Asia Pacific Mercury Monitoring Network

The Asia Pacific Mercury Monitoring Network (APMMN): An Update on Progress and Opportunities

APMMN Partners Meeting

December 9, 2025

Taipei, Taiwan

Outline

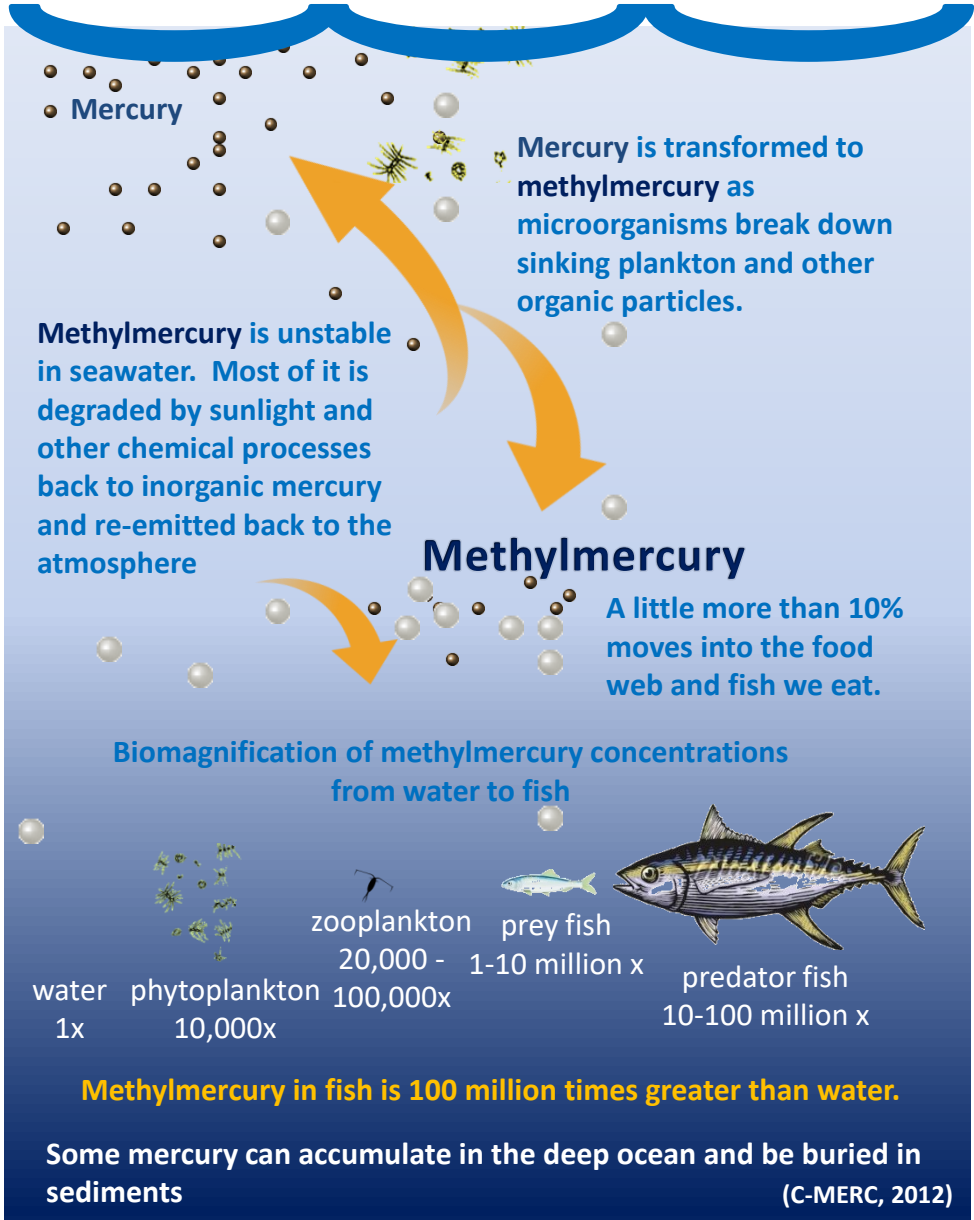
- The Mercury Problem
- Purpose of Mercury Monitoring
- Purpose of the Asia Pacific Mercury Monitoring Network (APMMN)
- Technology used by APMMN
- New National Atmospheric Deposition Program (NADP) Passive Mercury Pilot Effort within the United States

Mercury pollution is a children's health concern

- Methylmercury (MeHg) accumulates in fish and shellfish
- Consumption of fish is the main pathway of exposure
- Women of childbearing age and young children are especially vulnerable
- Interferes with brain and nervous system development
- Impacts cognitive thinking, memory, attention, language, and fine motor skills in children exposed to MeHg in utero

Methylmercury (MeHg) exposure through eating contaminated fish and/or seafood

- Eating fish, shellfish, and marine mammals is the largest source of human exposure to MeHg globally, accounting for approximately 75% of total MeHg exposure.
- In the US, marine fish and shellfish consumption are estimated to account for over 90% of human mercury exposure; tuna harvested in the Pacific Ocean account for 40% of this total exposure.
- In East/Southeast Asia and other regions, fish are a main source of animal protein.
- Depending upon the species of fish consumed, people who rely on subsistence fishing can experience a disproportionally higher risk of MeHg exposure through the diet.



Why do we need Hg monitoring?

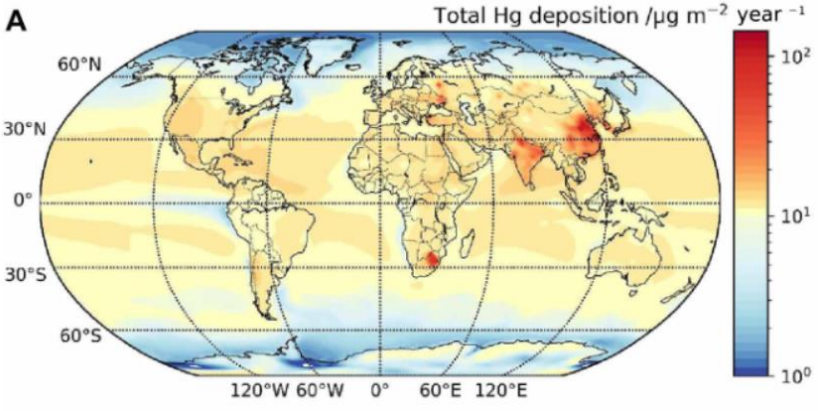
1. Understand the Hg problem
   - What is the extent of the problem?
   - Where is it getting better or worse?

2. Track changes over time and space
   - Are there trends?
   - Are they going up or down?
   - Link Hg deposition, Hg in fish, and Hg risk to vulnerable populations

3. Ground-truth models
   - How do model results compare to monitored data?

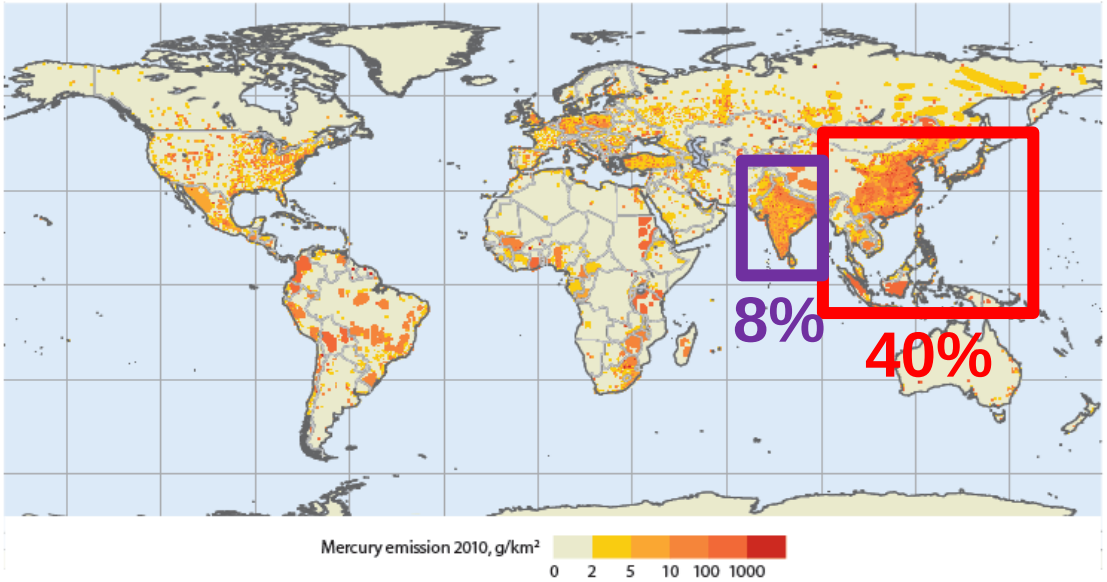
4. Determine if policy is working
   - What are the benefits and effectiveness of Hg controls?
   - Determine the effectiveness of policy and global treaties

Net Hg Deposition (Modeled)



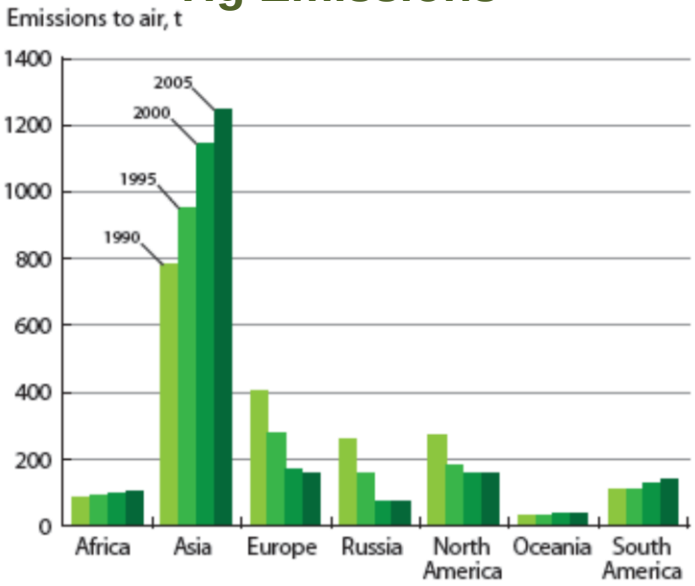
Saiz-Lopez et al., 2025

Asia is the largest Hg emitting source region



Region*	2010 Emission (range), tonnes**	%
Australia, New Zealand & Oceania	22.3 (5.4 - 52.7)	1.1
Central America and the Caribbean	47.2 (19.7 - 97.4)	2.4
CIS & other European countries	115 (42.6 - 289)	5.9
East and Southeast Asia	777 (395 - 1690)	39.7
European Union (EU27)	87.5 (44.5 - 226)	4.5
Middle Eastern States	37.0 (16.1 - 106)	1.9
North Africa	13.6 (4.8 - 41.2)	0.7
North America	60.7 (34.3 - 139)	3.1
South America	245 (128 - 465)	12.5
South Asia	154 (78.2 - 358)	7.9
Sub-Saharan Africa	316 (168 - 514)	16.1
Undefined (global total for emissions from contaminated sites)	82.5 (70.0 - 95.0)	4.2
Grand Total	**1960 (1010 – 4070)**	**100**

Trends in Anthropogenic Hg Emissions



Estimates of annual anthropogenic mercury emissions from different continents/regions, 1990-2005.

Anthropogenic Hg emissions from Europe and North America are declining, whereas emissions from Asia are increasing.

Source: UNEP, 2013

APMMN Network Goal and Objectives

Goal

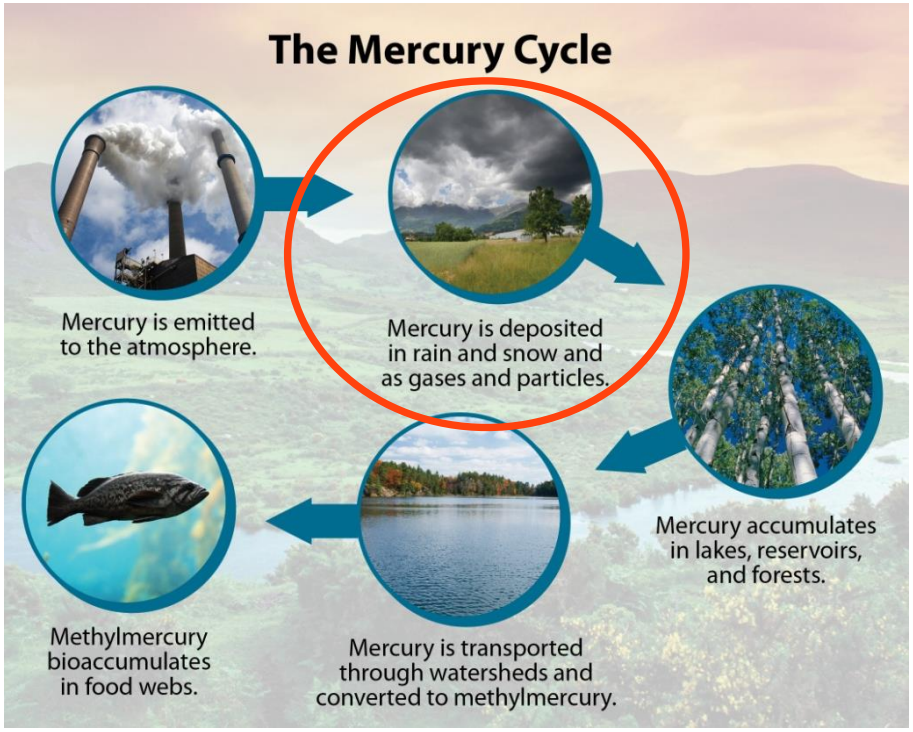
- Systematically monitor wet deposition and atmospheric concentrations of mercury in a network of stations throughout the Asia-Pacific region

Objectives

- Determine the status and trends in concentrations of ambient mercury species, and wet, dry, and total atmospheric deposition of mercury
- Develop a robust dataset for regional and global modeling
- Assist partner countries in developing monitoring and assessment capacity
- Share data and monitoring information
- Provides opportunities for EPA, Taiwan, and other partner countries to coordinate on monitoring approaches and strategy to reduce the effects of transboundary pollution to ensure clean air, land and water for U.S. communities – especially those on the west coast who are most likely to be affected by mercury pollution from Asia.

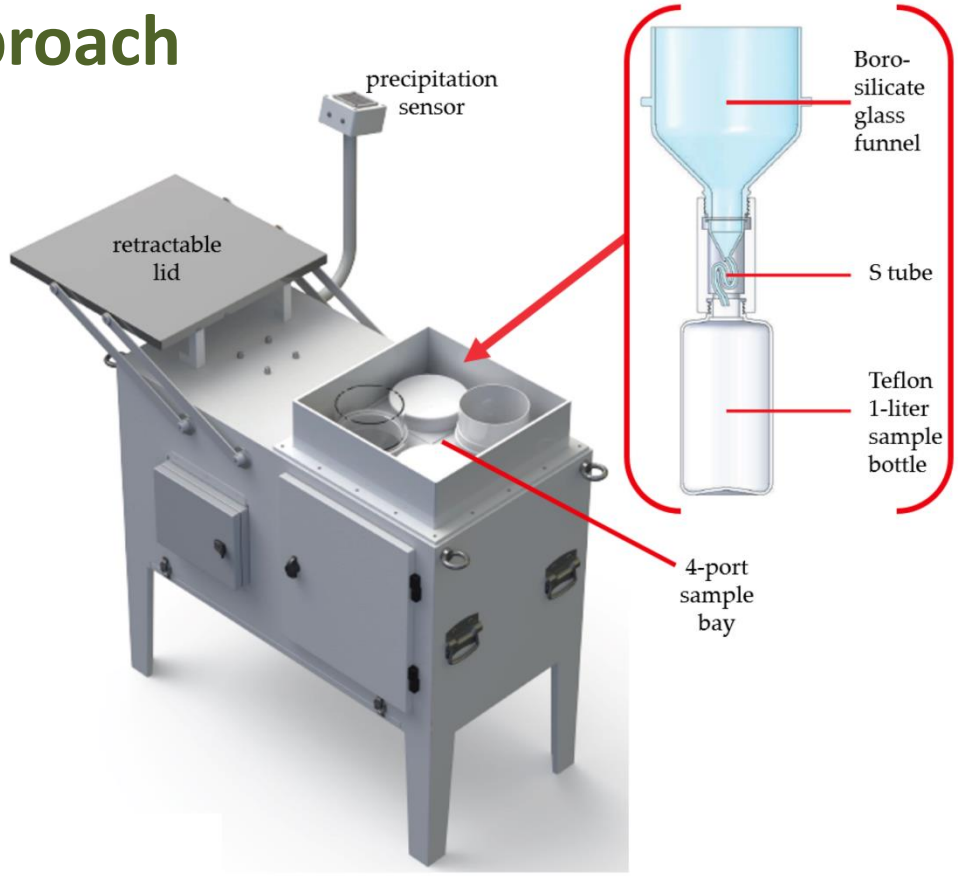
APMMN's focus is Hg deposition

- Hg is in rainwater and the atmosphere
  - Deposition is a major source of Hg to many water bodies
  - The atmosphere responds relatively quickly to decreasing Hg emissions, especially compared to other media
- Many experts in monitoring regionally/globally
- Opportunity to fill data gaps and improve monitoring coordination



APMMN's Monitoring Approach

- Started Hg wet deposition monitoring network as a three-year pilot in Vietnam, Thailand, and Indonesia
  - Used APMMN standard operating procedures based on the National Atmospheric Deposition Mercury Deposition Network (NADP/MDN) and adapted to regional conditions
  - Sample collection started 9/2014
- Samples shipped to National Central University in Taiwan for Hg analysis
- Data reported back to operating country
- Site operator training workshops annually, on new sites, and as requested
- Expand the network to improve spatial coverage across Asia-Pacific Region



Taiwan-Style APMMN Wet Deposition Sampler

Chemical Analysis: Cold vapor atomic fluorescence spectroscopy (CVAFS) at National Central University, Taiwan

Mercury Forms: Total Hg wet deposition and precipitation concentrations

Sampling Frequency: One week; Tuesday – Tuesday schedule

Meteorology: Precipitation depth measured onsite (best) or as close as possible to the sampler (within 5 km)

Site Types: Regionally representative; urban, remote, rural areas with estimated high levels of Hg and deposition; sensitive ecosystems

APMMN Summary of Progress Since 2012

- Built a monitoring community
  - **15** mercury wet deposition sites in **14** countries currently operating
  - Routine air and rainwater mercury monitoring training by Taiwan, Japan, and U.S. mercury scientific experts
  - Information sharing with partners in other regions (e.g., South Africa)
- Japan/Taiwan collaboration on a sampler inter-comparison since March 2020
- Air monitoring
  - Passive air sampling field testing
  - Same-day monthly active manual sampling (Japan, coordinated by IDEA Consultants, Inc.)
  - Participation in Environment and Climate Change Canada (ECCC) Global Passive Air Pilot Network
- Domestic investments in mercury monitoring (as examples)
  - Vietnam – 18 site mercury wet deposition network
  - Thailand – mercury laboratory
  - Indonesia – new mercury analyzer
- APMMN is included within the United Nations Environment Programme monitoring guidance to inform Effectiveness Evaluation of the Minamata Convention

What makes APMMN successful?

Ingredients for an Effective Network

1. Participatory - multiple stakeholders collaborating

2. Transparency is key; all network information publicly available
   - Webpage - APMMN.org
   - Goal -> quality assured data archived in an online database

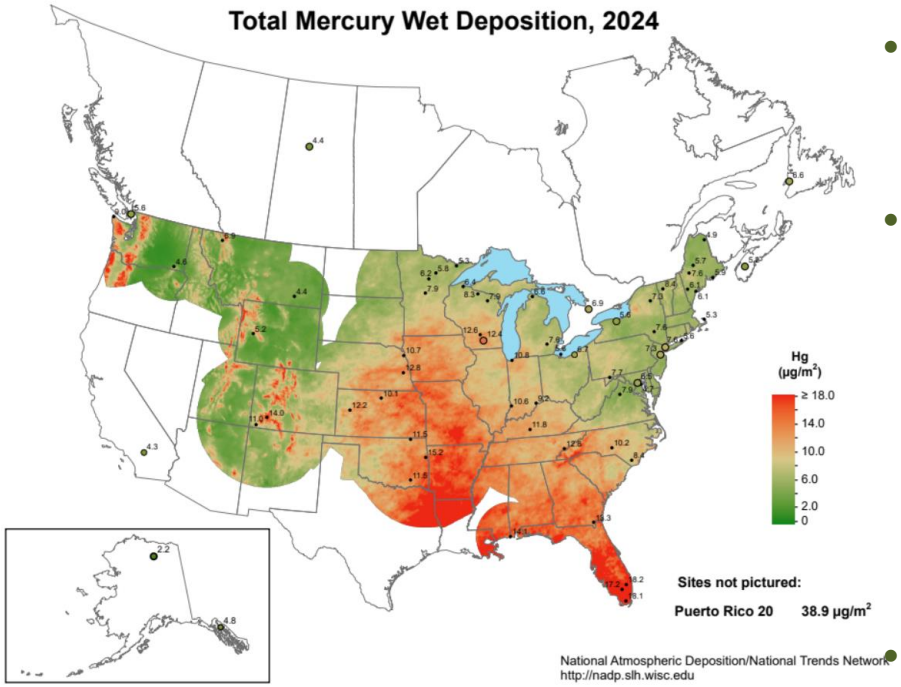
3. Scientifically credible – grounded in mercury science; routine training by Taiwan, Japan, and U.S. mercury scientific experts

4. Field and laboratory Quality Assurance (QA) plans and SOPs
   - Network-wide consistency (field and lab operations)

5. Cost effective
   - Minimize costs by leveraging existing infrastructure where possible

6. Data sharing – Key to network success and identifying trends

Hg Monitoring in the United States



- The U.S. EPA partners with the NADP to track Hg trends across the United States
- NADP MDN has operated since 1996 and collects **wet deposition**
- In 2024, NADP started a Passive Hg Monitoring Pilot Network to measure **atmospheric Hg**
  - This complements **atmospheric Hg** from AMNet (Tekran)
  - This effort is modeled after ECCC's Global Passive Air Pilot Network
- NADP hopes to transform the Passive Hg Pilot to a full network in 2026

NADP's New Passive Hg Pilot Network

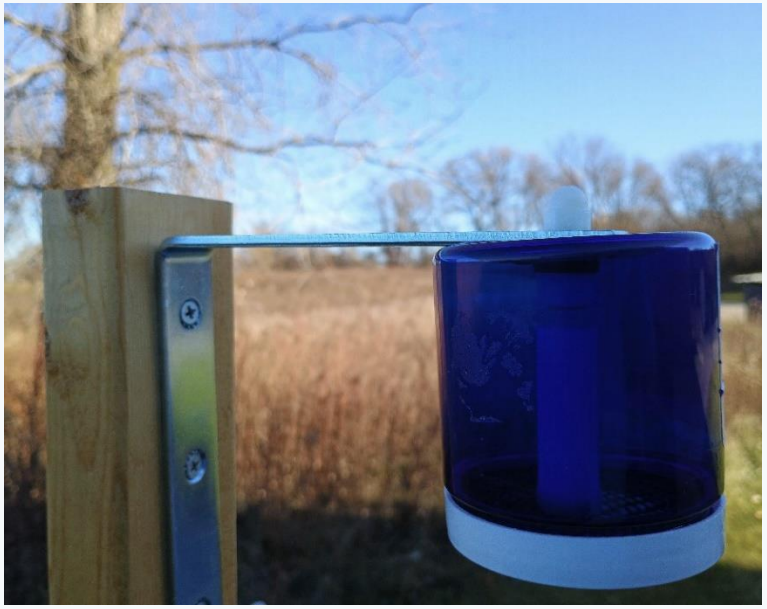
- Tekran MerPAS sampler measures gaseous elemental mercury (GEM) in nanograms Hg/m^3
- 90-day samples, or 4 sample periods per year
- 4 individual samplers for atmospheric concentration and 2 trip blanks will be deployed
  - These 4 values can be averaged to estimate a quarterly average concentration, and the 4 quarters can be averaged for an annual value.
- 3 samplers and 1 blank will be purchased from Tekran, and 1 sampler and 1 blank will be produced by NADP (in MerPAS bodies)

From McLagan et al., 2015

For more information: https://pubs.acs.org/doi/abs/10.1021/acs.estlett.5b00319

NADP's New Passive Hg Pilot Network

Tekran MerPAS Samplers



Pilot - Overview

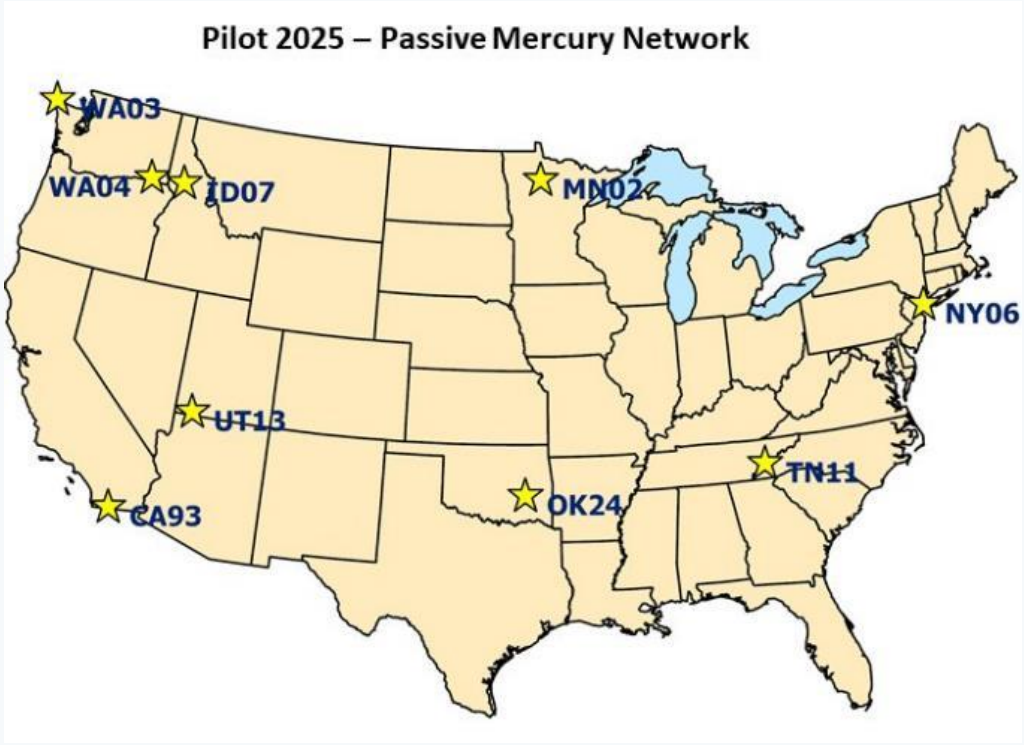
The primary objective is to establish a new monitoring network that will complement existing Hg networks

Measure quarterly average Gaseous Elemental Mercury (GEM) using a passive sampler.

4 individual samplers for atmospheric concentration and 2 trip blanks are deployed

- Comparing Tekran-provided with "homemade" versions using Tekran sampler bodies prepared by the NADP laboratory

NADP's New Passive Hg Pilot Network



10 Sites

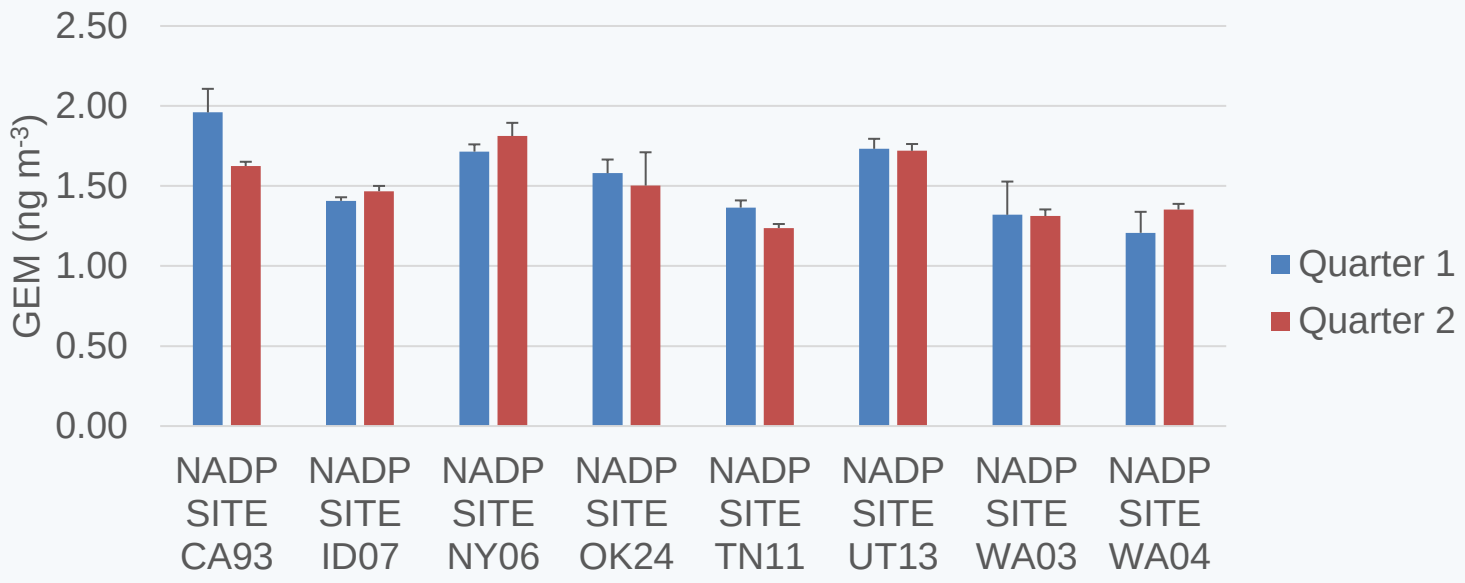
CA93 - La Posta Tribe
ID07 - Nez Pierce
NY06 - New York Department of Environmental Conservation
OK24 - Choctaw Nation
TN11 - Great Smoky National Park
WA03 - Makah Tribe near Olympic National Park
WA04 - Confederated Tribes of the Umatilla
UT13 - Zion National Park
MN02 - Red Lake Nation*
ME94 - Indian Township*

*added in Q3 - no data yet

2025 Sampling Schedule

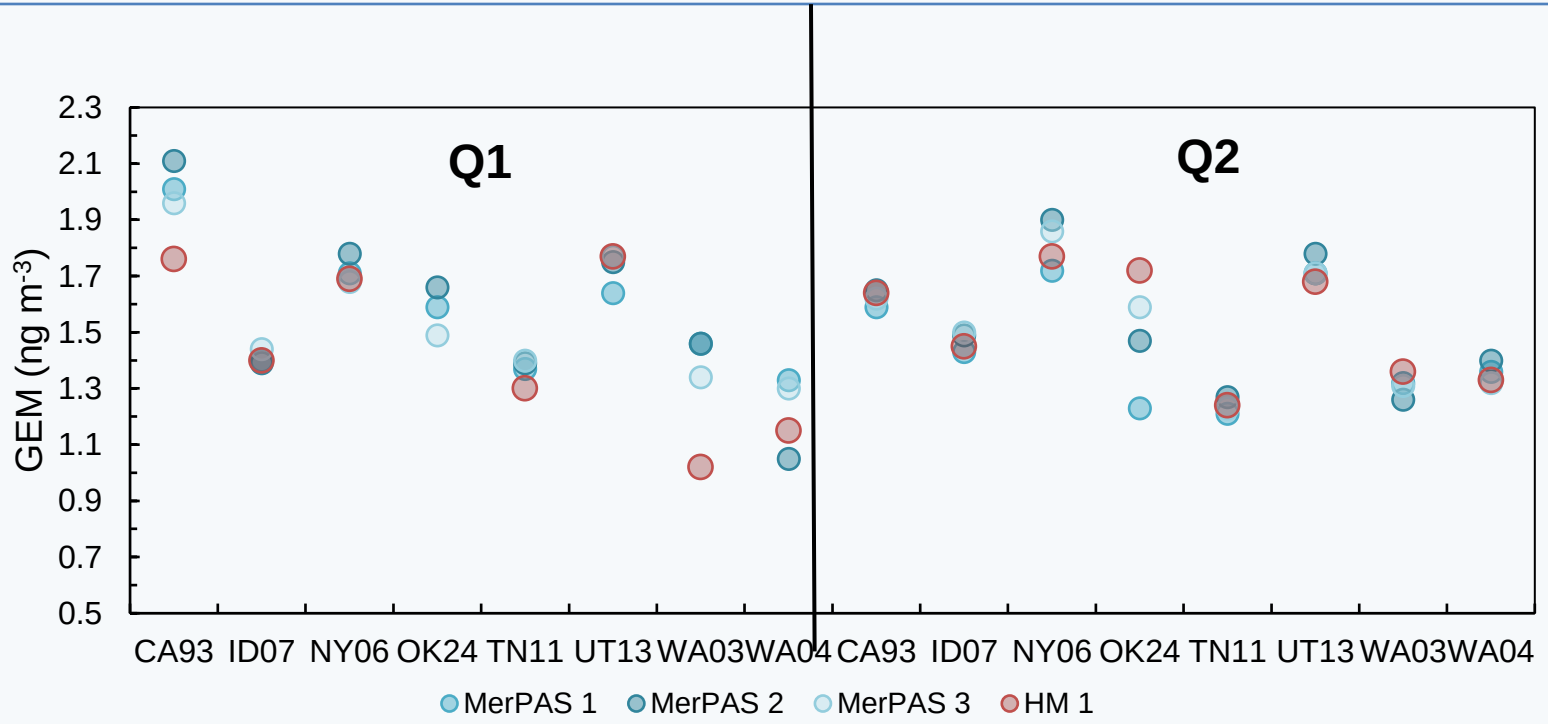
	Date On	Date off	Number of Days
Q1	DEC-31	APR -01	91
Q2	APR-01	JUL-01	91
Q3	JUL-01	SEPT-30	91
Q4	SEPT-30	DEC-31	91

2025 Preliminary Passive Hg Data



GEM = Gaseous Elemental Mercury (GEM)

Tekran vs. NADP Homemade (HM)



GEM = Gaseous Elemental Mercury (GEM)

Comparison of NADP Homemade and Tekran MerPAS GEM Samples

Q1

2025 Q1 Sample Stats (ng m-3)		
	Diff	RPD
Min	-0.400	1%
Max	-0.010	34%
Avg	-0.140	10%
Median	-0.090	7%
Site Count	7	

Q2

2025 Q2 Sample Stats (ng m-3)		
	Diff	RPD
Min	-0.057	0%
Max	0.287	19%
Avg	0.027	4%
Median	-0.010	2%
Site Count	8	

Notes:

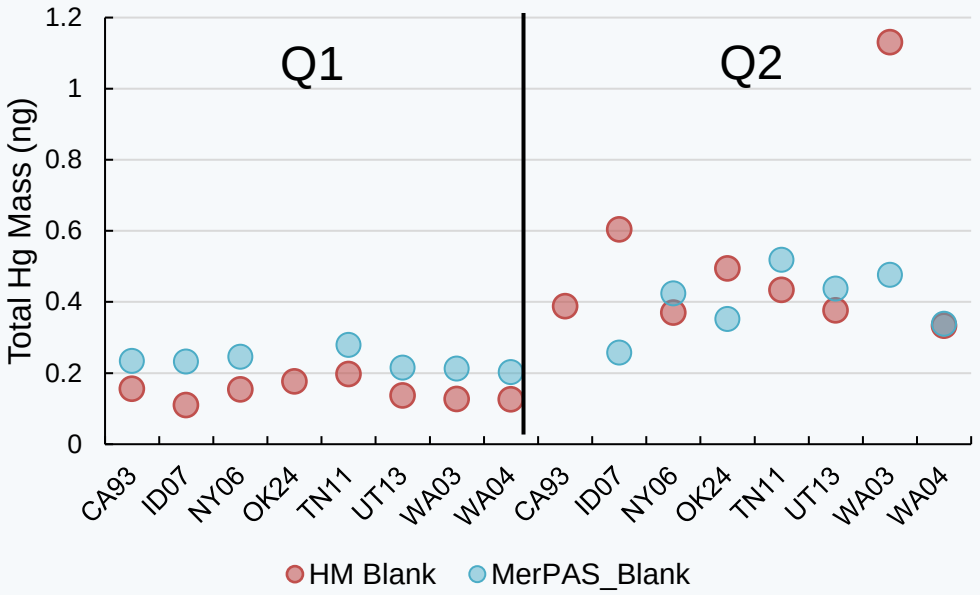
Difference (Diff) = Homemade minus Tekran MerPAS

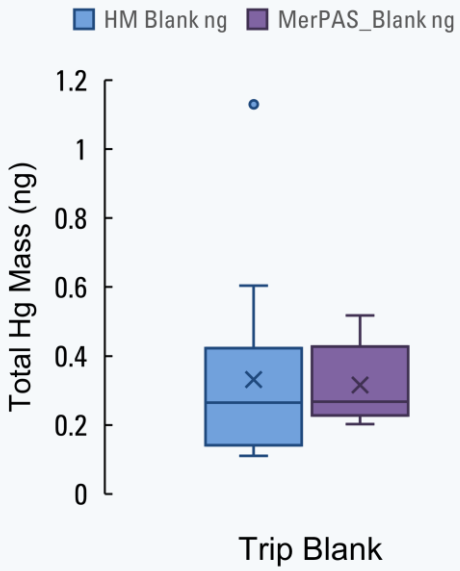
RPD = relative percent difference

Triplicate samples averaged by site

Samples using blank-corrected values

Trip Blanks


Q1
Q2
Total Hg Mass (ng)
1.2
1
0.8
0.6
0.4
0.2
0
CA93
ID07
NY06
OK24
TN11
UT13
WA03
WA04
CA93
ID07
NY06
OK24
TN11
UT13
WA03
WA04
HM Blank
MerPAS_Blank


HM Blank ng
MerPAS_Blank ng
Total Hg Mass (ng)
1.2
1
0.8
0.6
0.4
0.2
0
Trip Blank

Comparison of NADP Homemade and Tekran MerPAS Trip Blanks

Q1

2025 Q1 Blank Stats (ng m-3)		
	Diff	RPD
Min	-0.010	0%
Max	0.000	67%
Avg	-0.009	44%
Median	-0.010	40%
Site Count	7	

Q2

2025 Q2 Blank Stats (ng m-3)		
	Diff	RPD
Min	-0.010	0%
Max	0.030	67%
Avg	0.008	28%
Median	0.000	22%
Site Count	5	

Notes:

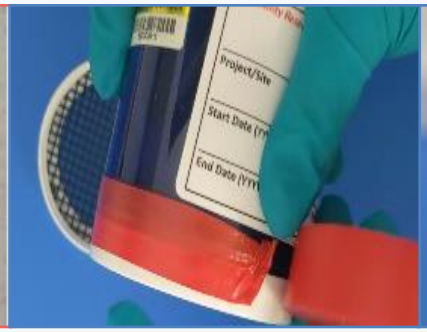
Diff = Homemade minus Tekran MerPAS

RPD = relative percent difference

Triplicate samples averaged by site

Goals achieved

- Quality controlled first 2 quarters of Hg data
  - Q3 is still being sent back and analyzed
- A data SOP for QA/QC data routines has been created.
- Refined cleaning and packing procedures.




For more information

Website: https://nadp.slh.wisc.edu/hg-passive-pilot-network/

Tekran: https://www.tekran.com/files/MerPAS-Instruction-Sheet.pdf

Thank you

APMMN Partners Meeting

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