Overview of the
The Atmospheric Mercury Network

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[3] Tekran Research and Development
[4] Environment Canada

National Atmospheric Deposition Program

EPA United States Environmental Protection Agency

TEKRAN Instruments Corporation WHERE MEASUREMENT BEGINS

Environment Canada · Environnement Canada

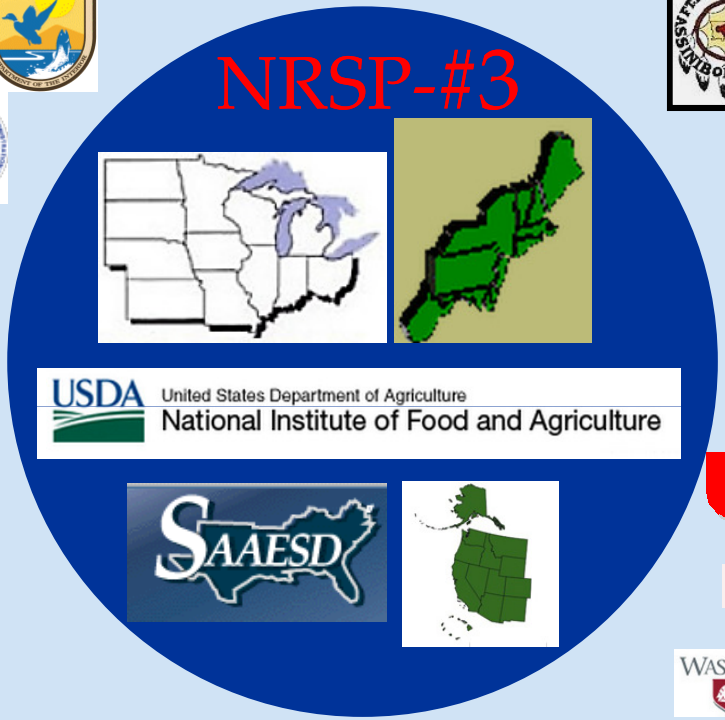
A Cooperative Research Program *(Un. Of Illinois)*

- Measure wet deposition of pollutants
  - Three networks (NTN, AIRMoN, Mercury Deposition Network)
- Monitor the rate of pollution movement to the surface
  - dry deposition est., AMoN, Atmospheric Mercury Network)
- North America
  - US, Canada, and some in Mexico
  - Also Taiwan, South America, Hawaii
- Owned and operated by our members
  - Decisions made by our members
  - Started in 1978, 37th year
- Over 450,000 precipitation chemistry samples



The NADP Cooperators

(100+ total agencies)



Federal Agency Members

Tribal Organizations

Universities

US States

Other Organizations

USGS science for a changing world

TVA

NAPAP

USDA Forest Service
Caring for the Land and Serving People

USDA

EPA United States Environmental Protection Agency

The National Park Service

PENNSTATE

UNC

CORNELL UNIVERSITY

PURDUE UNIVERSITY

WASHINGTON STATE UNIVERSITY

WISCONSIN 1848

EPRI
Providing Science and Technology Solutions to Our Global Energy Customers

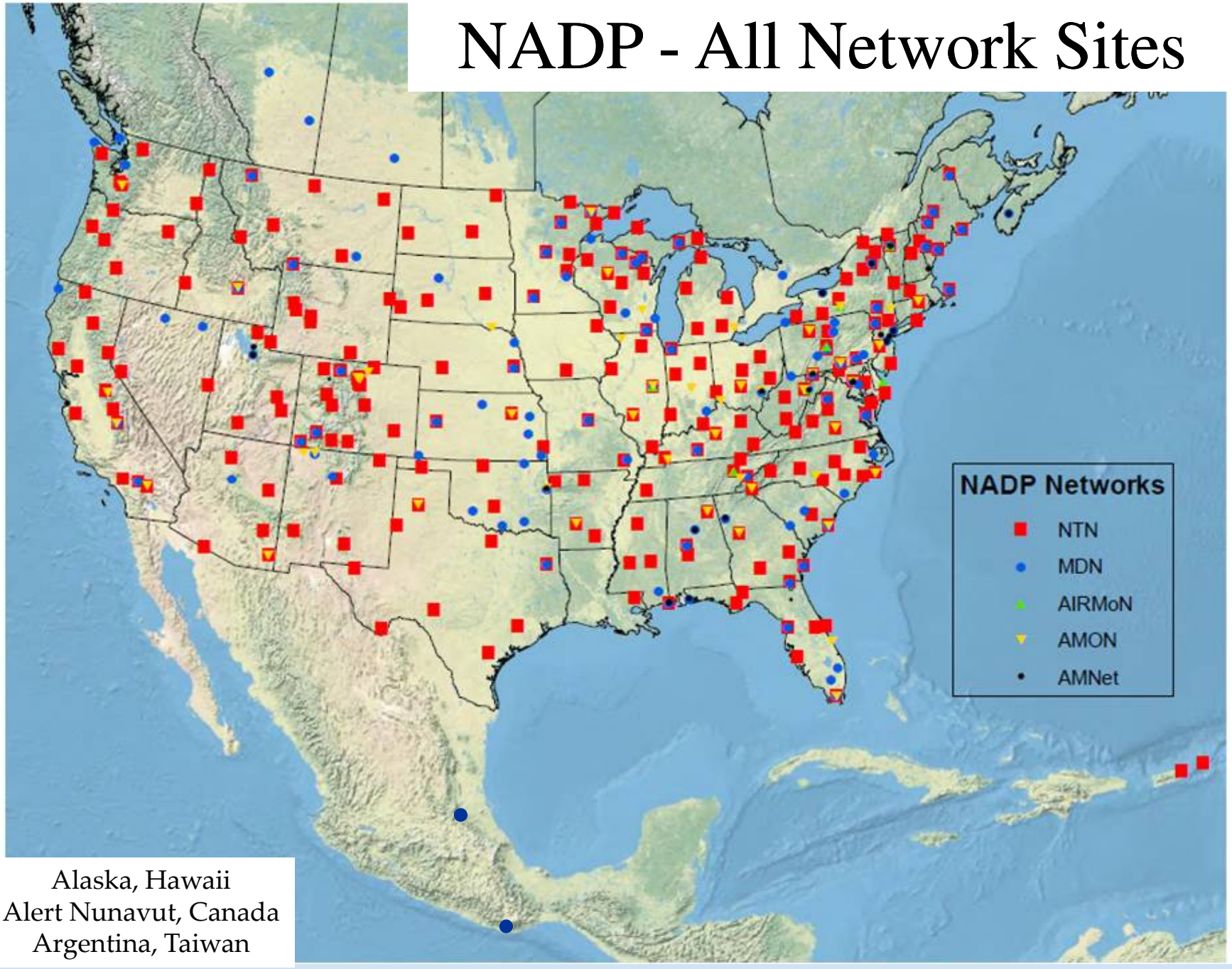
Environment Canada Environnement Canada

bp

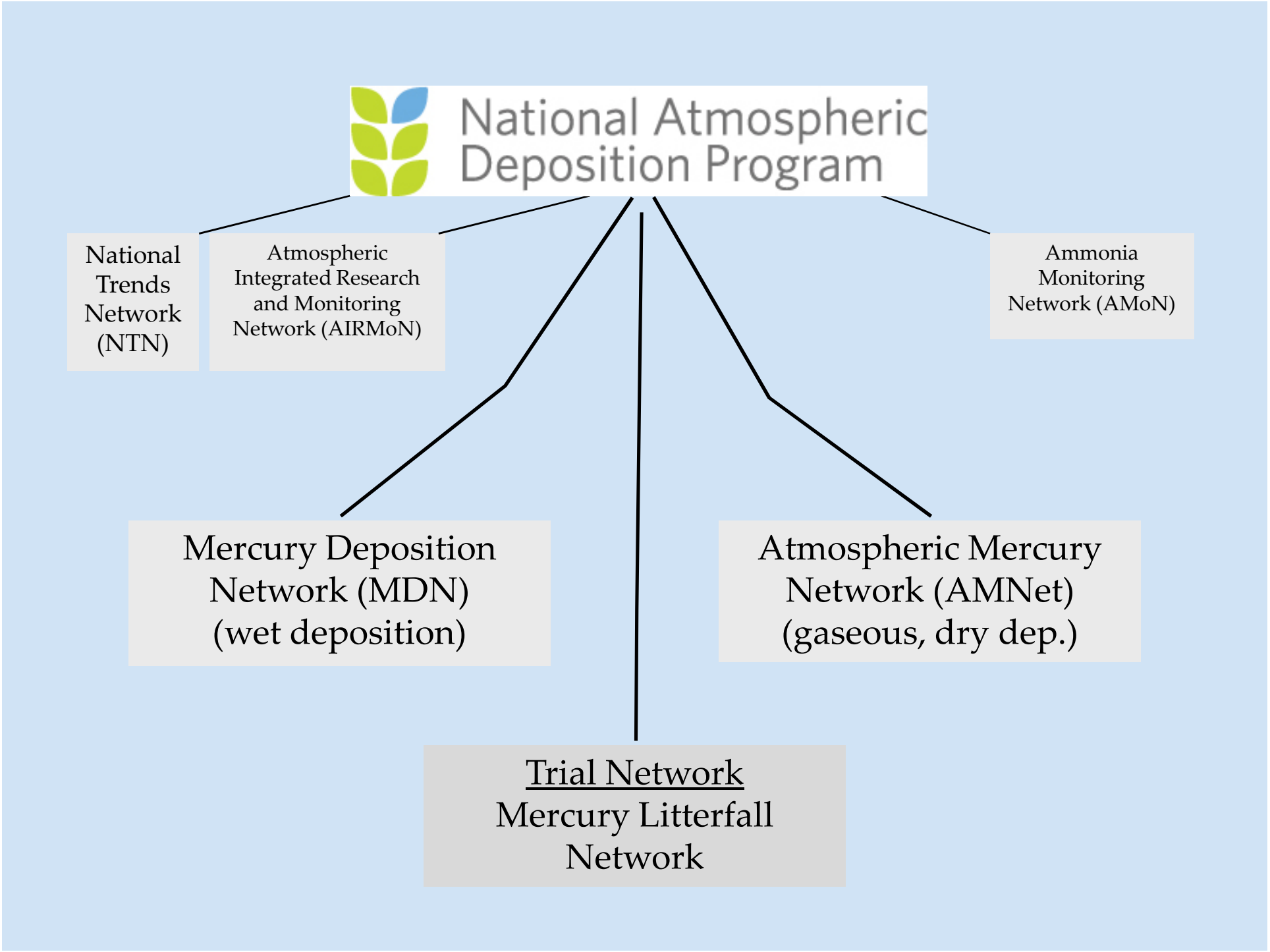
EPA Taiwan

SOUTHERN COMPANY
Energy to Serve Your World

NADP - All Network Sites



Alaska, Hawaii
Alert Nunavut, Canada
Argentina, Taiwan


National Atmospheric Deposition Program
National Trends Network (NTN)
Atmospheric Integrated Research and Monitoring Network (AIRMoN)
Ammonia Monitoring Network (AMoN)
Mercury Deposition Network (MDN) (wet deposition)
Atmospheric Mercury Network (AMNet) (gaseous, dry dep.)
Trial Network
Mercury Litterfall Network

Atmospheric Mercury Network Goals

Goals:

- dry deposition estimates in weekly fashion alongside wet deposition
- For use in model evaluation
- Trends estimates

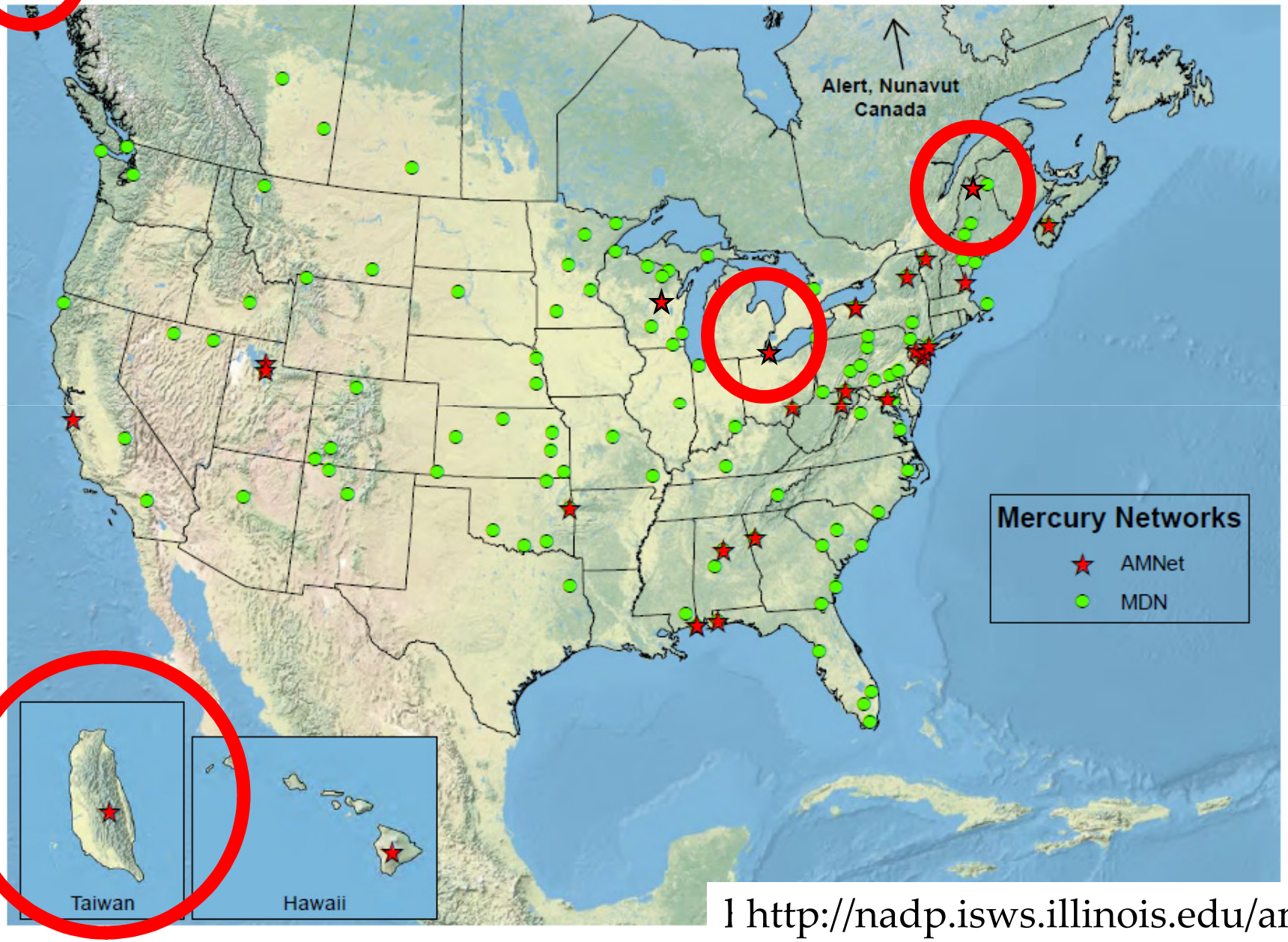


AMNet Measurements

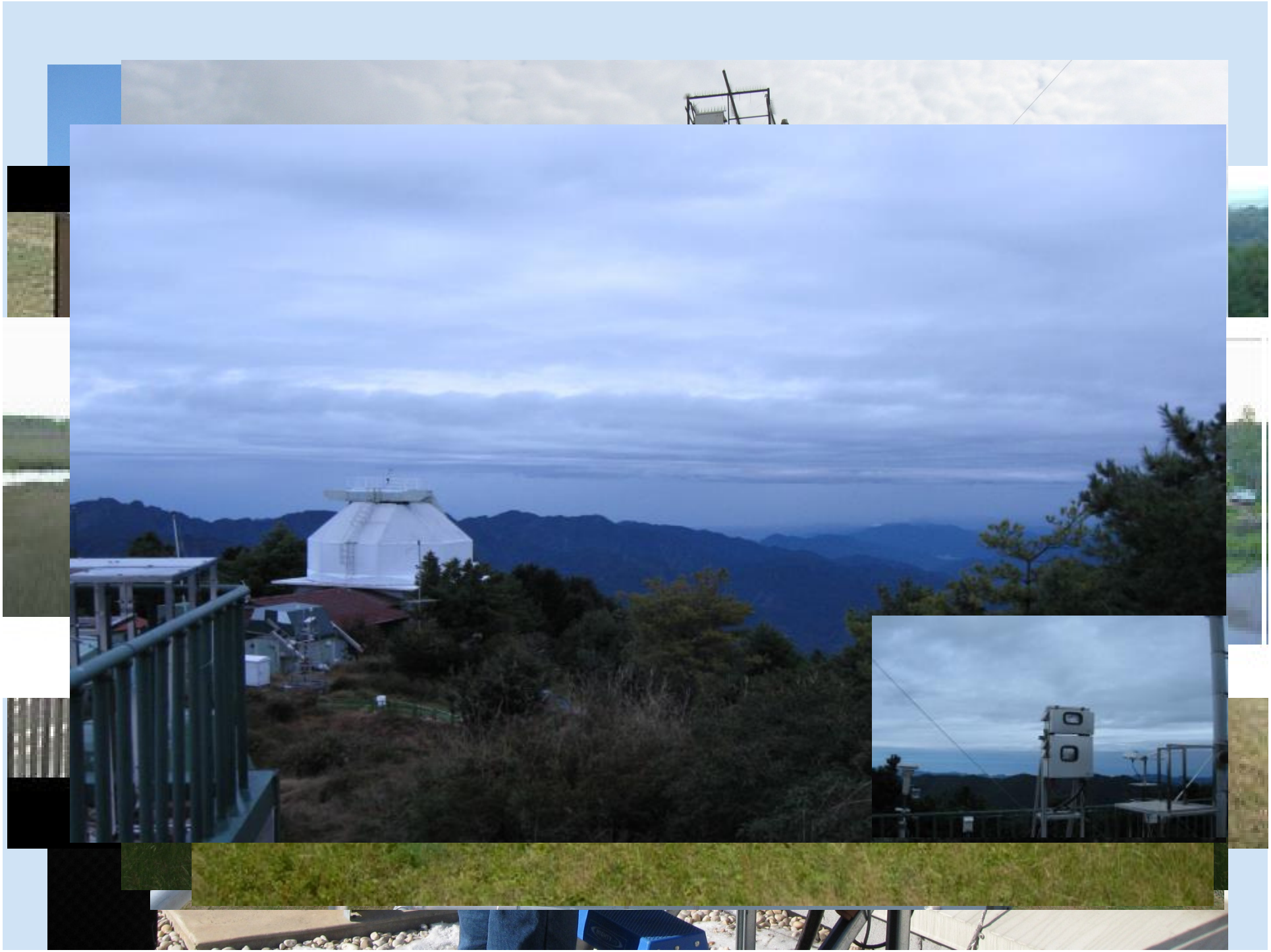
- Mercury fractions
  - GEM (hourly)
  - GOM (2 hourly)
  - $PBM_{2.5}$ (2 hourly)
- Tekran System
  - 2537, 1130, 1135
- With wet deposition flux
  - Mercury Deposition Network
- Land cover variables
  - for estimates of dry deposition flux



NADP's Mercury Networks



l http://nadp.isws.illinois.edu/amn/



Data Availability

- 98 site years of data available
  - Only validated data available
  - averaged to hourly GEM, 2-hourly GOM & $PBM_{2.5}$
- Through December 2013,
  - 291,000 valid observations
  - of GEM, of GOM, and of $PBM_{2.5}$
  - 2009 – current, ongoing
- Available: http://nadp.isws.illinois.edu

AMNet Quality Assurance Overview

- Field Operations SOP
  - operation, reporting, etc.
  - weekly/monthly/quarterly maintenance
- Data Management SOP
- Site Survey SOP
  - siting criteria
- Quality Assurance Plan
- Site pictures, information

Available on the NADP Webpage



Automated Quality Assurance

- Upon import of raw data, flags are assigned to each observation
- AMNet currently utilizes 51 Quality Assurance flags, most are automated
    - 23 are warning flags which leave the data valid
    - 26 are control flags which invalidate the data
- Then manual review, with final flag assignment
- QA system available for GMOS



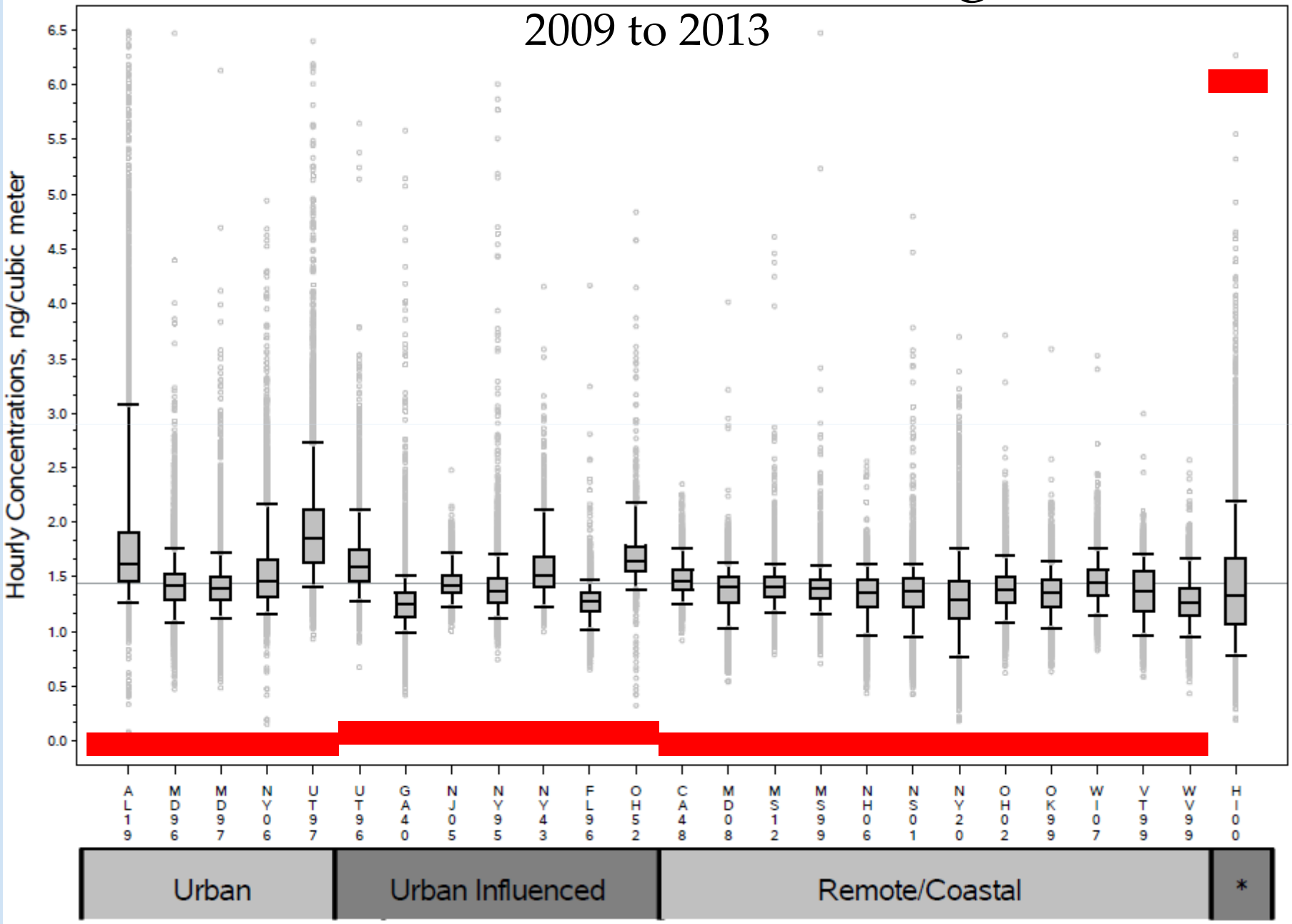
Examples of QA Flags

Data Flag*	Description	Mercury Species
null	Data meets criteria used in the automated scripts	All
A1	$\lvert(\text{Air cartridge bias}_i - \text{Air cartridge bais}_{i+1})/\text{Air cartridge bias}_i\rvert > 0.10$ for 24 consecutive hours	GEM
A2	$\lvert(\text{Air cartridge bias}_i - \text{Air cartridge bais}_{i+1})/\text{Air cartridge bias}_i\rvert > 0.15$ for 24 consecutive hours	GEM
B0	Baseline voltage < 0.01V	All
B1	Baseline voltage < 0.05V, or Baseline voltage > 0.25V	All
B2	$\lvert\text{Baseline voltage}_i - \text{Baseline voltage}_{i+1}\rvert > 0.01$V	All
B3	Baseline deviation > 0.10V for 5 consecutive readings	All
B5	Baseline deviation > 0.20V	All
C0	$\lvert(\text{Calibration}_i - \text{Calibration}_{i+1})/\text{Calibration}_i\rvert > 0.10$	All
C1	$\lvert(\text{Calibration cartridge bias}_i - \text{Calibration cartridge bais}_{i+1})/\text{Calibration cartridge bias}_i\rvert > 0.10$	All
C2	$\lvert(\text{Calibration cartridge bias}_i - \text{Calibration cartridge bais}_{i+1})\rvert/\text{Calibration cartridge bias}_i > 0.20$	All
C5	$\lvert(\text{Calibration}_i - \text{Calibration}_{i+1})/\text{Calibration}_i\rvert > 0.05$	All
E0	First GEM from each cartridge	GEM
E1	GEM < 1.00 ng/m^3 for same cartridge	GEM
E5	$\lvert(\text{GEM}_i - \text{GEM}_{i+1})/\text{GEM}_i\rvert > 0.50$ for same cartridge	GEM
F1	72 hours < Time between calibrations < 144 hours	All
F2	Time between calibrations > 144 hours	All
G0	GOM = 0 pg/m^3 for more than 24 hours	GOM
G1	Cycle(H) < 0.70 x GOM, or Cycle(I) > 0.20 x GOM, or Cycle(J) > 0.10 x GOM	GOM
G2	GOM < 0 pg/m^3	GOM
L1	GEM cycles < 24 before desorption	GOM $PBM_{2.5}$
L2	GEM cycles <> $\text{GEM cycles}_{\text{historical}}$	GOM $PBM_{2.5}$
M2	Status = M2 (multiple peaks)	All
M3	Status > M2 (multiple peaks)	All
NP	Status = NP (no peak)	GEM
OL	Status = OL (overload)	All

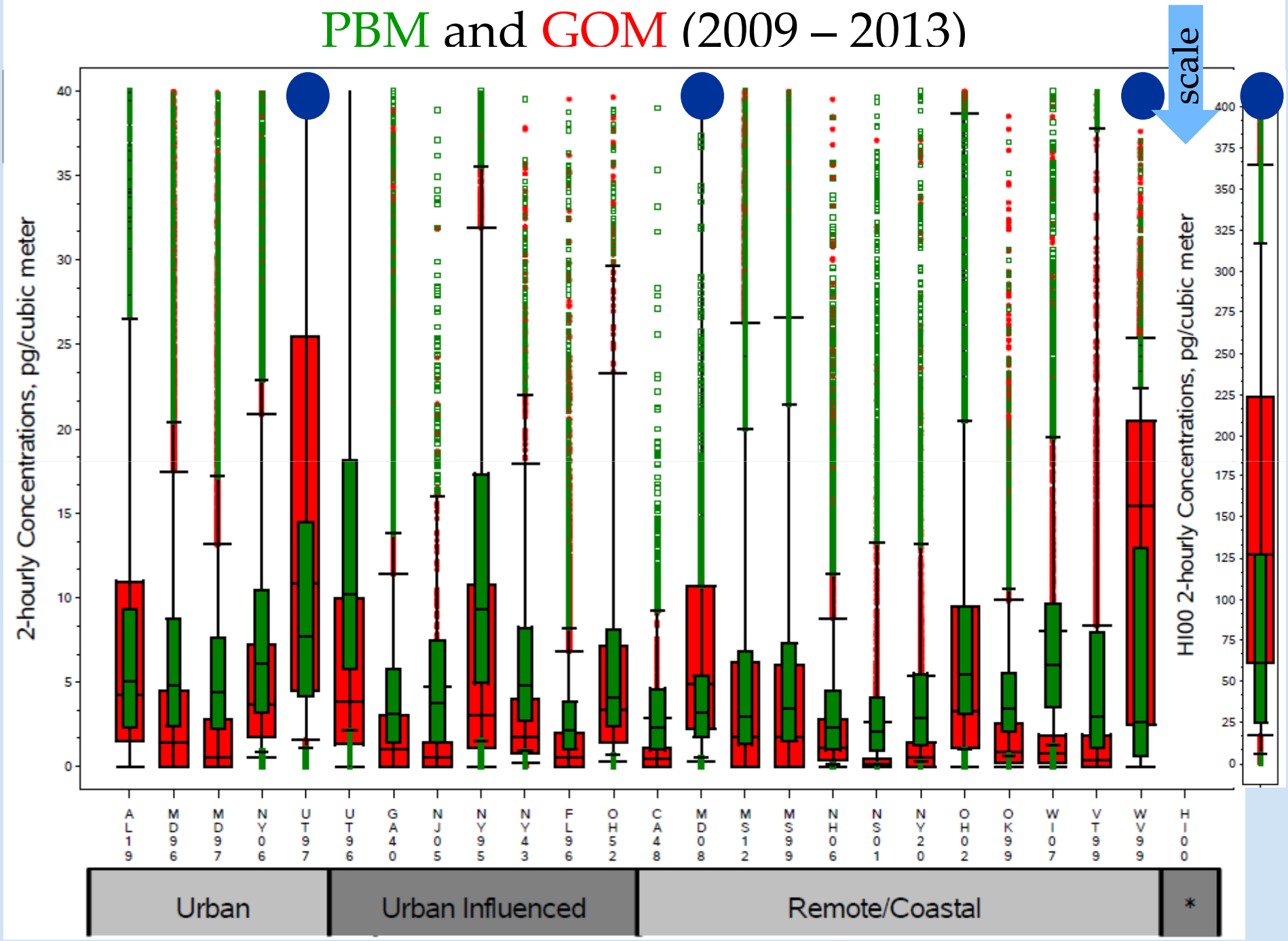
Output Data from the AMNet

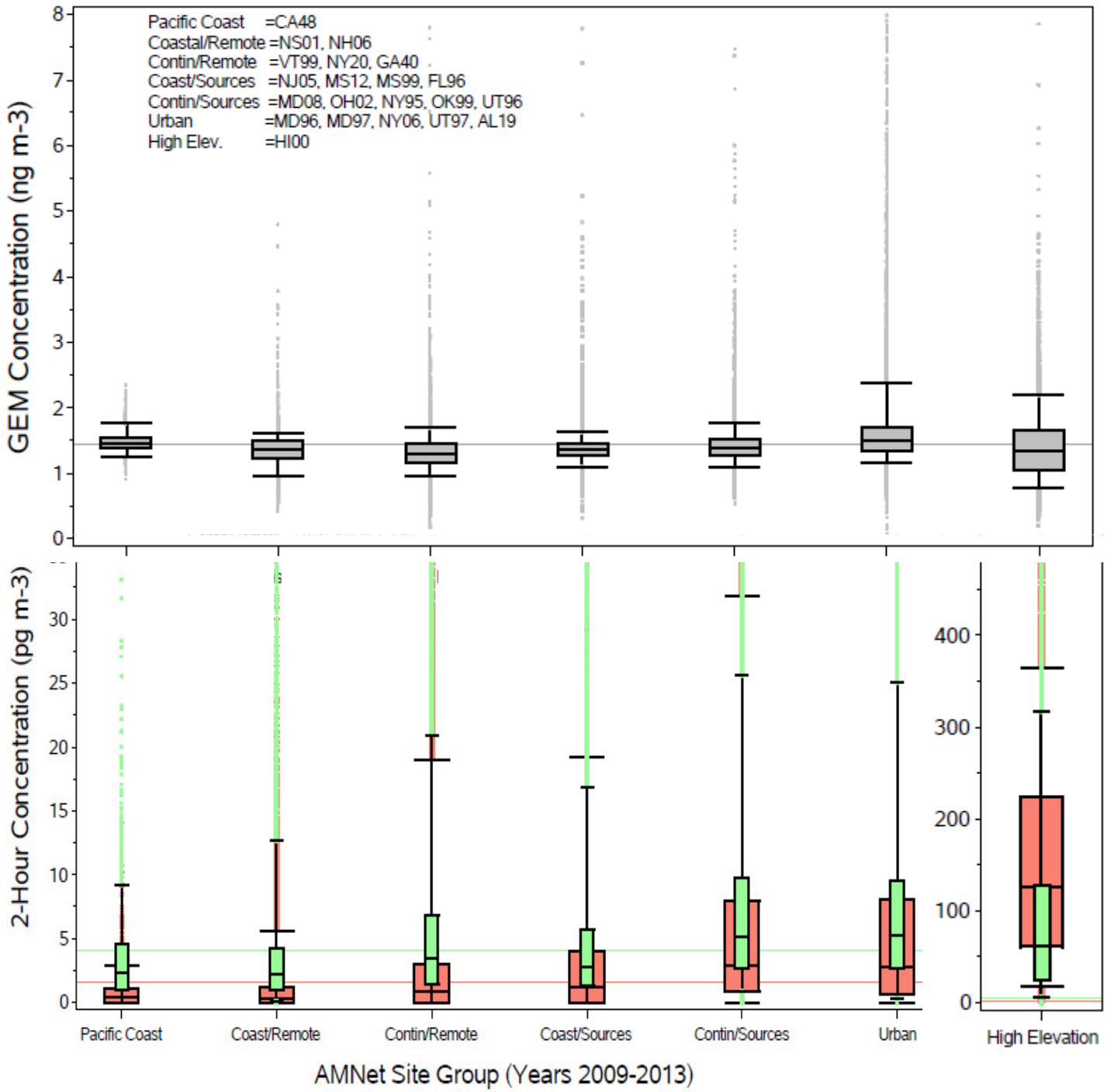
Gaseous Elemental Hg

2009 to 2013



PBM and GOM (2009 – 2013)




Pacific Coast =CA48
Coastal/Remote =NS01, NH06
Contin/Remote =VT99, NY20, GA40
Coast/Sources =NJ05, MS12, MS99, FL96
Contin/Sources =MD08, OH02, NY95, OK99, UT96
Urban =MD96, MD97, NY06, UT97, AL19
High Elev. =HI00
GEM Concentration (ng m-3)
2-Hour Concentration (pg m-3)
Pacific Coast
Coast/Remote
Contin/Remote
Coast/Sources
Contin/Sources
Urban
High Elevation
AMNet Site Group (Years 2009-2013)

Proposed: Estimate Dry Deposition

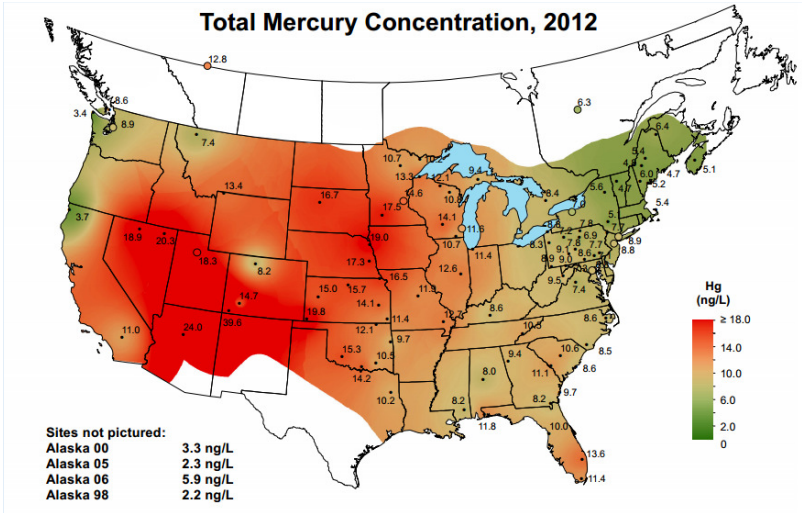
- Weekly GOM, PBM, and GEM (downward)
- flux (*F*) = *air concentration x dry deposition velocity* (V_d)

$$F = V_{deposition} * Concentration_{air}$$

where:

$$V_d = \frac{1}{R_a + R_b + R_c}$$

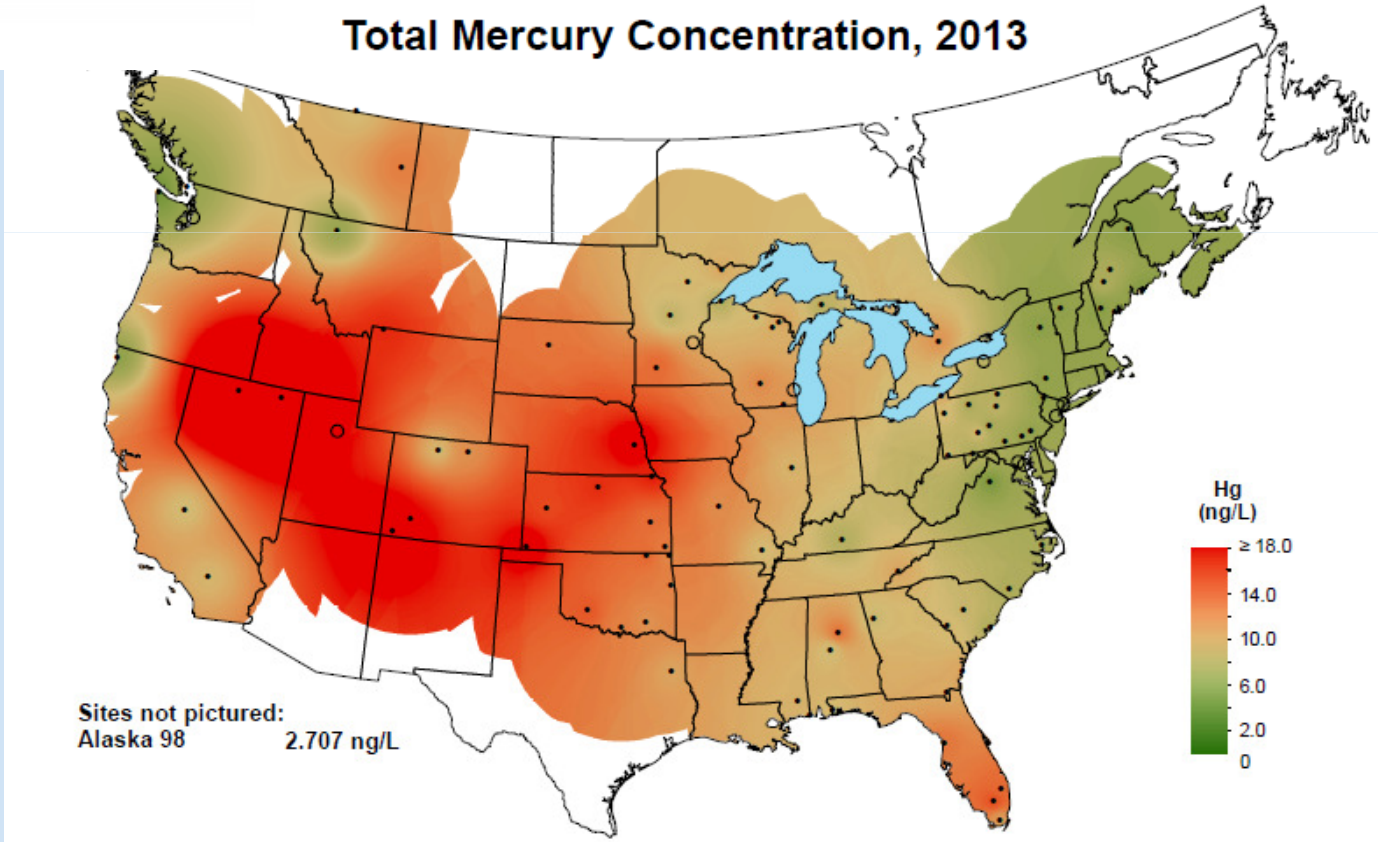
- R_a *as aerodynamic resistance,* R_b *as quasi-laminar resistance, and* R_c *as canopy resistance*



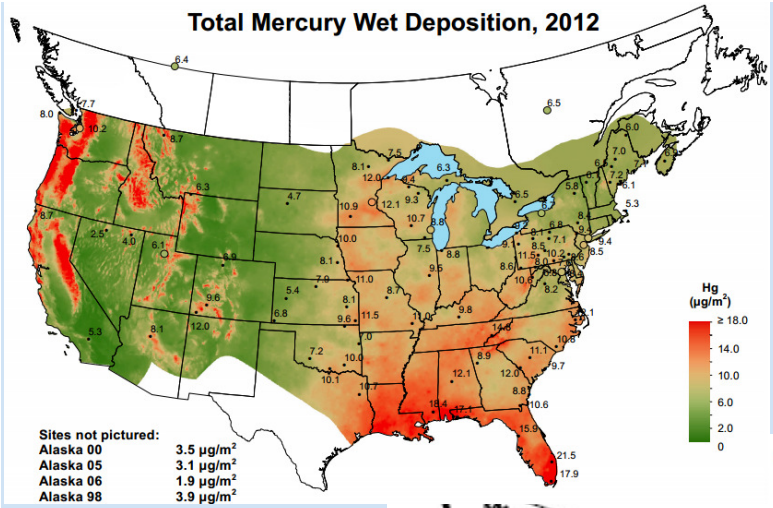
National Atmospheric Deposition Program/Mercury Deposition Network
http://nadp.isws.illinois.edu

Preliminary

2013 MDN Wet Concentration Map

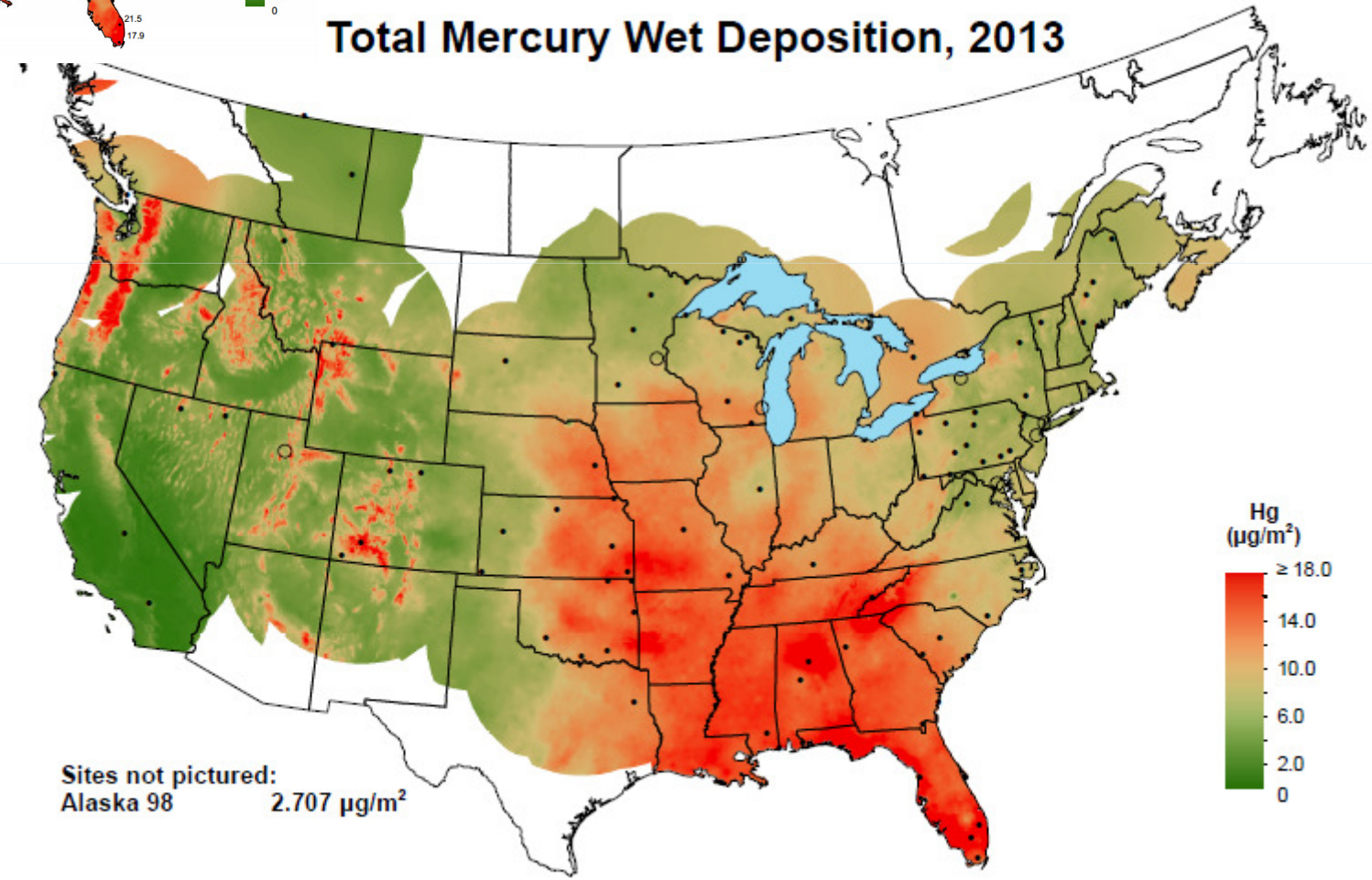


National Atmospheric Deposition Program/Mercury Deposition Network
http://nadp.isws.illinois.edu



Preliminary

2013 MDN Wet Deposition Map



New NADP Trial Network: Mercury Litterfall

- Started in 2012
- In cooperation with USGS
  and USGS Mercury Research Lab
- 14 stations (w/MDN)
- Monthly observations
  (May to Nov)



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journal homepage: www.elsevier.com/locate/envpol

Litterfall mercury dry deposition in the eastern USA

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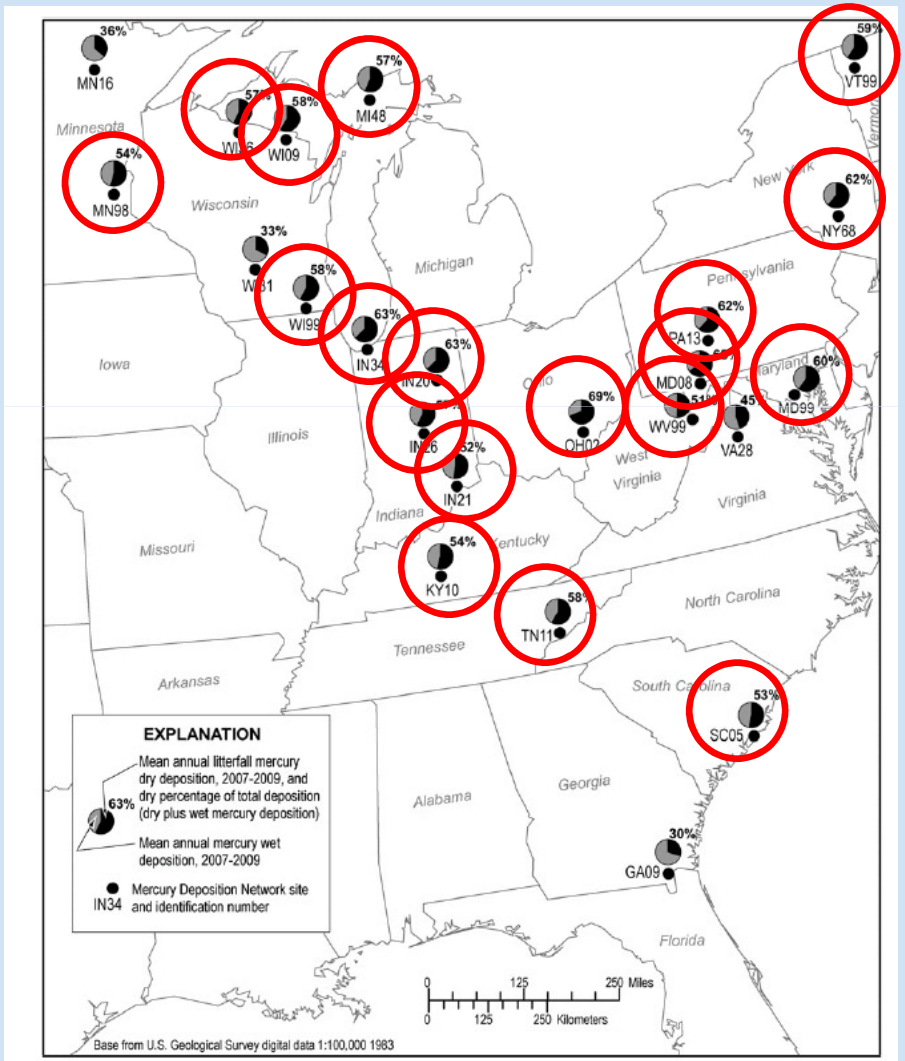


Fig. 2. Mean annual litterfall Hg dry and Hg wet deposition at litterfall Hg study sites, 2007–2009.

Future Plans: Networking Asia

Asia Pacific Mercury Monitoring Network

- Consistent wet deposition observations
- Gaseous measurements
  - Tekran GEM and current GOM/PBM
  - Manual GEM/GOM/PBM
- Consistent sampling and data reduction methods
- Open access to data

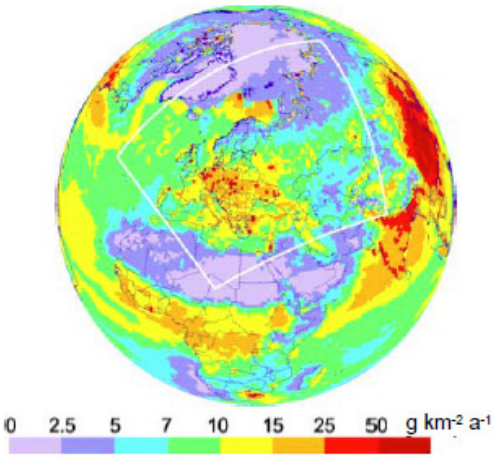
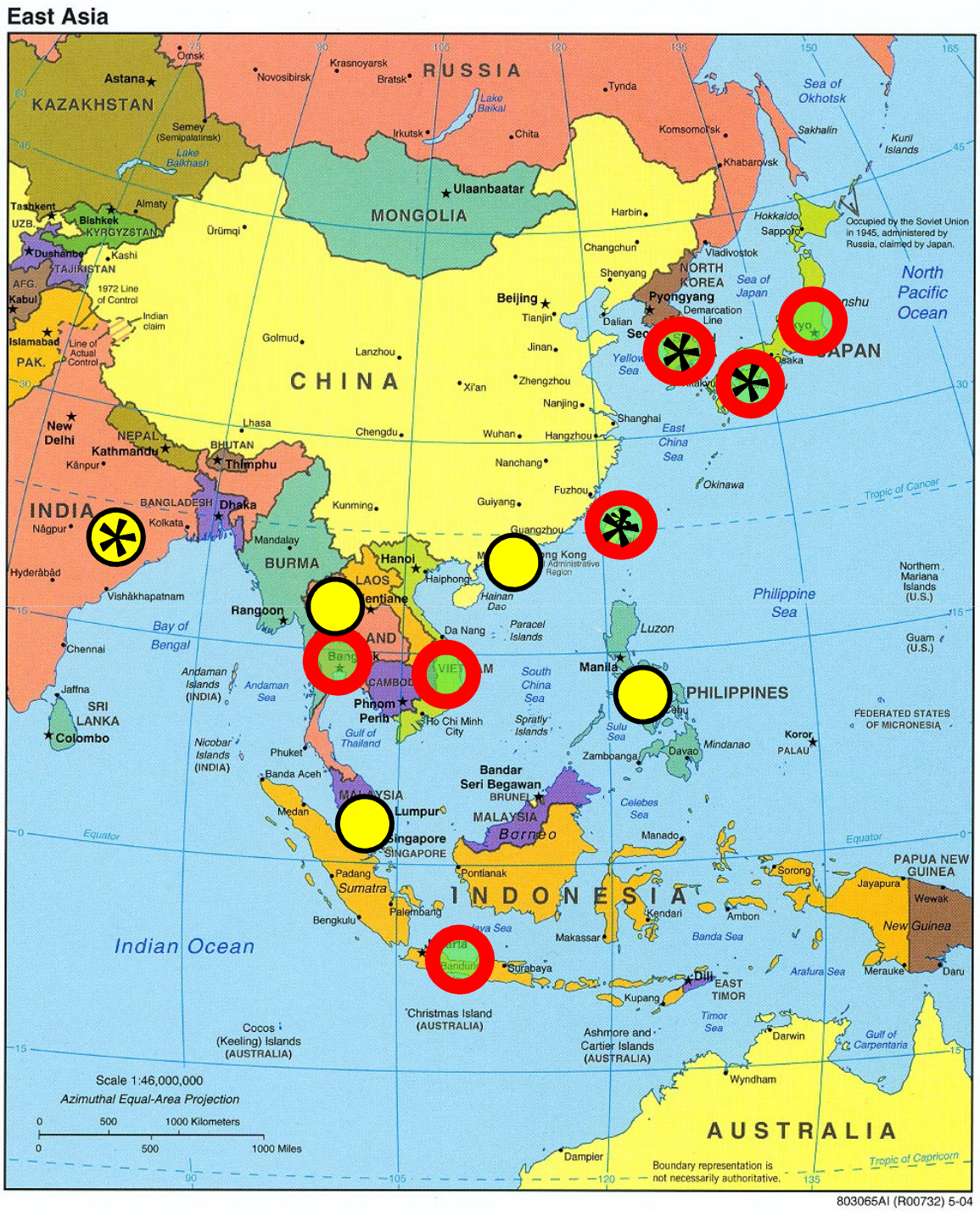


Fig. 3.13. Spatial distribution of mercury deposition flux on a global scale in 2010. White rectangle shows location of the EMEP domain.



Initial Locations Asia Pacific Mercury Monitoring Network Wet Deposition Sites

Current Members

Attending next meeting
(Sept. 2014 in Da Nang Viet.)

* Multiple instruments and or Tekrans

Thank you.





