

Global Mercury Monitoring and Advantages of Monitoring

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The Mercury Problem

- Accumulation of mercury (methyl mercury) in biological systems
- Human exposure & effects,
- Fish & wildlife effects,
- Numerous others (bats, spiders, birds).



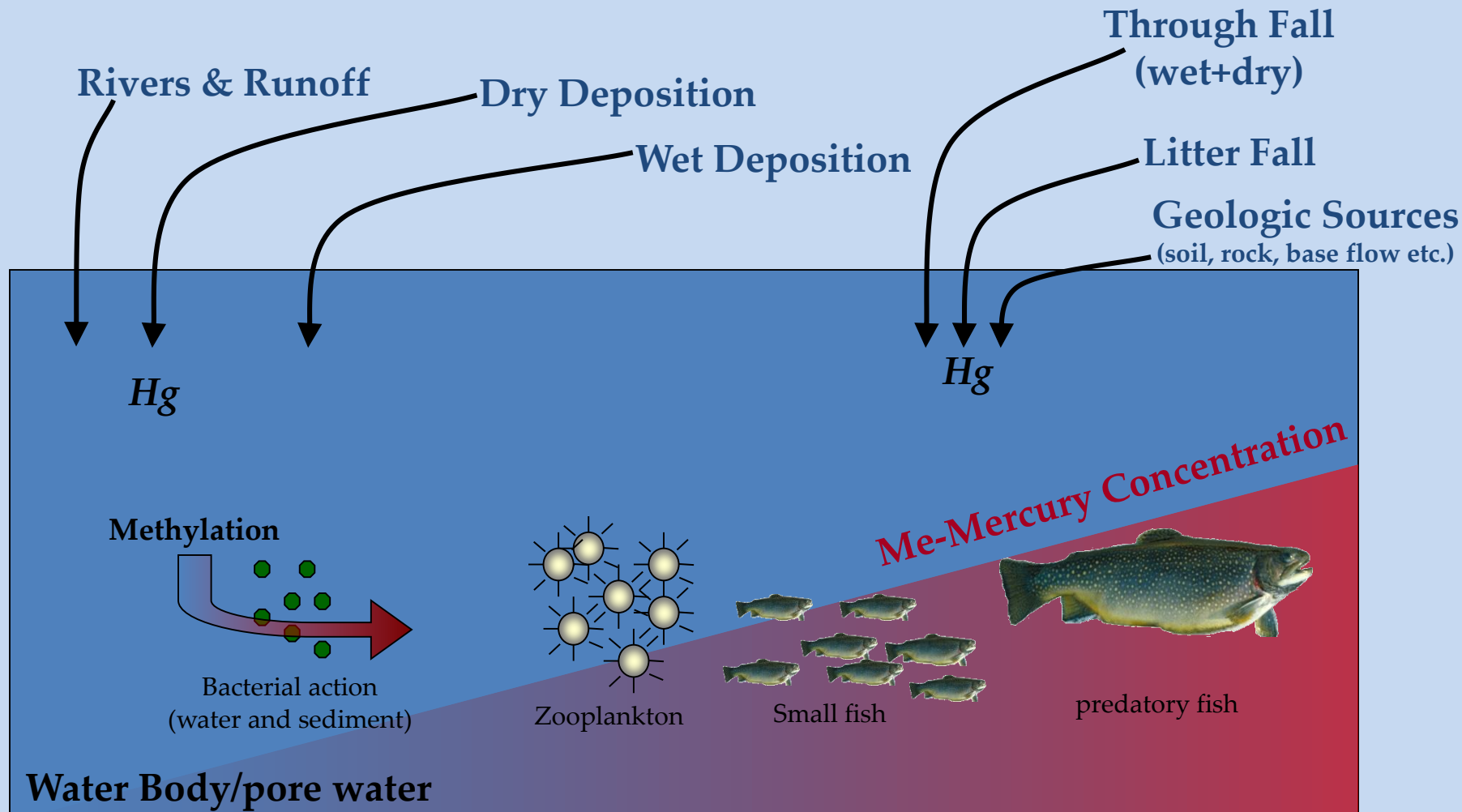
A Human Health Concern

- Neurological Disorders
 - Persistent bioaccumulative neurotoxin
 - Large problem in children to about age 7-12
 - » Birth defects
 - » learning disabilities
 - Problem in adults under certain conditions
- Other Disorders:
 - Kidney disorders
 - Possible human carcinogen (EPA 2005)

Other Health Specifics

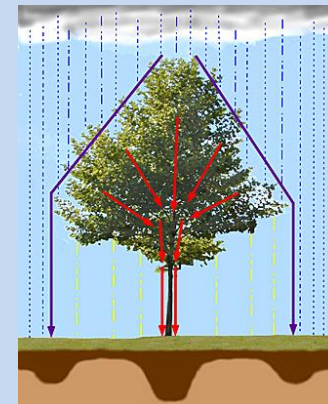
- Overt poisoning, central nervous system
 - causing parasthesias, ataxia, dysarthria, hearing impairment, and progressive constriction of the visual fields, typically after a latent period of weeks to months.
- High-level prenatal exposure may cause
 - many developmental deficits that includes mental retardation, cerebellar ataxia, dysarthria, limb deformities, altered physical growth, sensory impairments, and cerebral palsy (NRC, 2000).
- lower levels of prenatal exposure
 - abnormal neurocognitive test results in children
 - Possible increased risk for cardiovascular disease

Bioaccumulation of Methyl Mercury

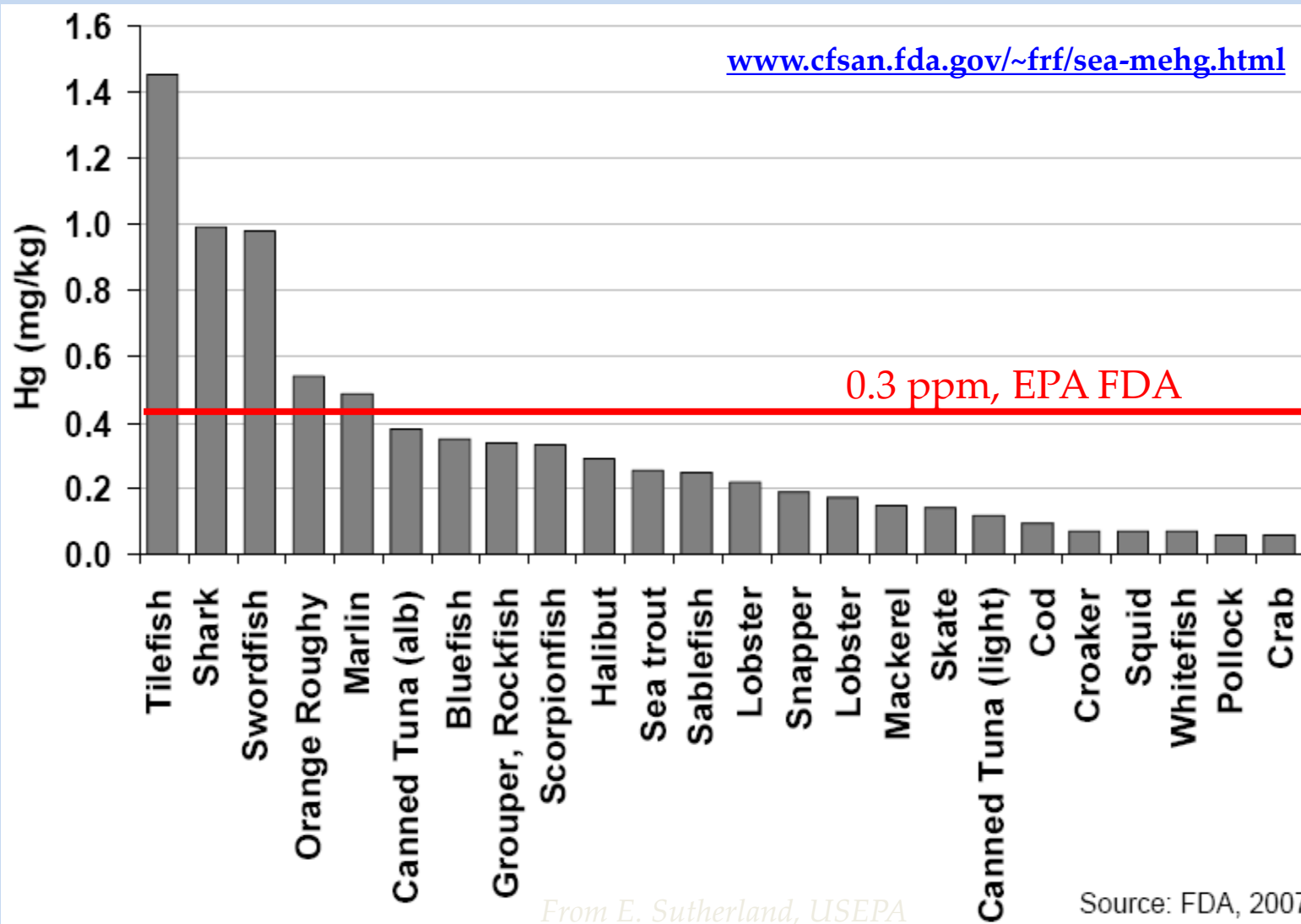


Processes Contributing to Total Atmospheric Hg Deposition...

- Wet Deposition
- Dry Deposition
- Litterfall
- Throughfall



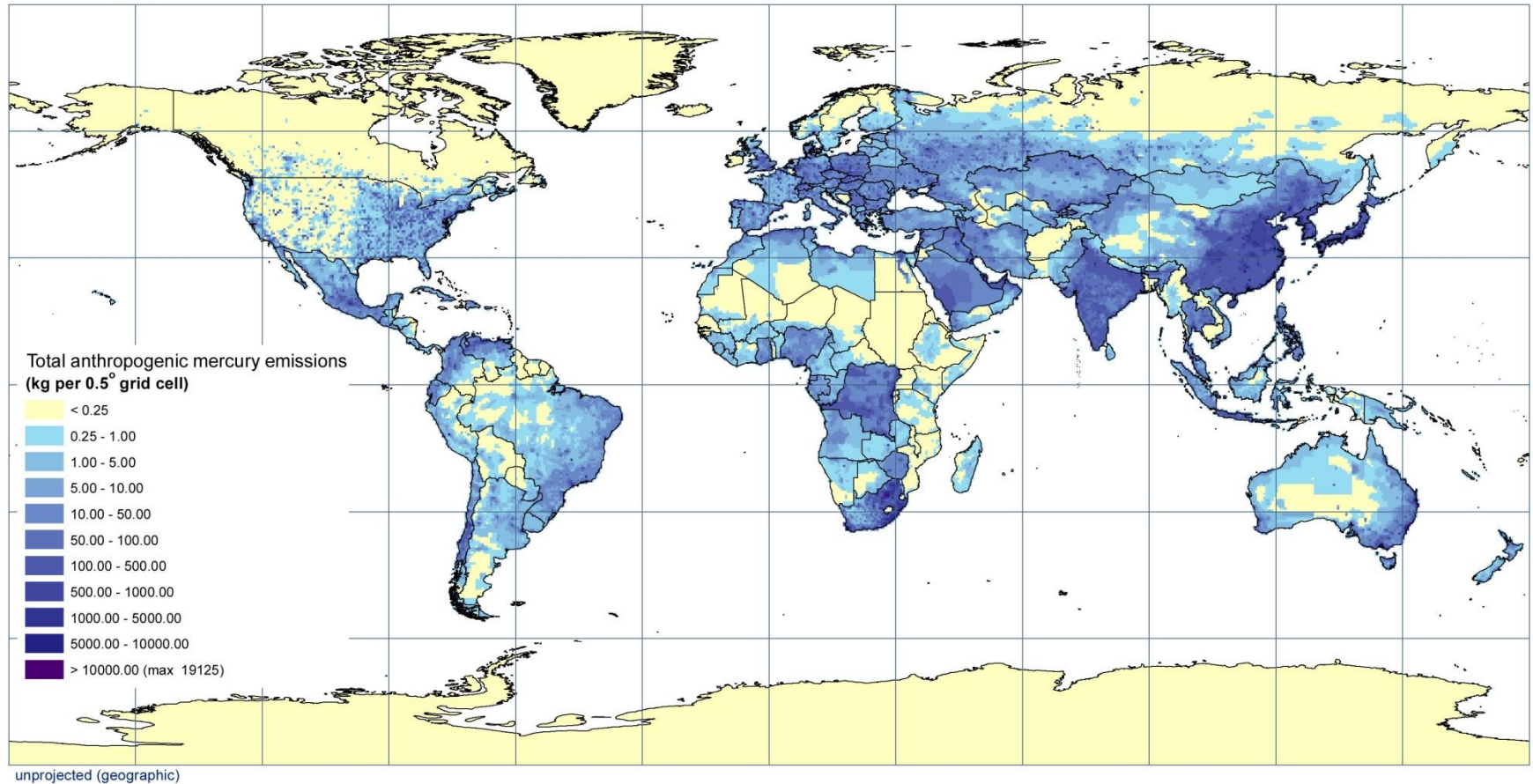
Significant Fish Hg Concentrations Being Reported



Major Sources of Mercury Emission

Spatially Distributed Inventories of Global Anthropogenic Emissions of Mercury to the Atmosphere, 2000

Total Hg, point sources + distributed sources, 0.5° grid



citation:

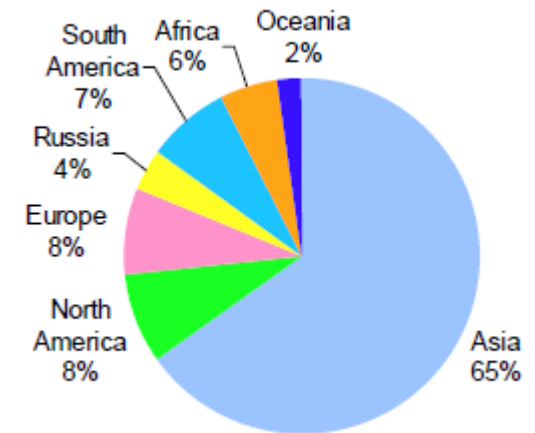
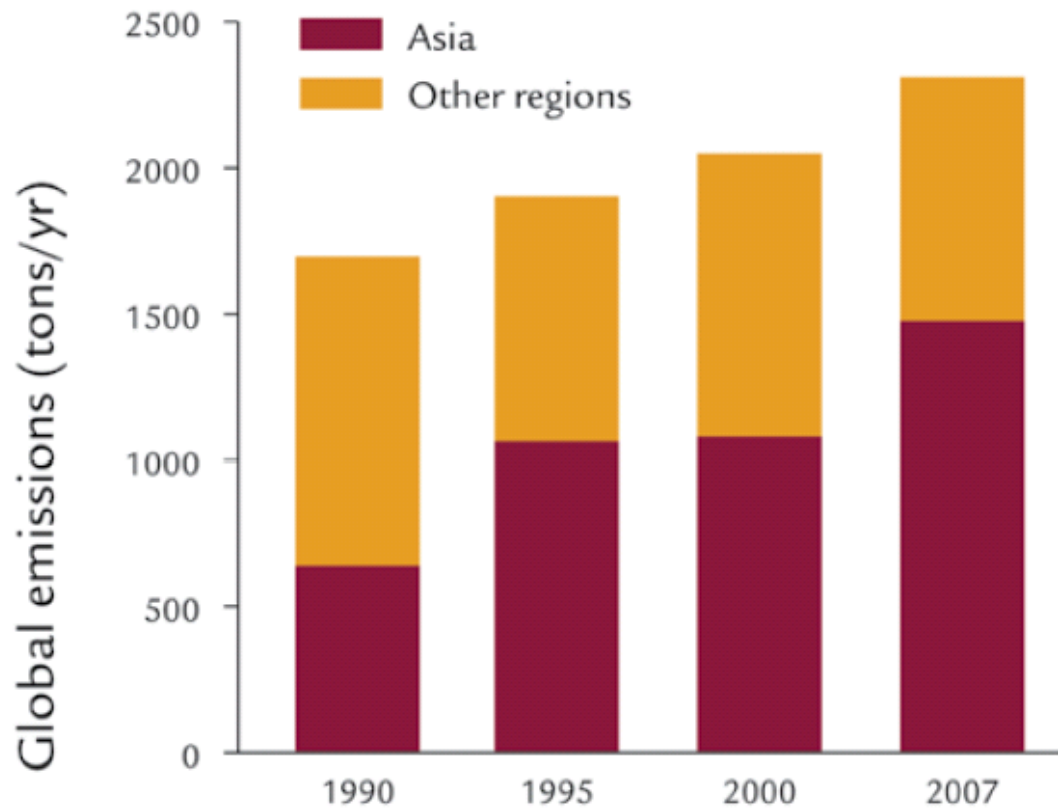
Pacyna, J., S. Wilson and F. Steenhuisen. 2005.
Spatially Distributed Inventories of Global Anthropogenic
Emissions of Mercury to the Atmosphere.
(www.amap.no/Resources/HgEmissions/HgInventoryMain.html)



S. Wilson (AMAP), F. Steenhuisen (Arctic Centre, RuG), J. Pacyna (NILU)

Emissions Are Increasing

Asian Growth



EMEP, 2012

Sources of Atmospheric Mercury

- **Coal combustion**
- Incineration
 - Medical
 - Trash
 - Cremation
- Industrial emissions (chlor-alkali)
- Cement production (Hg in lime)
- Mining
 - Hg use in gold and silver mining (amalgam formation)
 - Mining for Hg
 - taconite
- Automobile Recycling
- Mercury in Landfills
 - Fluorescent lamps
 - dental amalgams (also in sewers)
 - Thermometers
 - Batteries
 - Discarded electrical switches
- Others will surface
 - Other carbon fossil fuels (gas/oil/diesel)?
- Volcanoes (St. Helens)
- Naturally enriched ores/soils
 - Plate tectonic boundaries
 - Cinnabar (HgS), taconite, others
- Soils and rocks (0.08 to 0.5 ppm in crust)
- Evaporation
 - Soils
 - Fresh water and Oceans
- Natural forest fires
 - Tree bark (wood fire places)
 - soils
- Volatilization from rocks?
- Wind Blown reintroduction
 - Mine tailings
 - Industrial contaminated soils
- Evolving Gases
 - Mines, industrial areas
 - Waste facilities (municipal in particular)
 - Out of soil

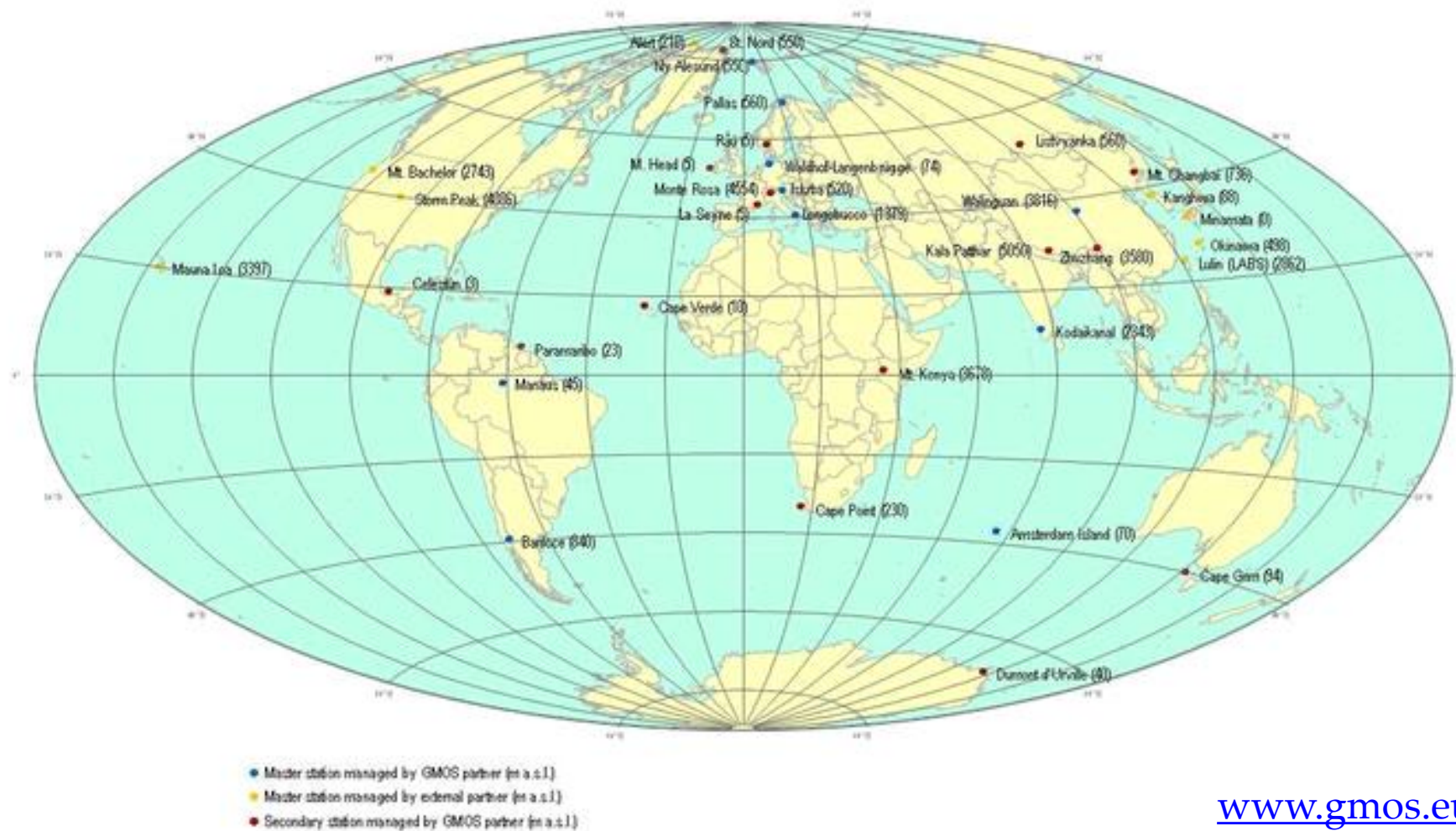
Who

is monitoring atmospheric
mercury deposition from the
atmosphere?

Global Mercury Observation System



- European Commission funded program (CNR-Italy)
- Tied into UNEP initiatives on mercury
- Gaseous speciation of Hg
- Wet deposition
- Goal: measure ambient concentrations and “estimate” deposition fluxes of mercury species around the world, at ~ 24 locations.
- In cooperation with NADP
 - SOPs
 - QA procedures

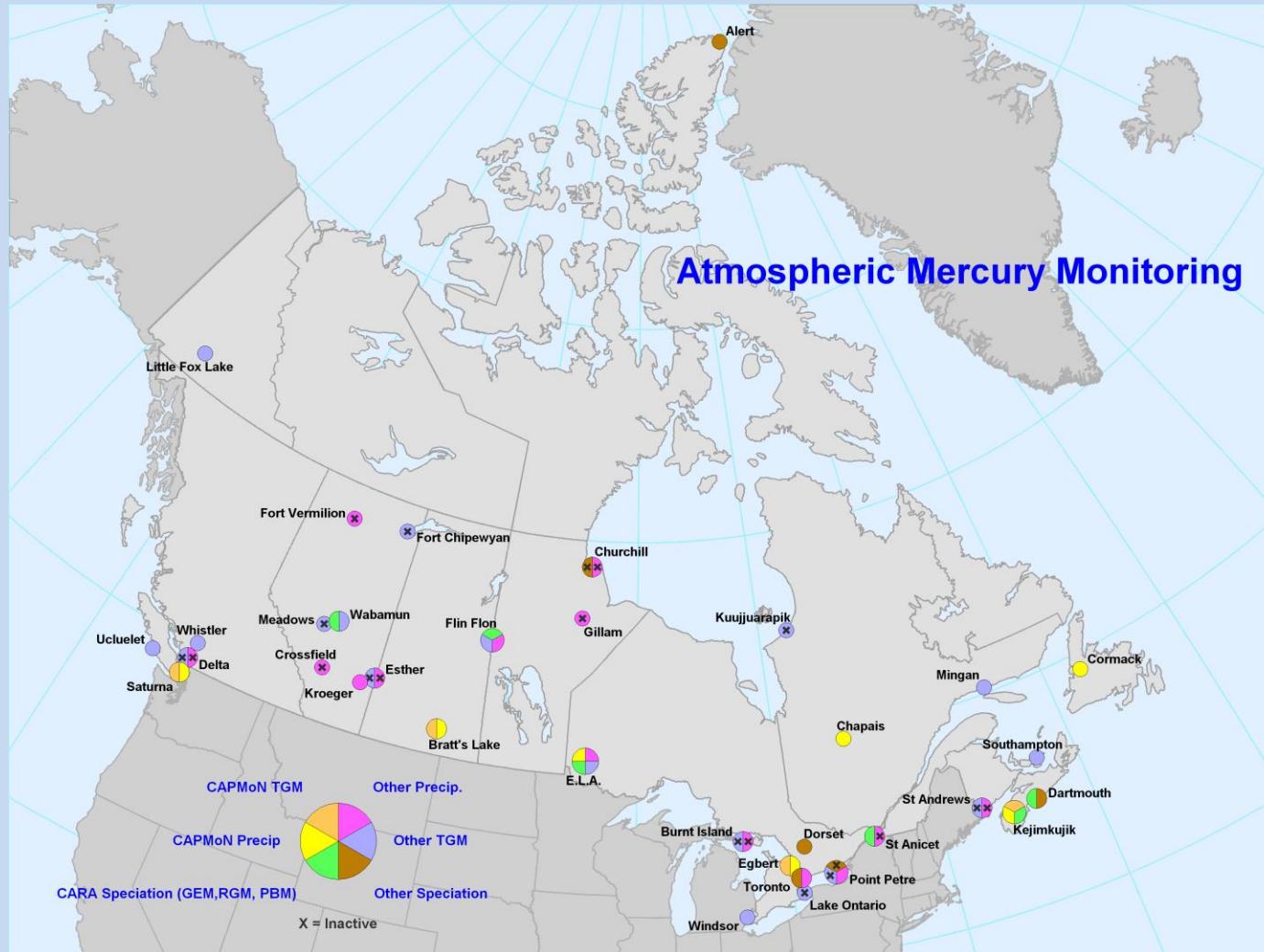


Canadian Atmospheric Mercury Measurement Network (CAMNet)

- Gaseous speciation of Hg
- Wet deposition (some with NADP)
- SOPs developed and used for many years
- Long records of TGM & Hg Species (such as Alert, Nunavut)
- Goals:
 - To improve the understanding Hg Cycle and processes.
 - To establish spatial variability and temporal trends.
 - To identify major sources, and trans-boundary transport.



Canadian Atmospheric Mercury Measurement Network (CAMNet)



Taiwan and Area

- 3 Networks
 - Lulin Atmospheric Background Station (LABS)
 - Area Network of Total Atmospheric Mercury
 - Mercury Wet Deposition Monitoring Network

Lulin Atmospheric Background Station (LABS)

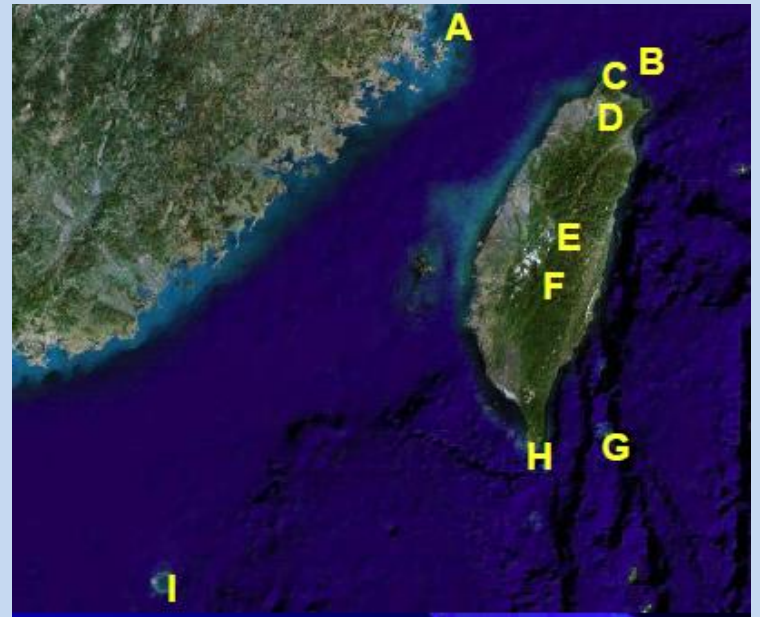
- Speciating Tekran
 - GEM, GOM, PBM_{2.5}
 - NADP Site and GMOS site
 - Since 2006
 - EPA-T and Dr. G-R. Sheu



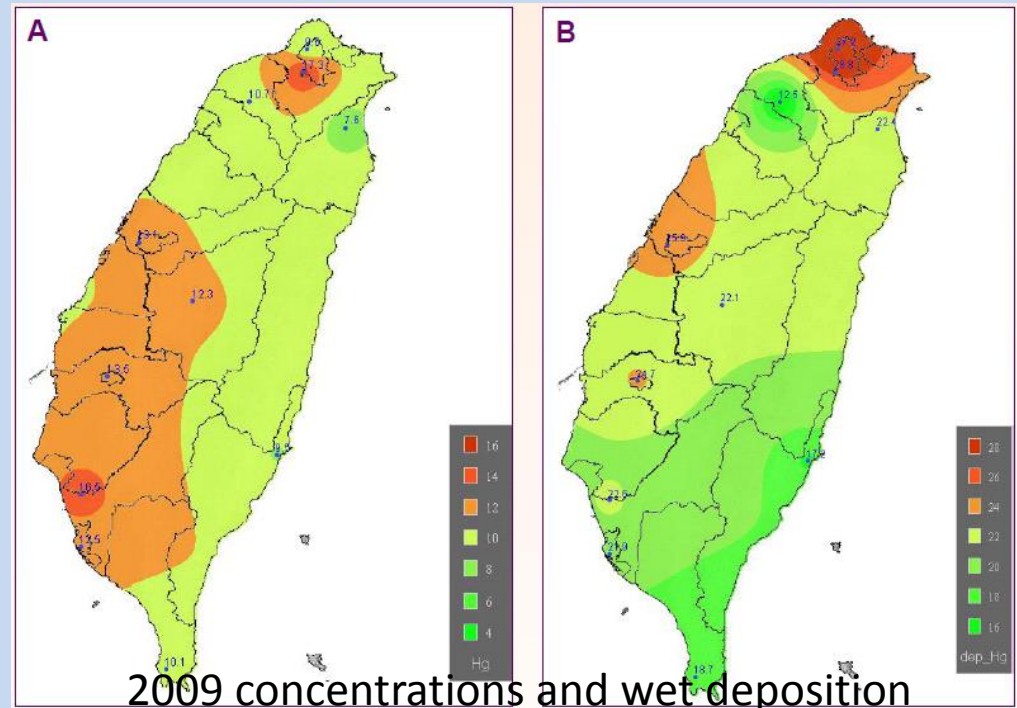
Manual System Network

Total Atmospheric Mercury

- 9 sites
- manual gold traps
- EPA-T and Dr. G-R. Sheu



Wet Deposition Monitoring Network of Mercury in Taiwan



European Monitoring and Evaluation Programme (EMEP)

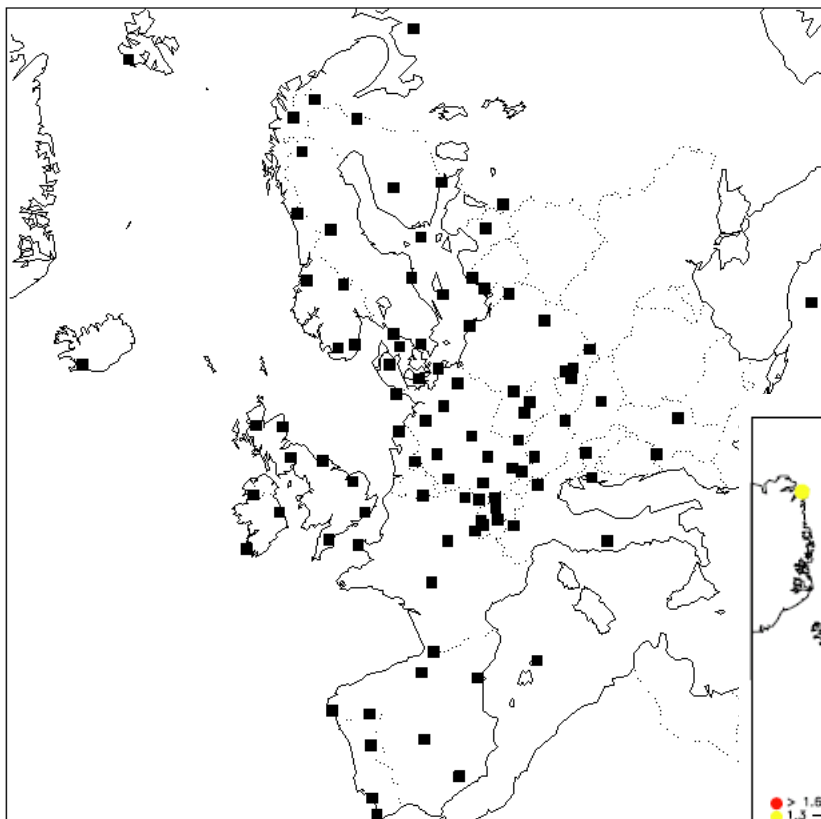


Figure 3.1: Location of EMEP stations (per 31.12.1995).
(Ozone sites not included).

About 15 performing sites

- Wet deposition
- Total gaseous mercury at ~20 sites
- ~7 speciating sites
- many since late 1980s

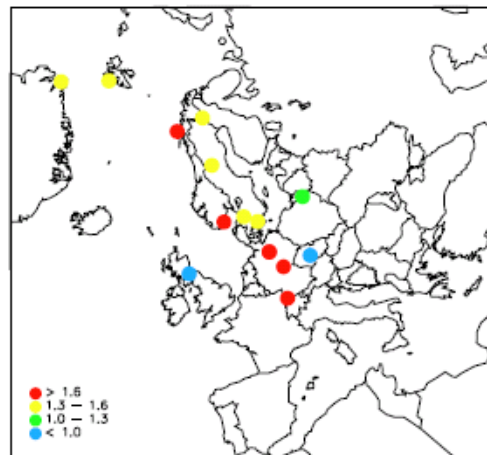


Fig. 2.5. Hg (g) in air, ng/m³

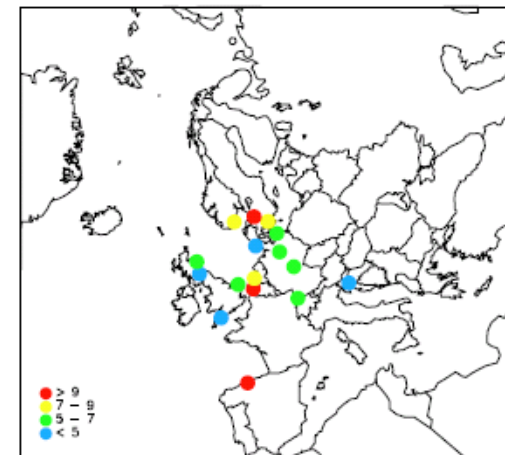


Fig. 2.6. Hg in precipitation, ng/L

EMEP Total Gaseous Mercury Sites

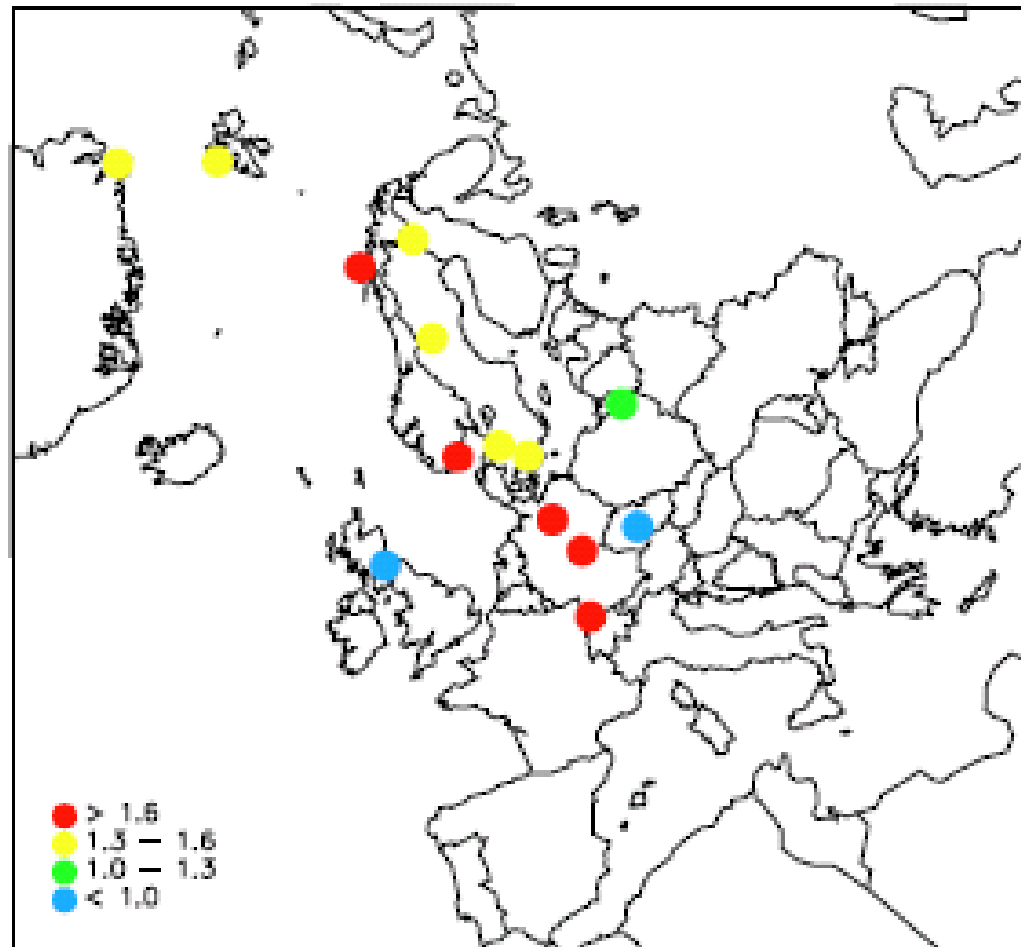
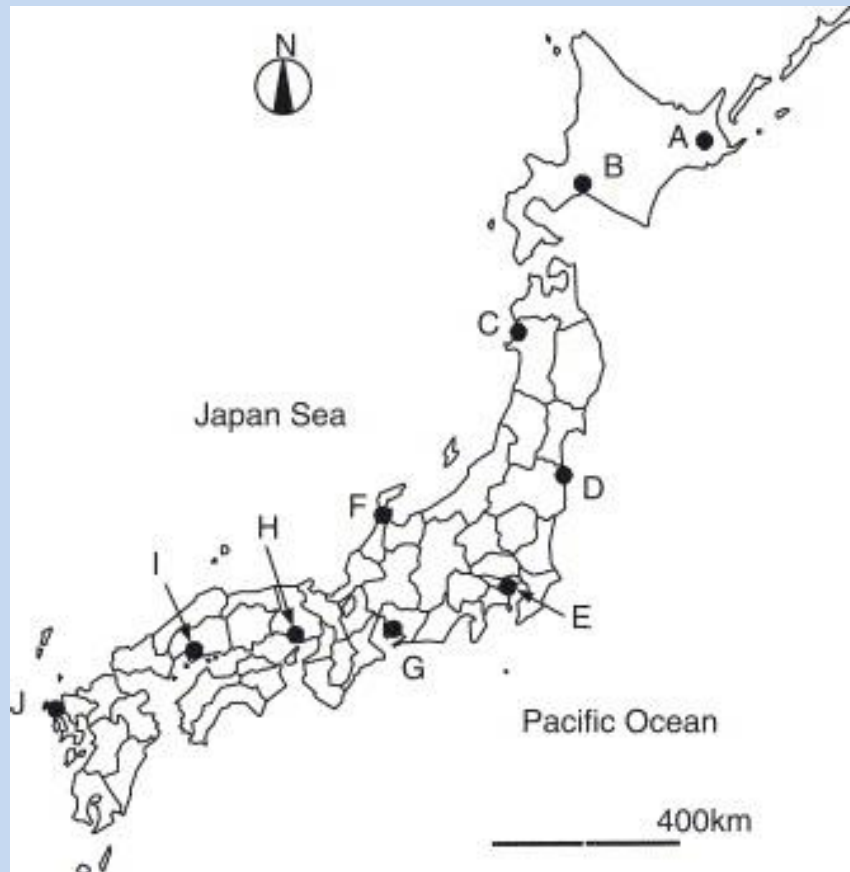


Fig. 2.5. Hg (g) in air, ng/m³

Japan's Mercury Wet and Dry Deposition Network



- ~ 10 sites
- Wet deposition record, 2001 and on
- Dry deposition with a water-based measurement
- Dr. M. Sakata et al.

- Basic chemical constituents
 - pH, electrical conductivity, concentrations of sulfate, nitrate, and other ions
- No Hg as of yet
 - just the individual country monitoring
- Since ~2001.



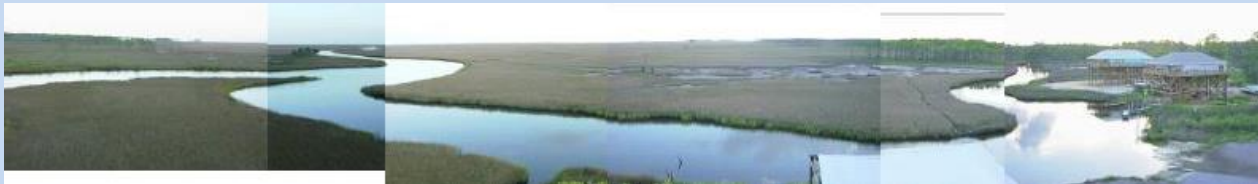
Other East Asia Hg Monitoring Networks

- **China –**
 - Dr. Xinbin Feng,
 - others
- **Korea –**
 - National Institute of Environmental Research (NIER)
 - Several researchers
- **Vietnam–**
 - Some atmospheric mercury systems
 - primarily total gaseous mercury

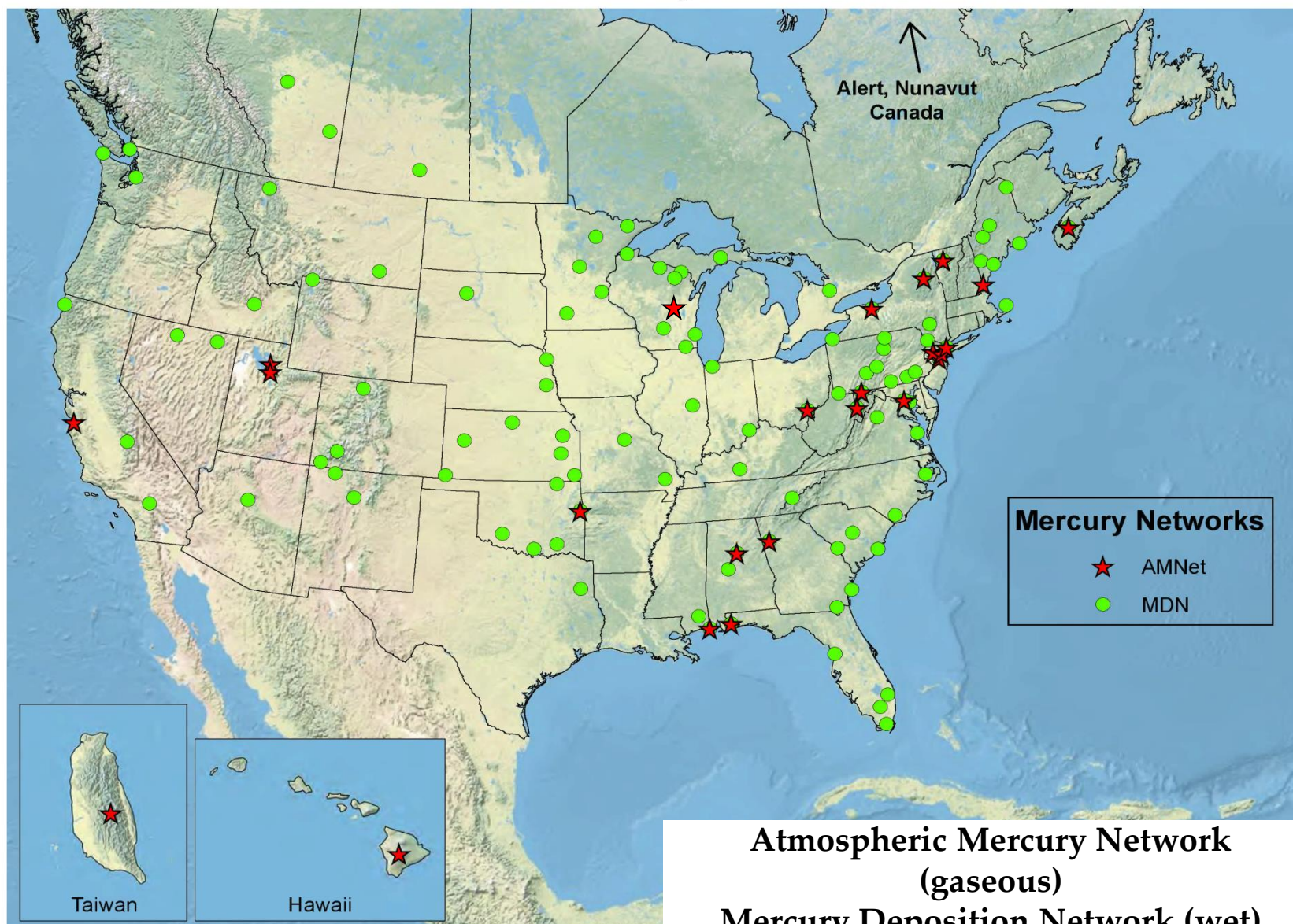


National Atmospheric Deposition Program

- 2 Networks
 - Atmospheric Mercury Network, gaseous speciation of Hg
 - Mercury Deposition Network, wet deposition
- SOPs developed and used for many years
- MDN began in 1996
- AMNet began in 2009
- To improve the understanding Hg Cycle and processes.
- To establish spatial variability and temporal trends.
- Open data access



NADP Mercury Networks



Developing a Litterfall Monitoring Network

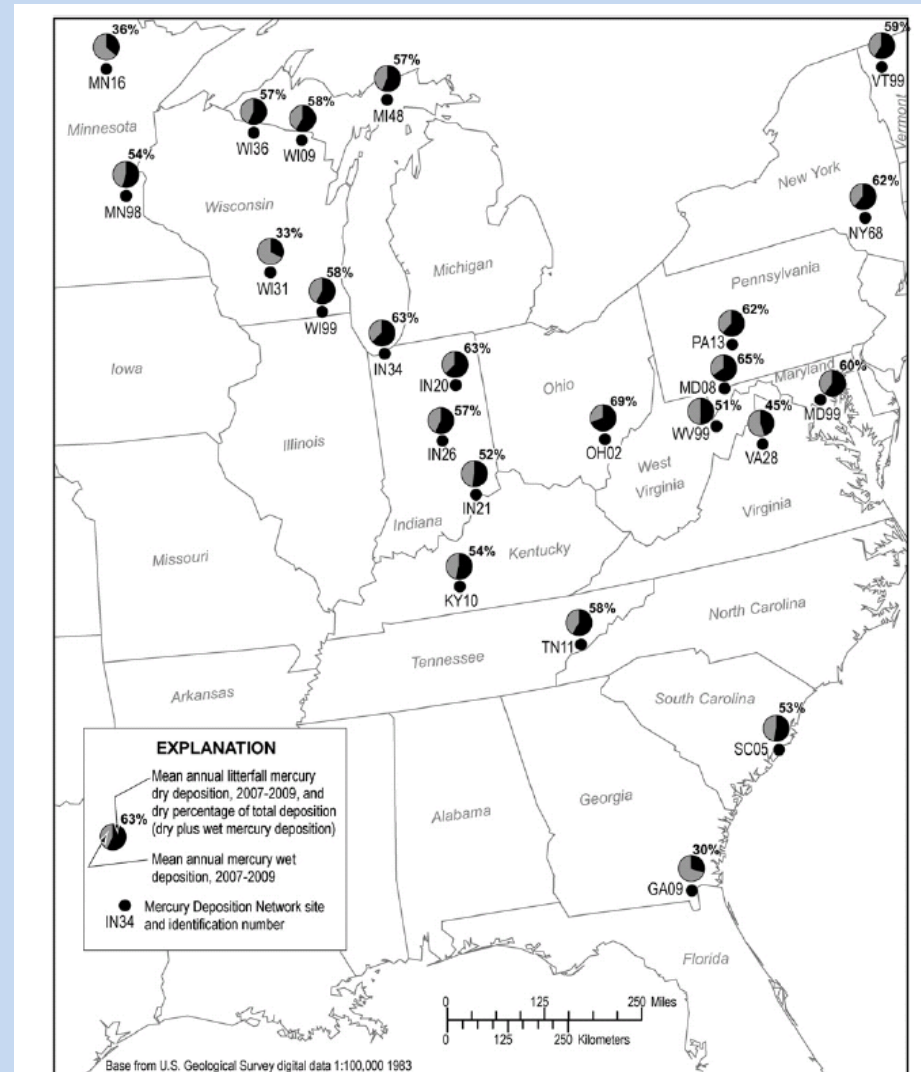
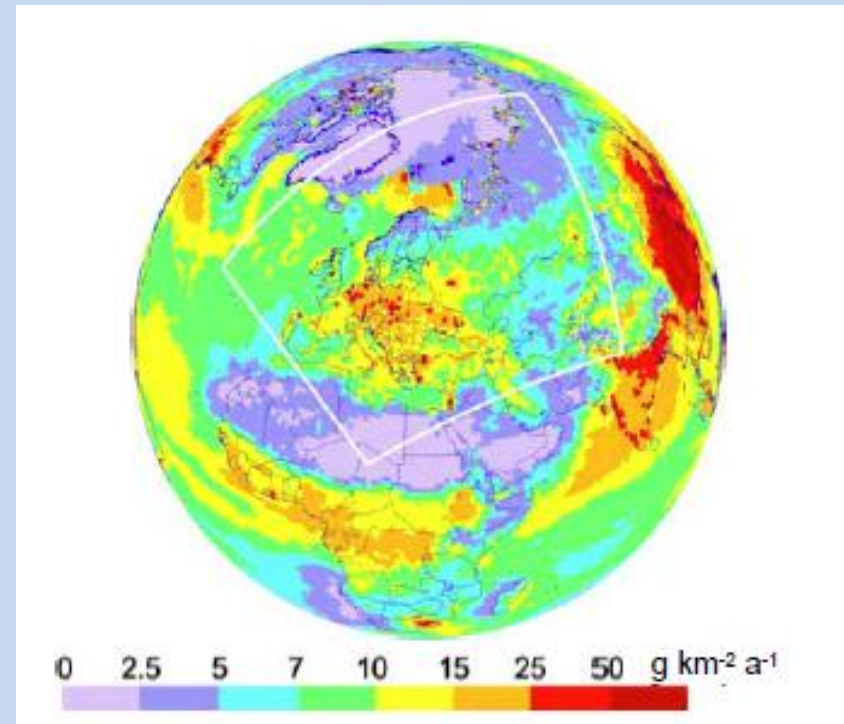


Fig. 2. Mean annual litterfall Hg dry and Hg wet deposition at litterfall Hg study sites, 2007–2009.

Individual Researchers

- Many individual scientists and researchers
- Other individual countries

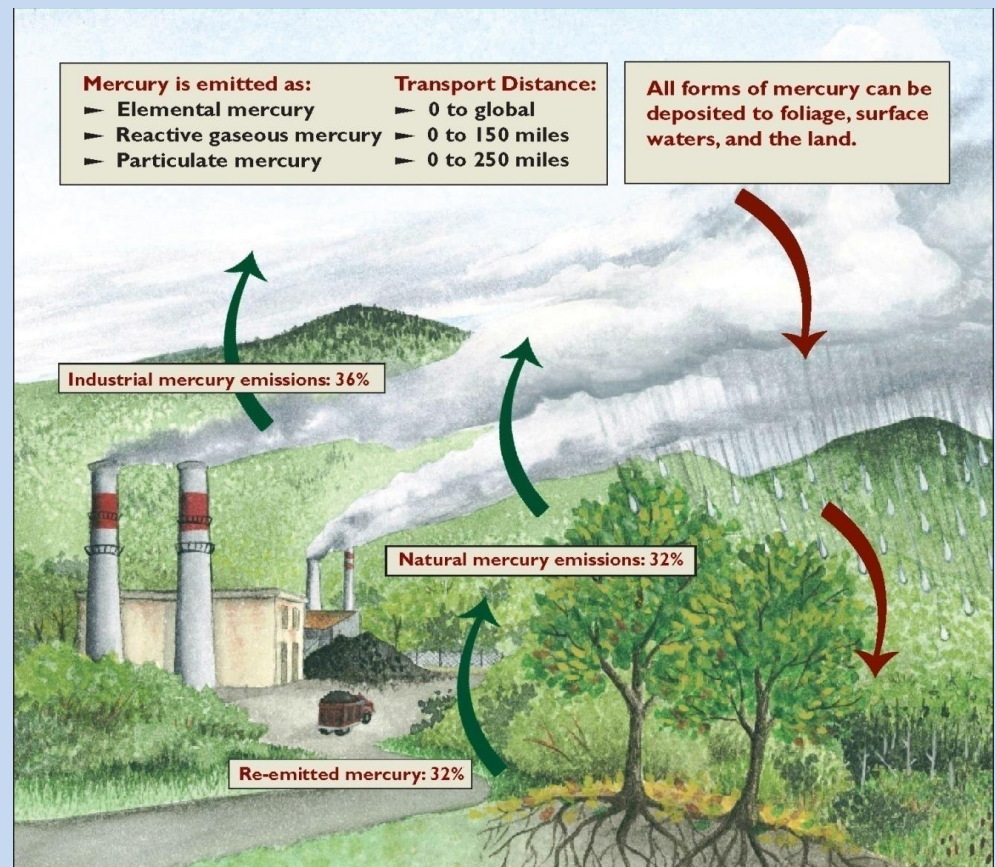


What and How

are the measurements being made?

Gaseous Mercury Fractions of Mercury in the Atmosphere

- Gaseous Elemental Mercury (GEM)
- Gaseous Oxidized Mercury (GOM)
mercurous Hg_2^{2+}
mercuric Hg^{2+}
- Particulate Bound Mercury ($\text{PBM}_{2.5}$)



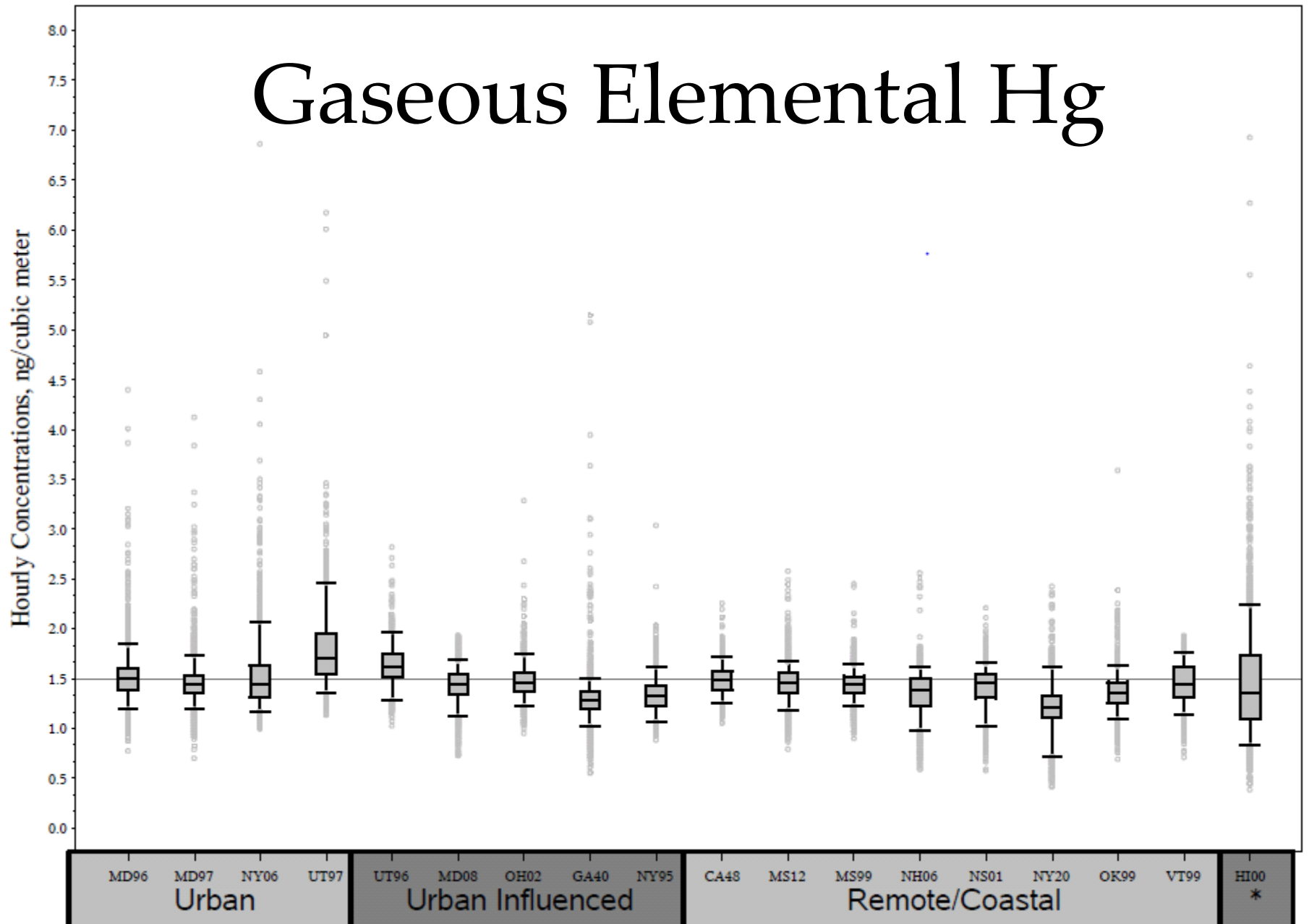
System Used Globally

Tekran 2537/1130/1135

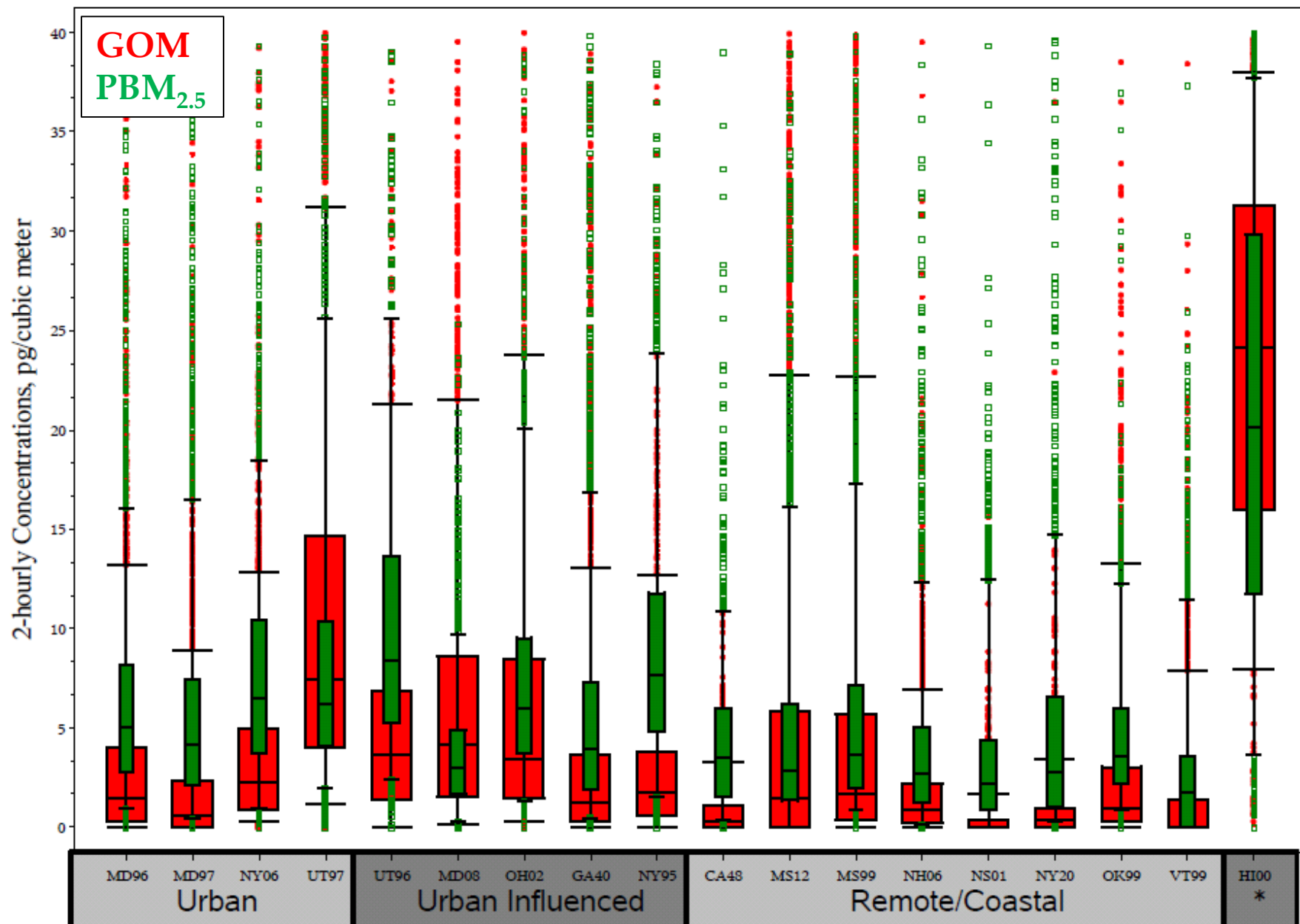
- Tekran Instruments Corp.
- Speciating Mercury Instrument
 - 2537 for GEM
 - 1130 for GOM
 - 1135 for $\text{PBM}_{2.5}$
- Continuous monitoring of Hg fractions



Gaseous Elemental Hg

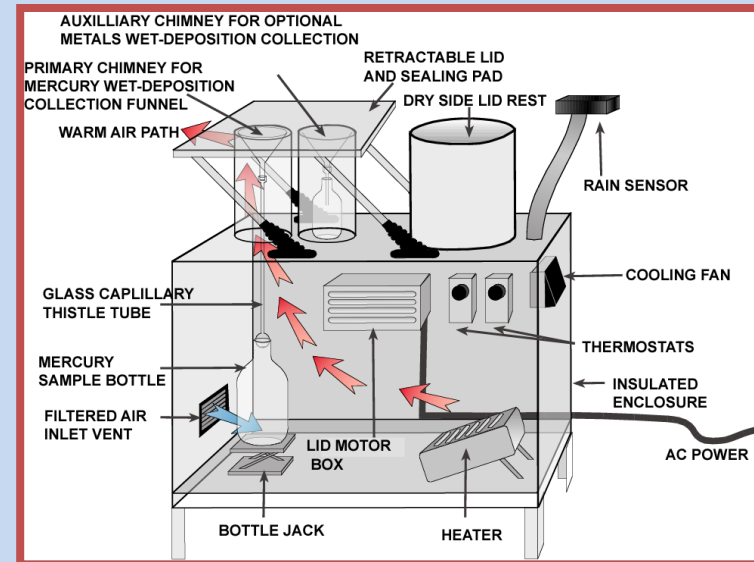
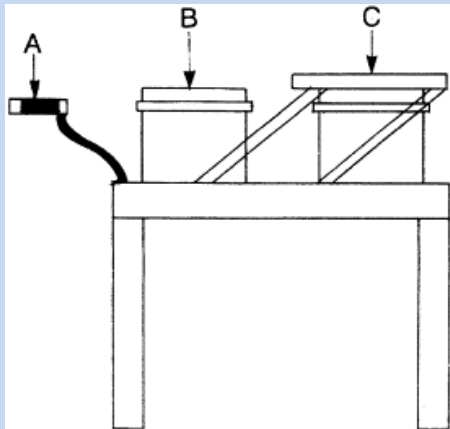


Particulate Bound and Oxidized Hg



Wet Deposition

- Everyone using some version of a wet-only sampler
- Total Hg wet deposition
- Daily or weekly sample times
- Fairly consistent sampling methods
- Need better data reporting

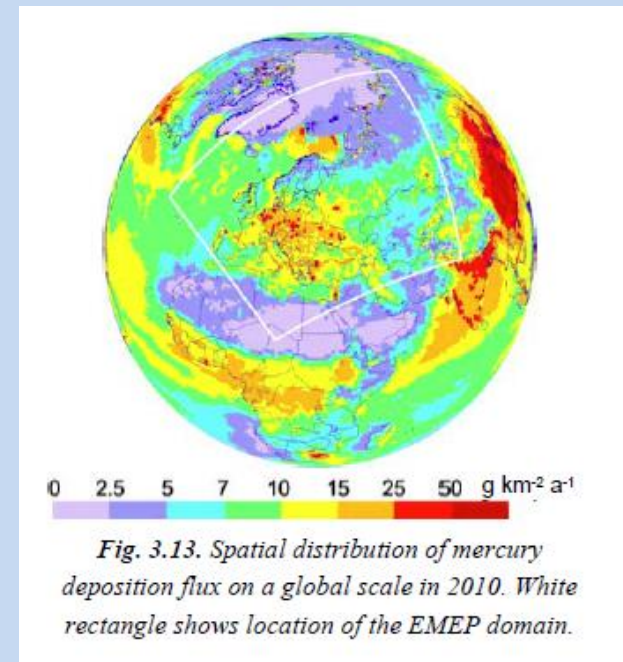


Summary of the Measurements

- Several gaseous and wet deposition measurement networks
 - Wet deposition networks
 - More sites/networks than atmospheric Hg
 - fairly consistent methodology
 - Atmospheric Networks
 - Some operating
 - Relatively few sites
 - More unorganized, with different operating methods

Summary of the Measurements

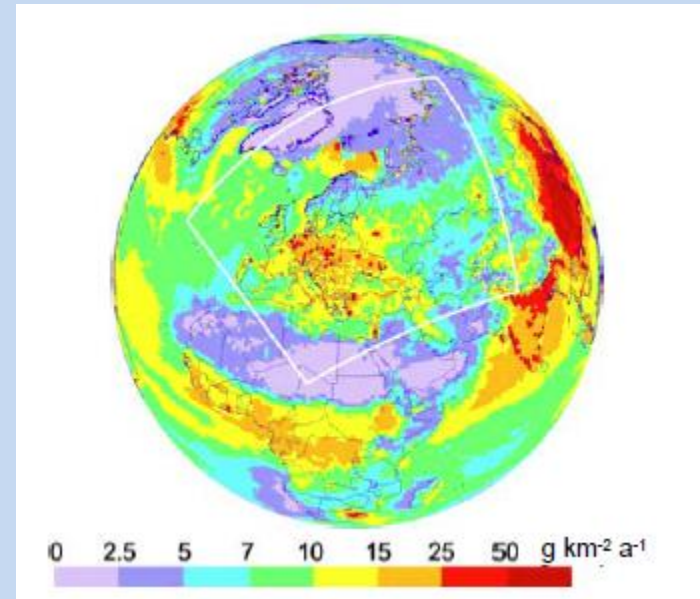
- Mercury is a global pollutant, so...
 - Need global organization
 - Harmonize methods and measurement times
 - Global reporting of measurements



What is the value of measuring,
and measuring consistently?

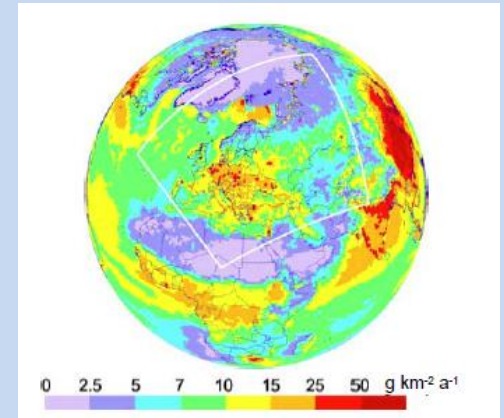
The Value of Monitoring

- Understand the problem....
 - Science
 - Deposition and cycling in the aquatic environment
- Track changes over time and space
 - Trends present?
 - Increasing or decreasing?
- Is Policy Working?
 - With legislation in place,
 - But is it working?
 - Is the problem improving?



Consistency in Measurement is the KEY!

- Long term monitoring is required to see small changes.
- Using the same methods!!!
 - “apples to apples”
 - on a global basis
- Sharing Data
 - We need global data to understand a global pollutant



Working together is the *best way forward!*



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