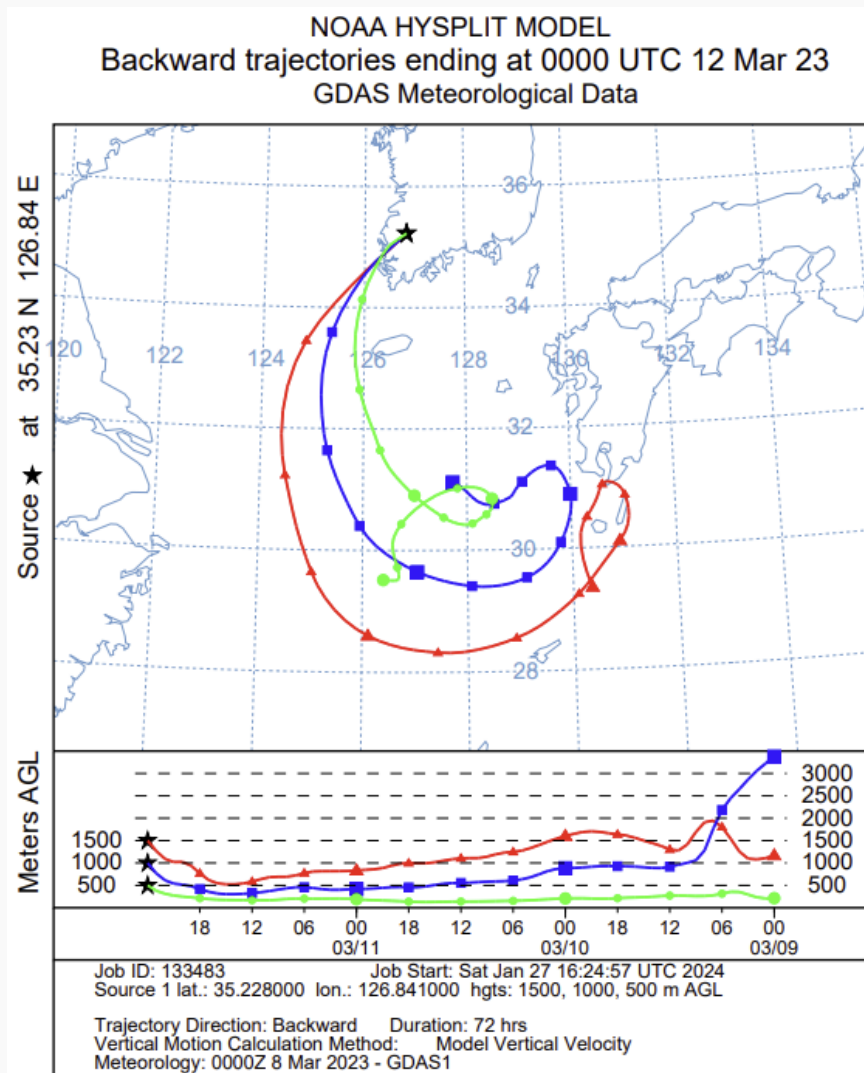
PM_{2.5}

18	23/02/10
36	23/02/09
57	23/02/08
41	23/02/07
28	23/02/06
36	23/02/05



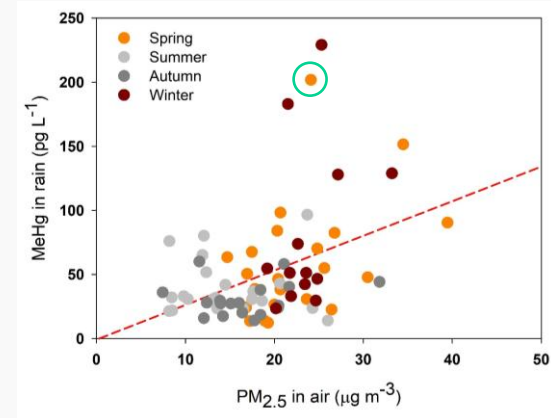
- Since February 7, air mass has been moving through China's industrial area

-> Coal-fired power plants



2023.03.12

- MeHg = 202 pg/L
- Precipitation depth = 9.5 mm
- PM2.5 level was consistently high before the rain
- A forest fire broke out in Unam Mountain(2023.03.11. 5.4 km away from the rain collection site)



PM2.5

25	23/03/12
35	23/03/11
44	23/03/10
31	23/03/09
23	23/03/08
29	23/03/07



THg

- VWM concentration : 4.42 ng L⁻¹
Annual wet deposition flux : 4.1 µg m⁻²
- THg Concentration and wet deposition flux decrease with time (2016.04 – 2023.12)
- VWM conc was highest in winter with positive correlation with PM_{2.5} (r = 0.55), PM₁₀ (r = 0.44), NH₄ (r = 0.53) and NO₂ (r = 0.50)
: Anthropogenic sources

MeHg

- VWM concentration of : 41 pg L⁻¹
(0.53% of THg)
Annual wet deposition : 45 ng m⁻²
(1.6 % of THg)
- VWM conc was highest in winter and spring with positive correlation with PM_{2.5} (r = 0.59), PM₁₀ (r = 0.50), NH₄ (r = 0.30) and NO₂ (r = 0.45)
: Higher contribution of natural sources

- HYSPLIT Backward trajectory for data with high concentration of MeHg
 - Yellow dust, coal fired power plants, forest combustion
 - Follow-up research is needed to determine the relationship

Thank you

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