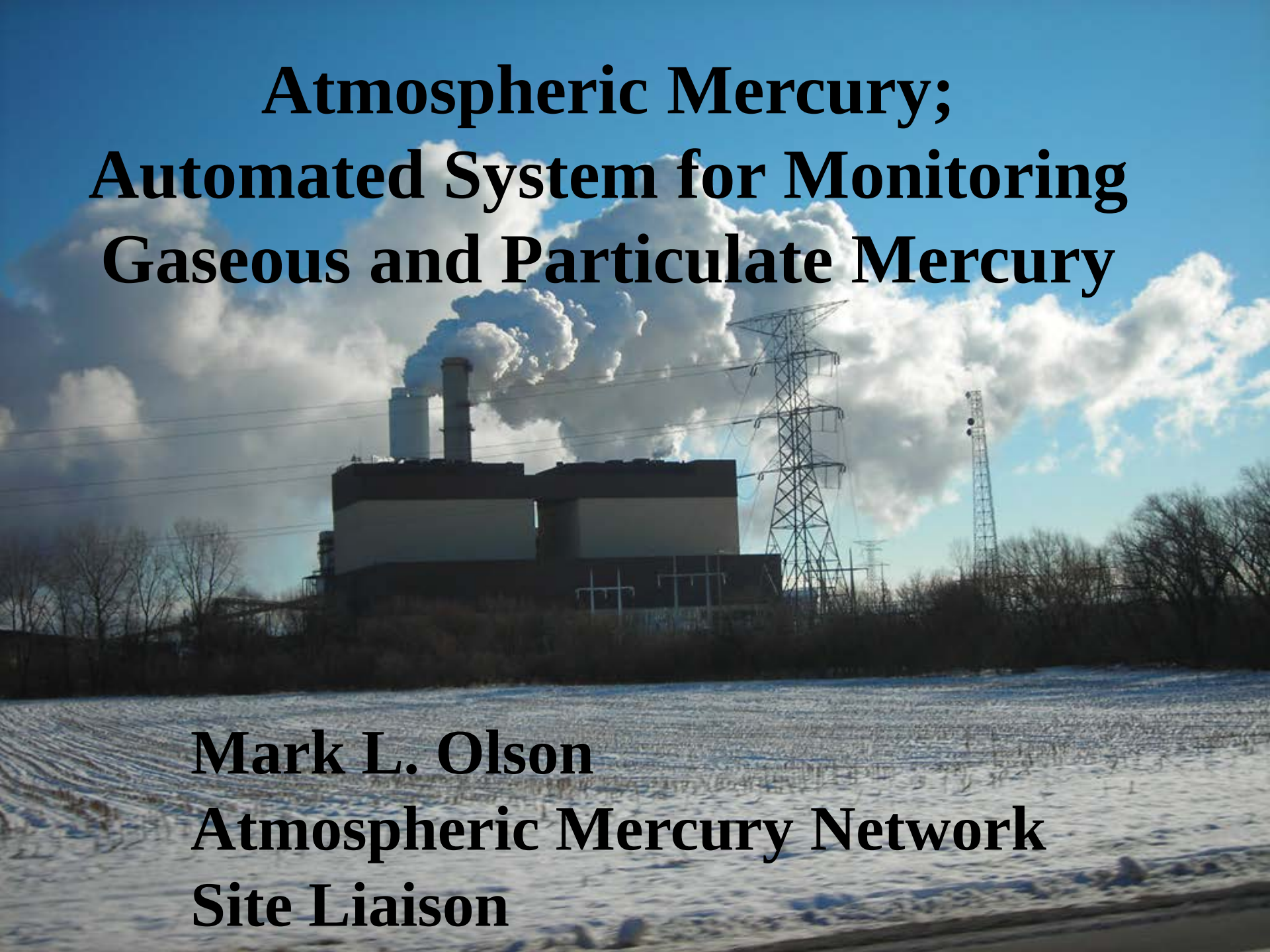


Atmospheric Mercury; Automated System for Monitoring Gaseous and Particulate Mercury



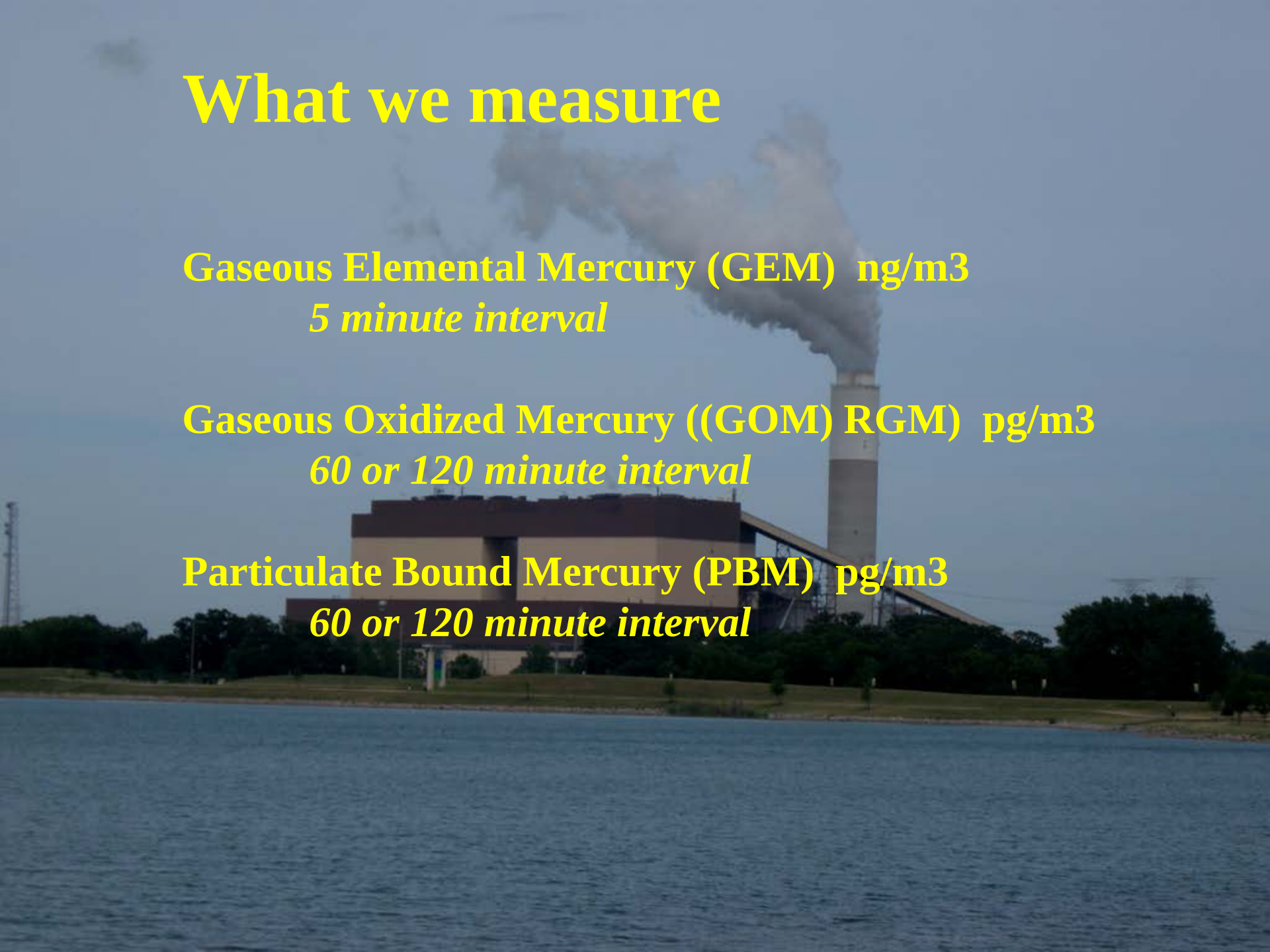
**Mark L. Olson
Atmospheric Mercury Network
Site Liaison**

What we measure

Gaseous Elemental Mercury (GEM) ng/m^3
5 minute interval

Gaseous Oxidized Mercury ((GOM) RGM) pg/m^3
60 or 120 minute interval

Particulate Bound Mercury (PBM) pg/m^3
60 or 120 minute interval



Why we measure atmospheric Mercury

Dry deposition can make up a significant percent of the total Mercury input to the ecosystem

$\text{Dry} + \text{Wet} = \text{Total Hg Deposition}$

Mercury speciation and scale of impact



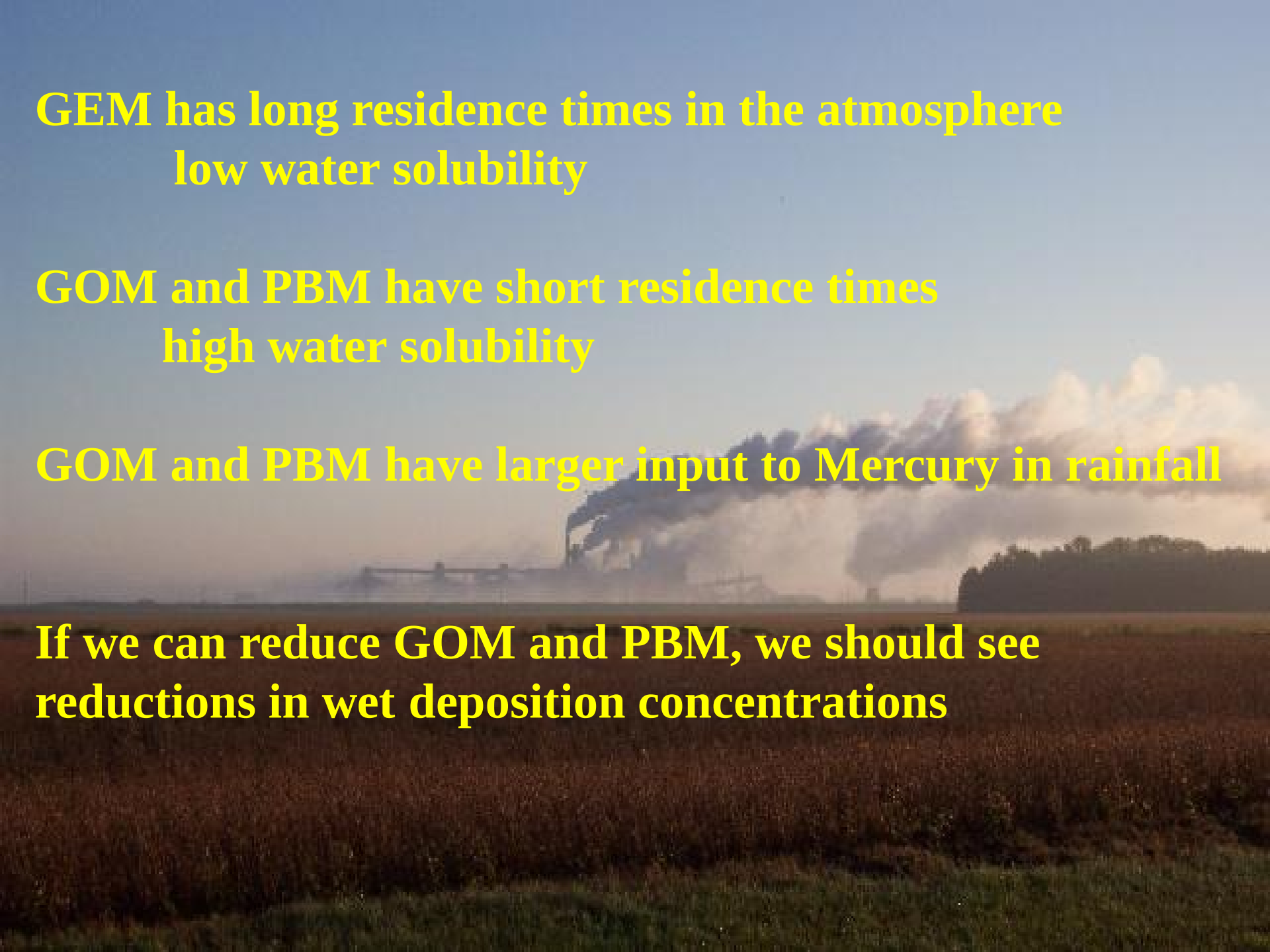
Global - Regional - Local

**GEM has long residence times in the atmosphere
low water solubility**

**GOM and PBM have short residence times
high water solubility**

GOM and PBM have larger input to Mercury in rainfall

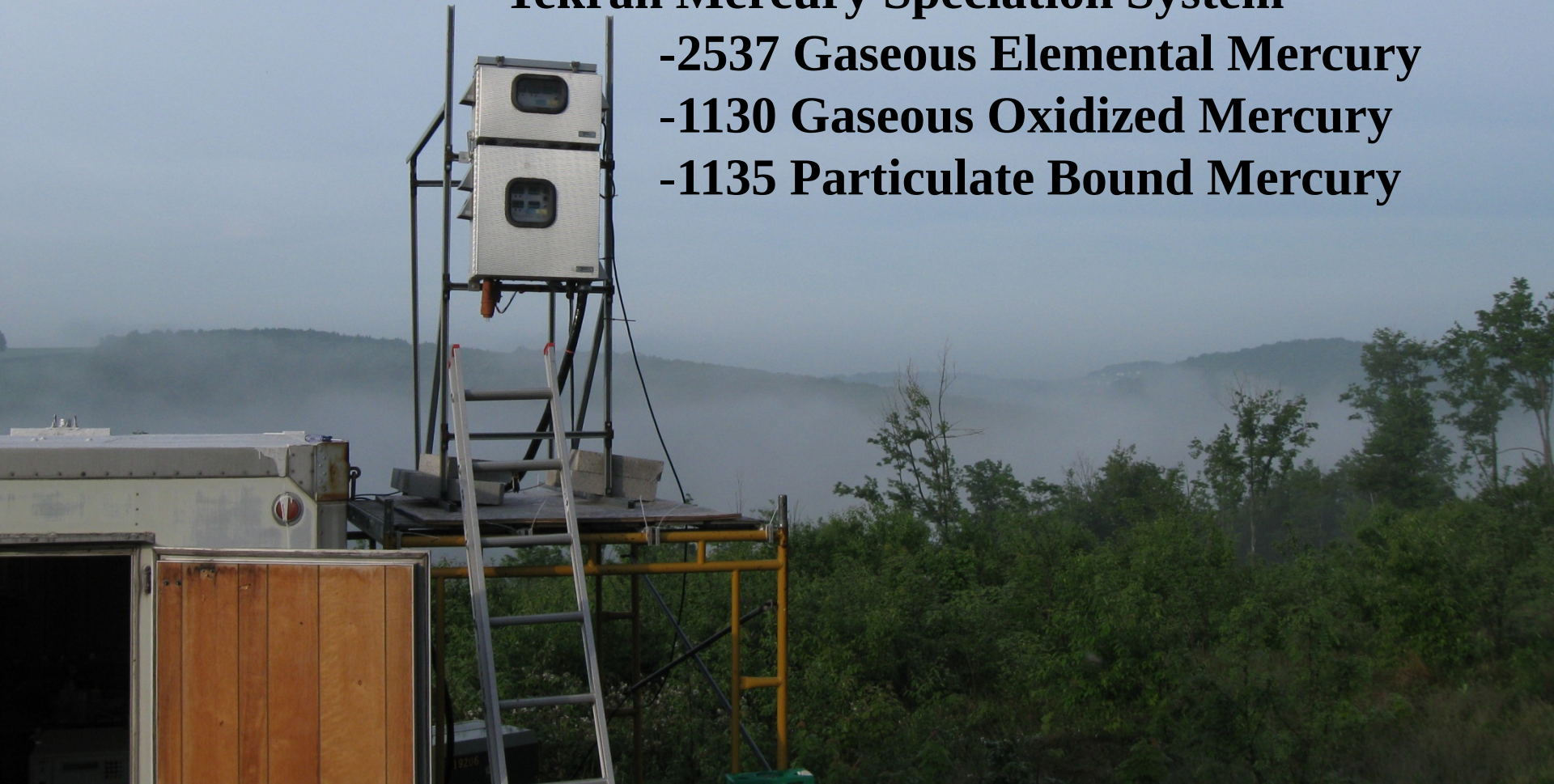
**If we can reduce GOM and PBM, we should see
reductions in wet deposition concentrations**

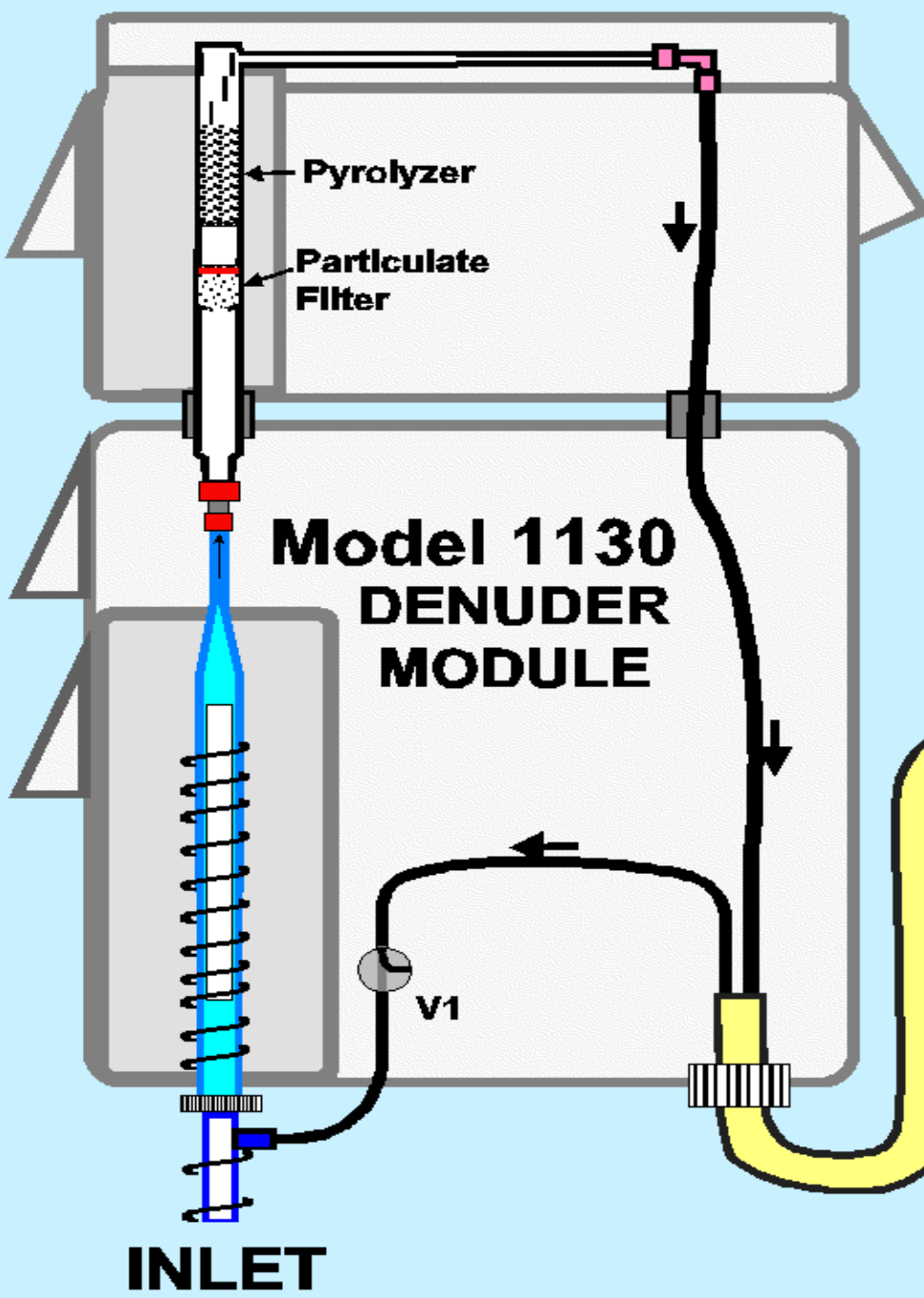


How we measure atmospheric Mercury Speciation

Tekran Mercury Speciation System

- 2537 Gaseous Elemental Mercury
- 1130 Gaseous Oxidized Mercury
- 1135 Particulate Bound Mercury





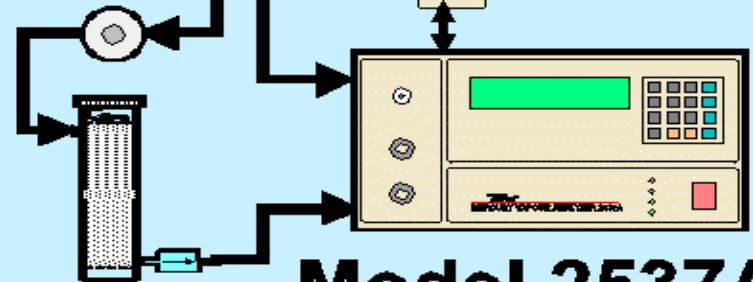
**Model 1135
PARTICULATE
MODULE**

**Model 1130
PUMP MODULE**

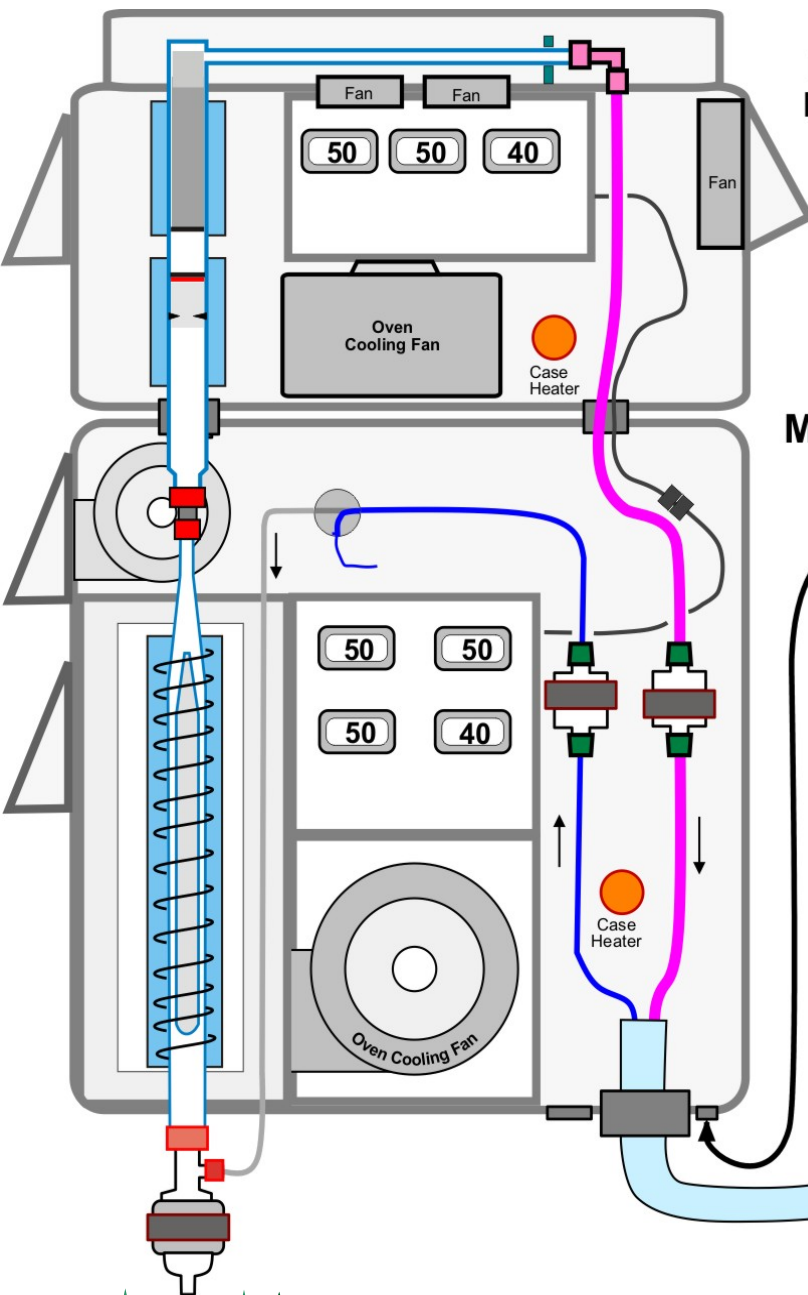
Heated Line



CONTROLLER



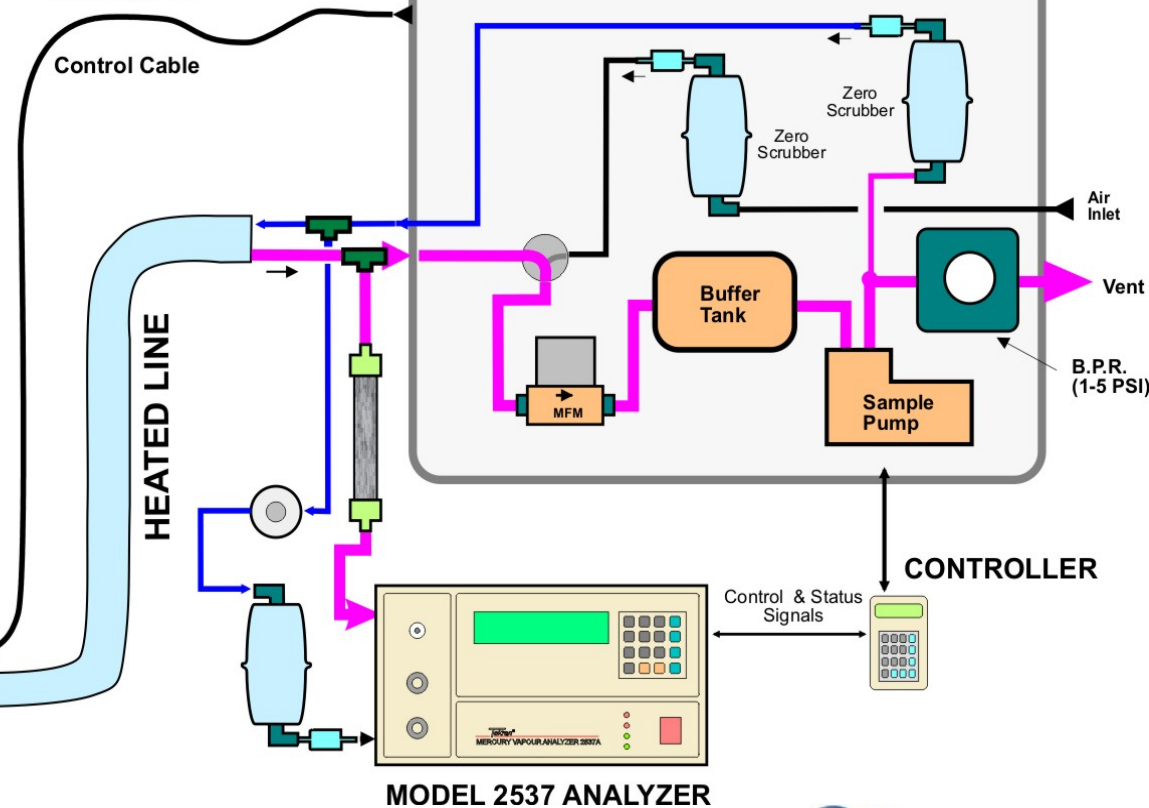
Model 2537A

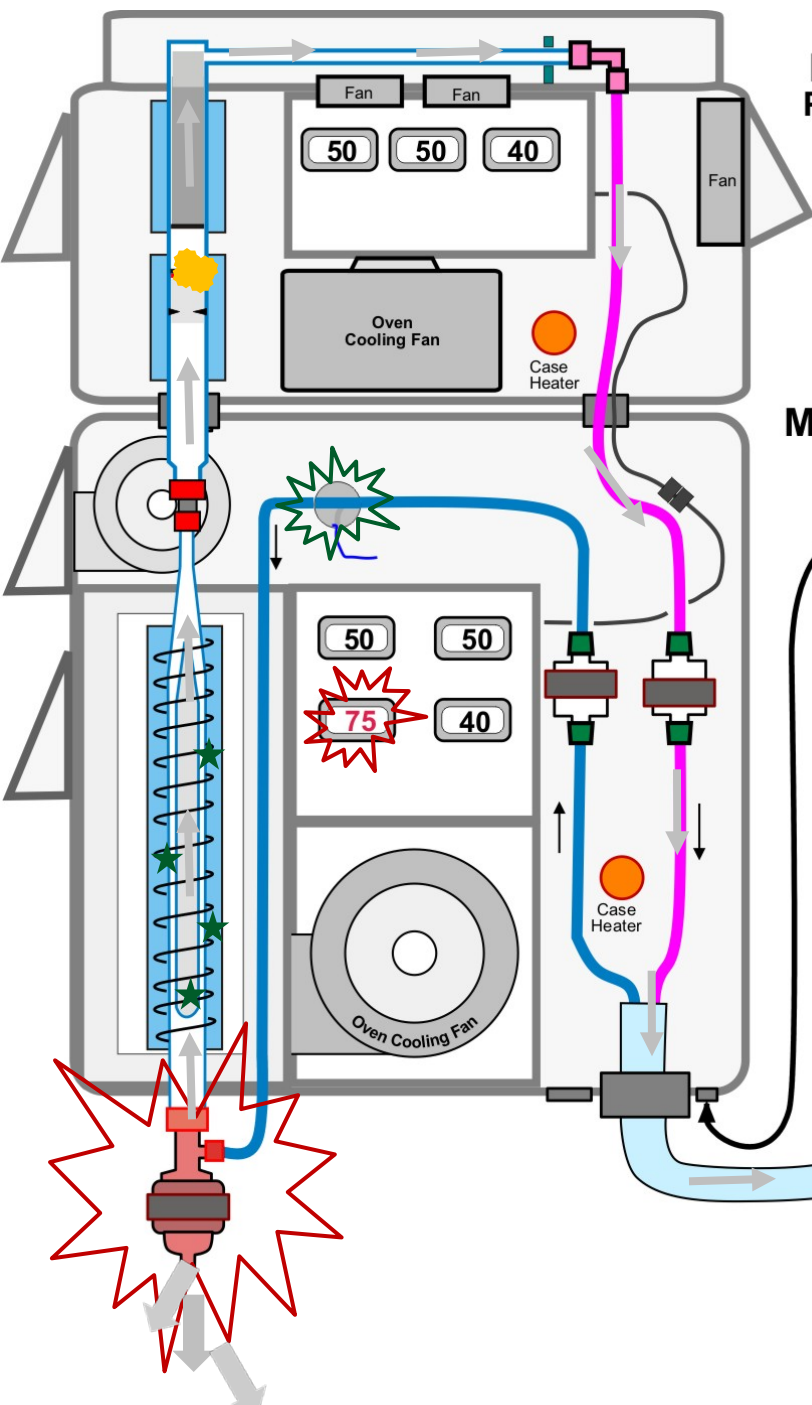


Step 0: Sample

- ★ Elemental Hg (Hg^0)
- ★ Oxidized Hg (Hg^{II})
- ★ Particulate Hg (Hg_p)

Model 1130 PUMP MODULE





Model 1135 PARTICULATE MODULE

Model 1130 RGM MODULE

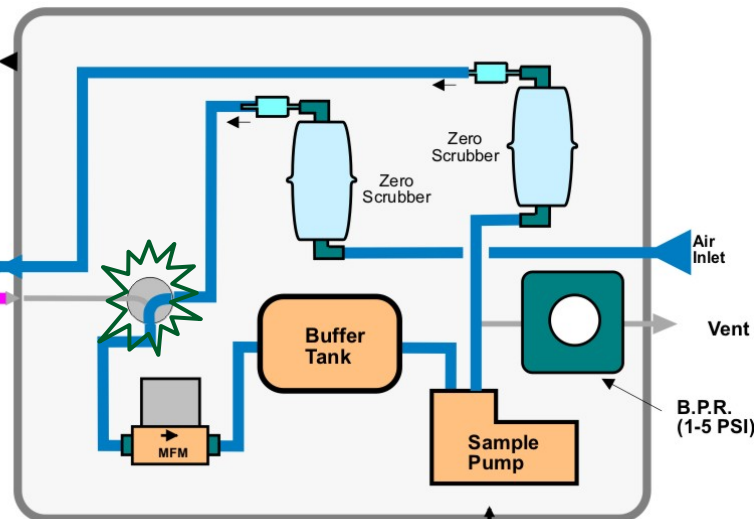
Control Cable

HEATED LINE

Step 1: Sample

- ★ Elemental Hg (Hg^0)
- ★ Oxidized Hg (Hg^{II})
- ★ Particulate Hg (Hg_p)

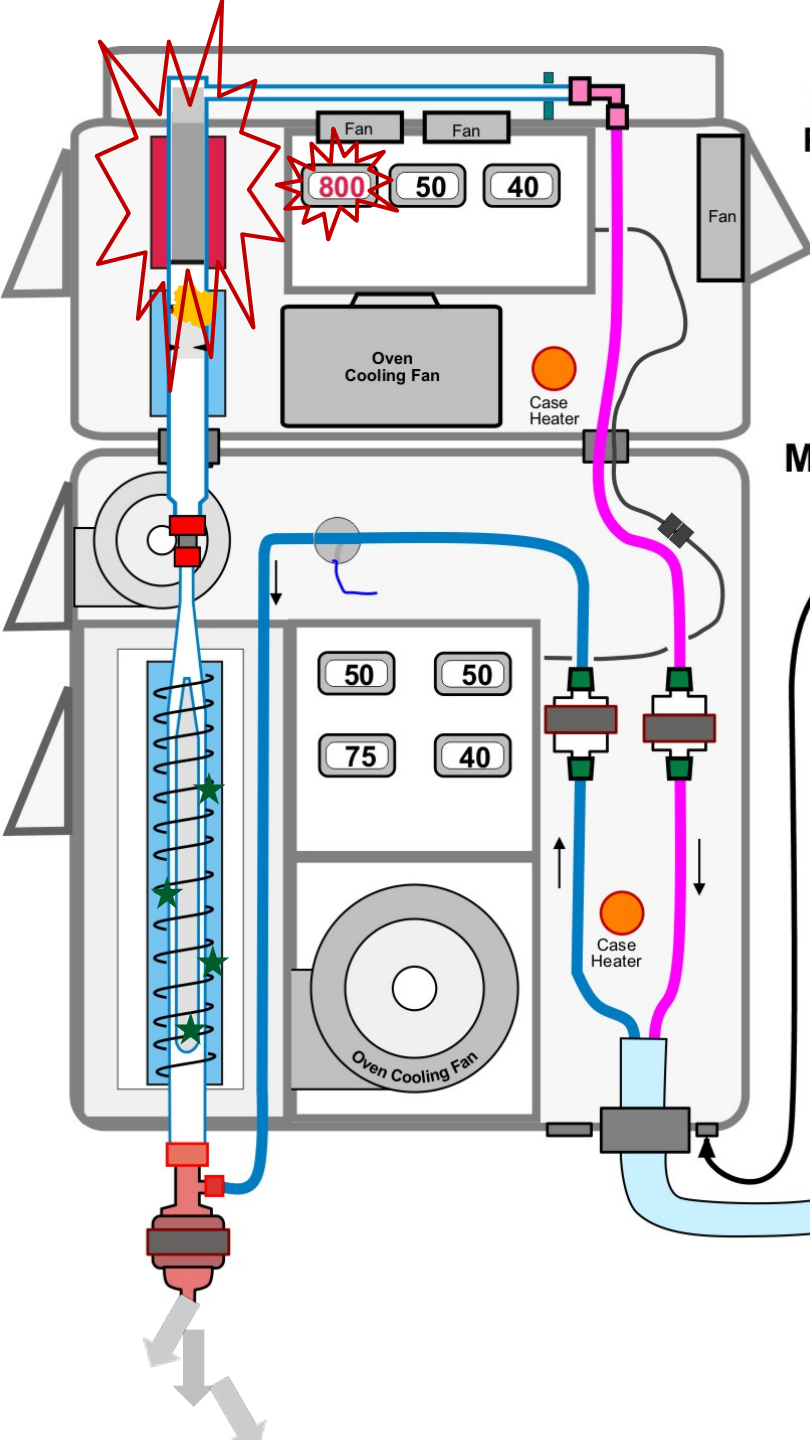
Model 1130 PUMP MODULE



CONTROLLER



MODEL 2537 ANALYZER



Step 2: PyroHt

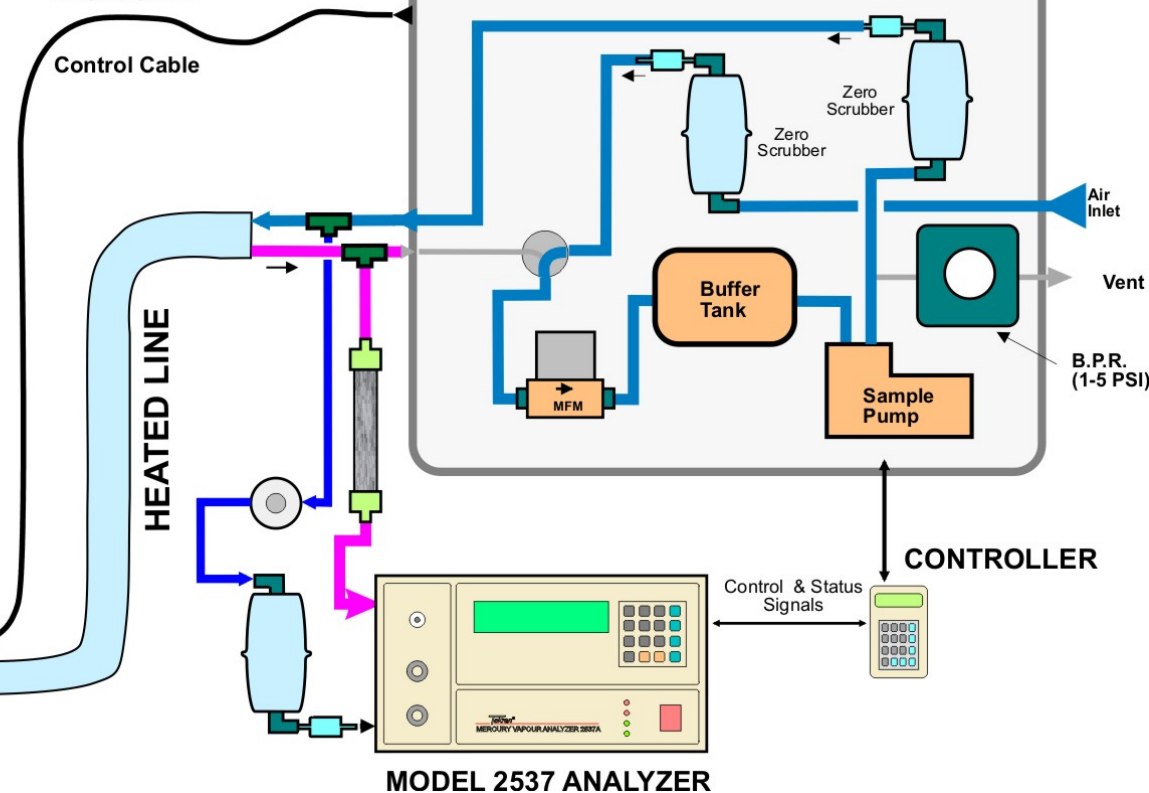
★ Elemental Hg (Hg^0)

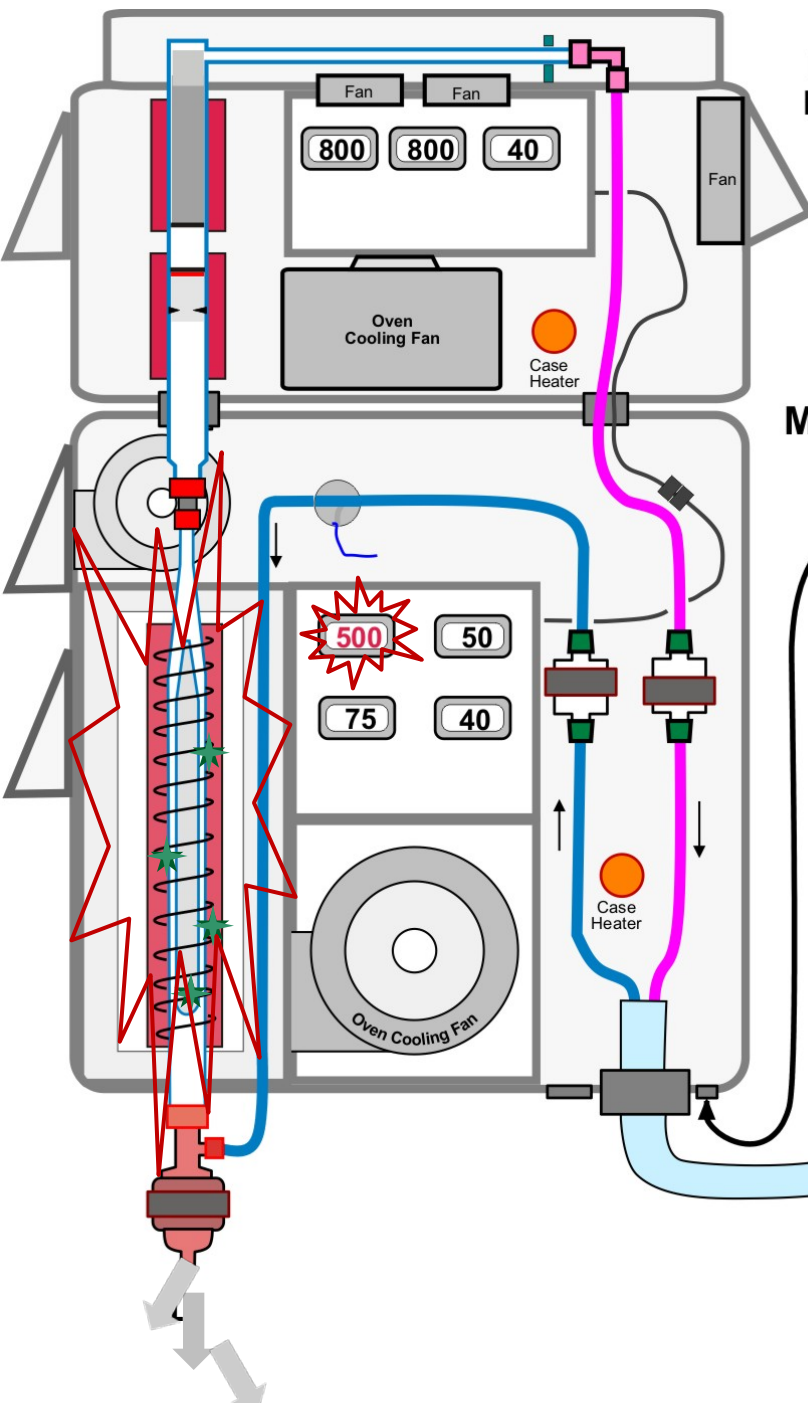
★ Oxidized Hg (Hg^{II})

★ Particulate Hg (Hg_p)

Model 1130 RGM MODULE

Model 1130 PUMP MODULE





Model 1135 PARTICULATE MODULE

Step 3: Re-Match

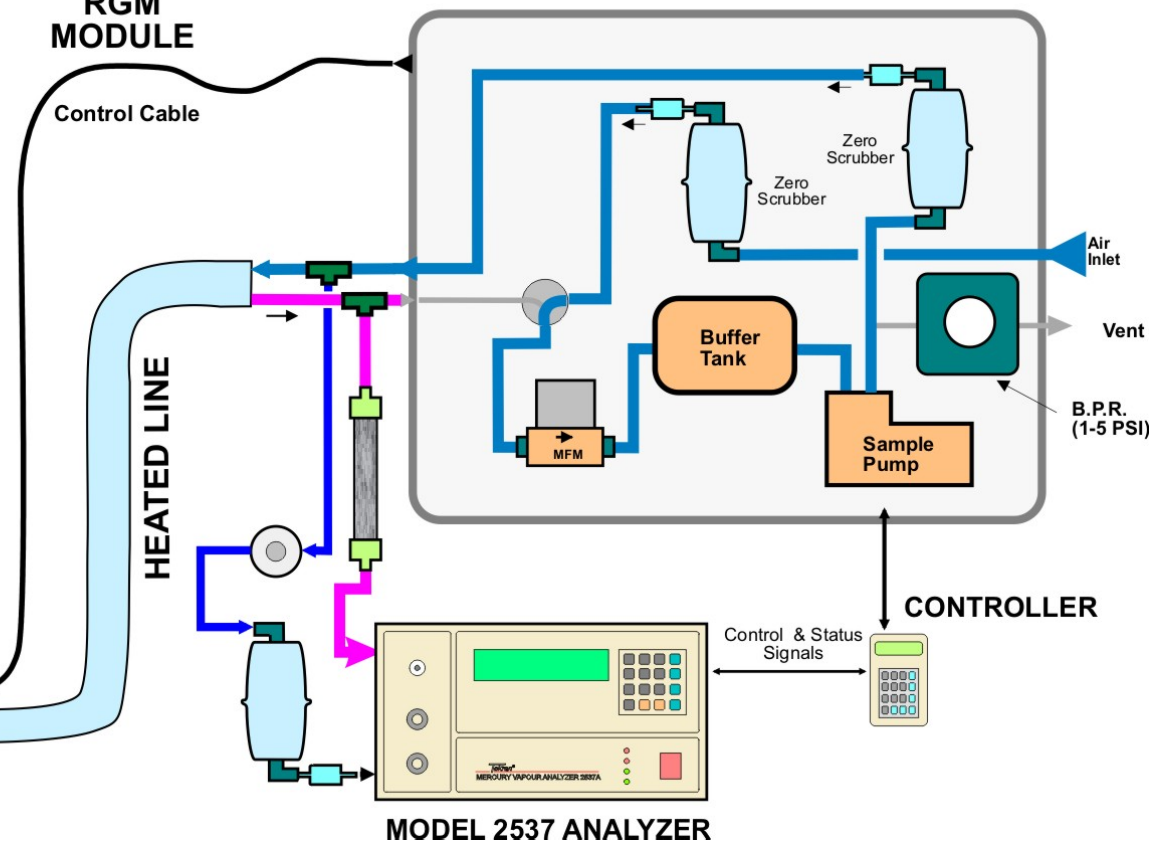
- ★ Elemental Hg (Hg^0)
- ★ Oxidized Hg (Hg^{II})
- ★ Particulate Hg (Hg_P)

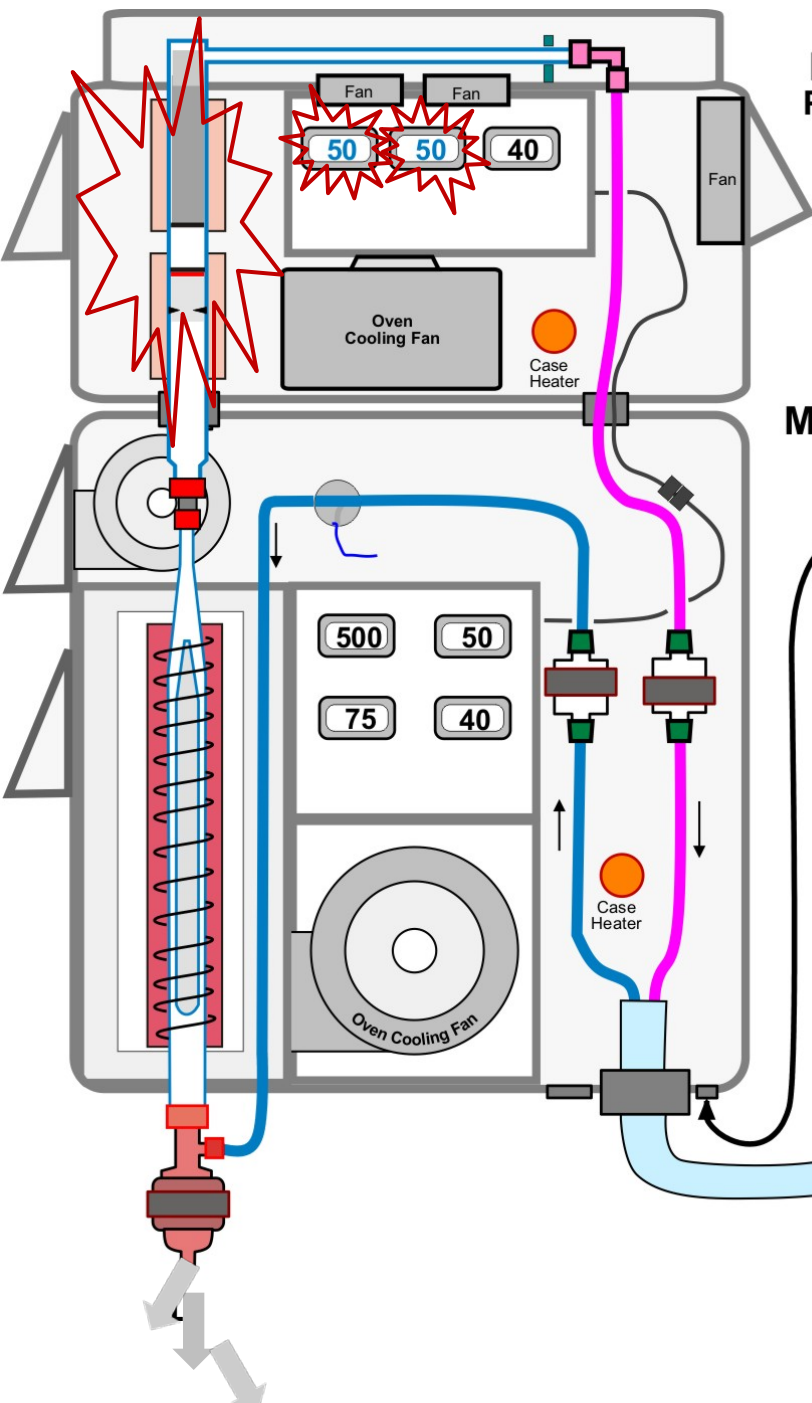
Model 1130

RGM

MODULE

Model 1130 PUMP MODULE





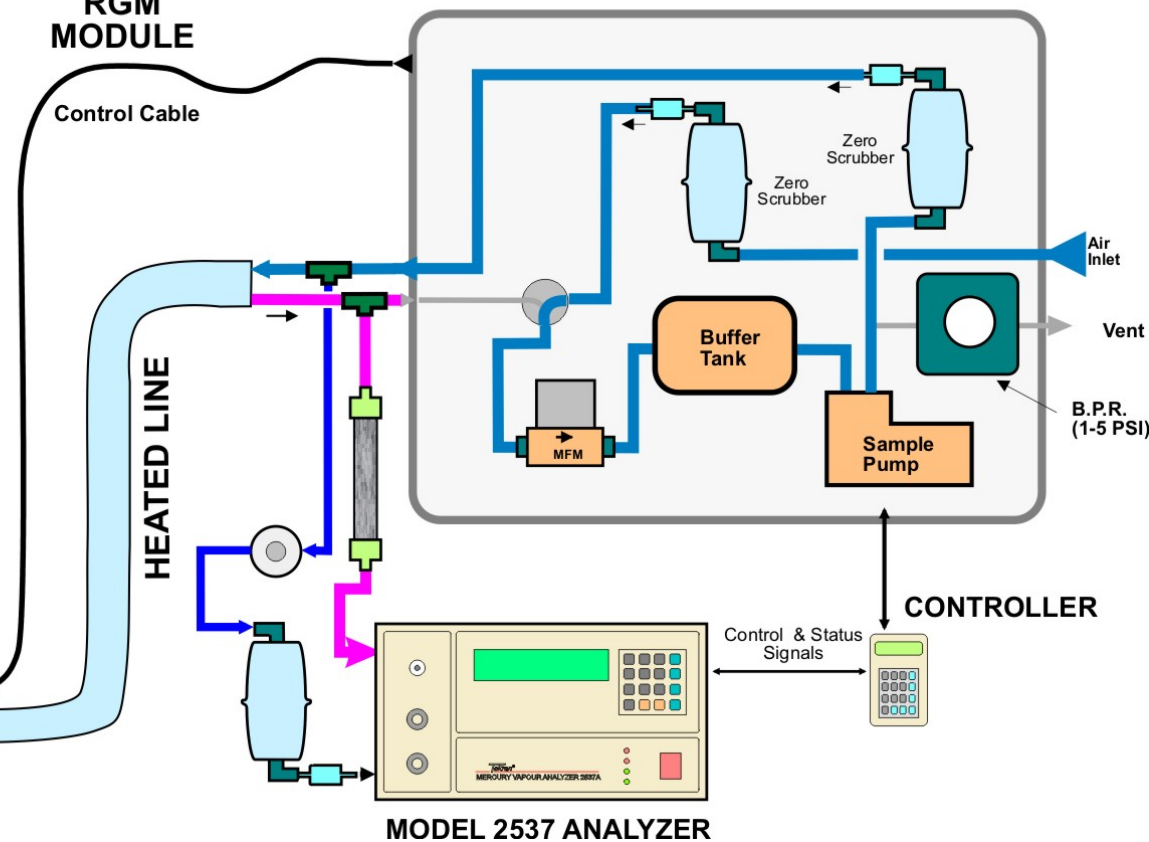
Step 4: RGM-Ht2

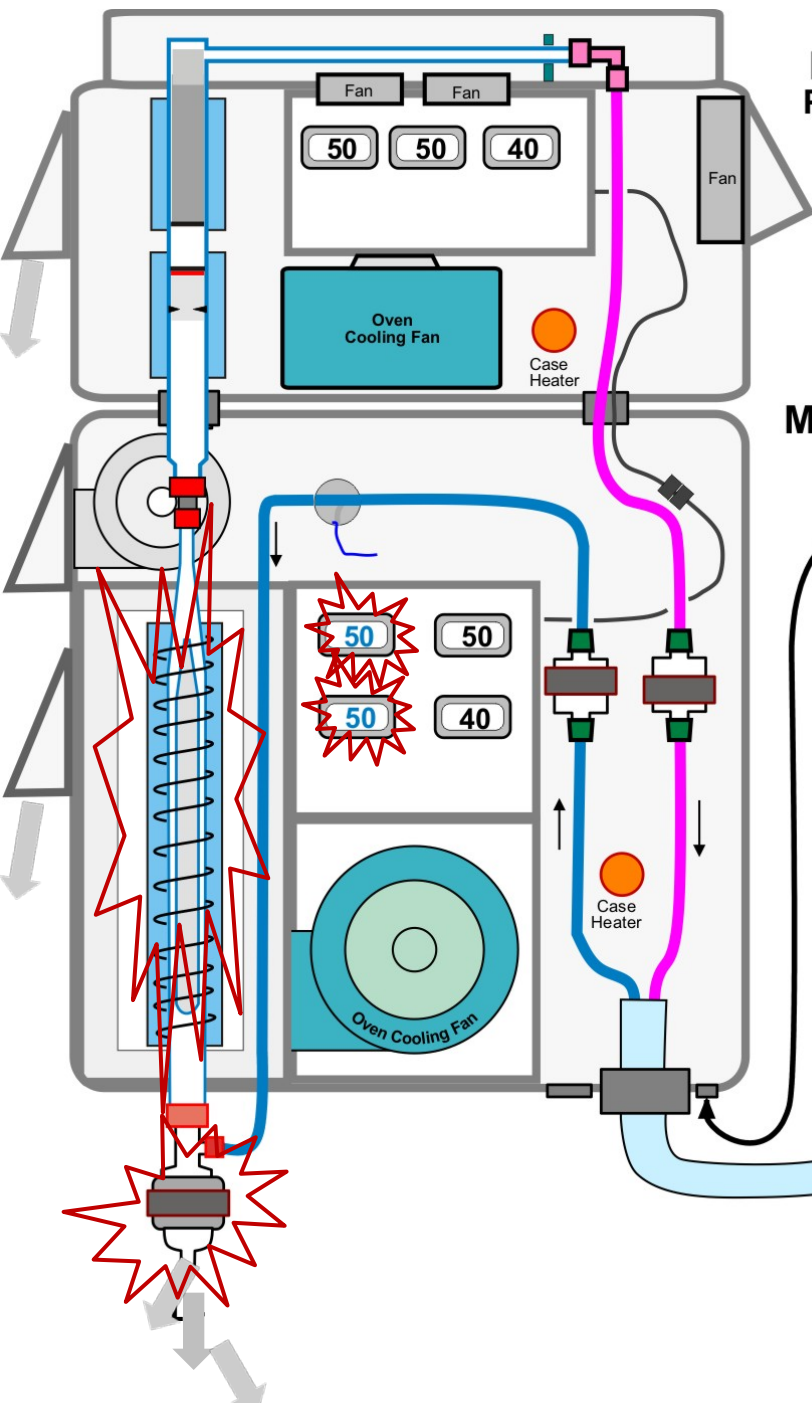
★ Elemental Hg (Hg^0)

★ Oxidized Hg (Hg^{II})

★ Particulate Hg (Hg_p)

Model 1130 PUMP MODULE





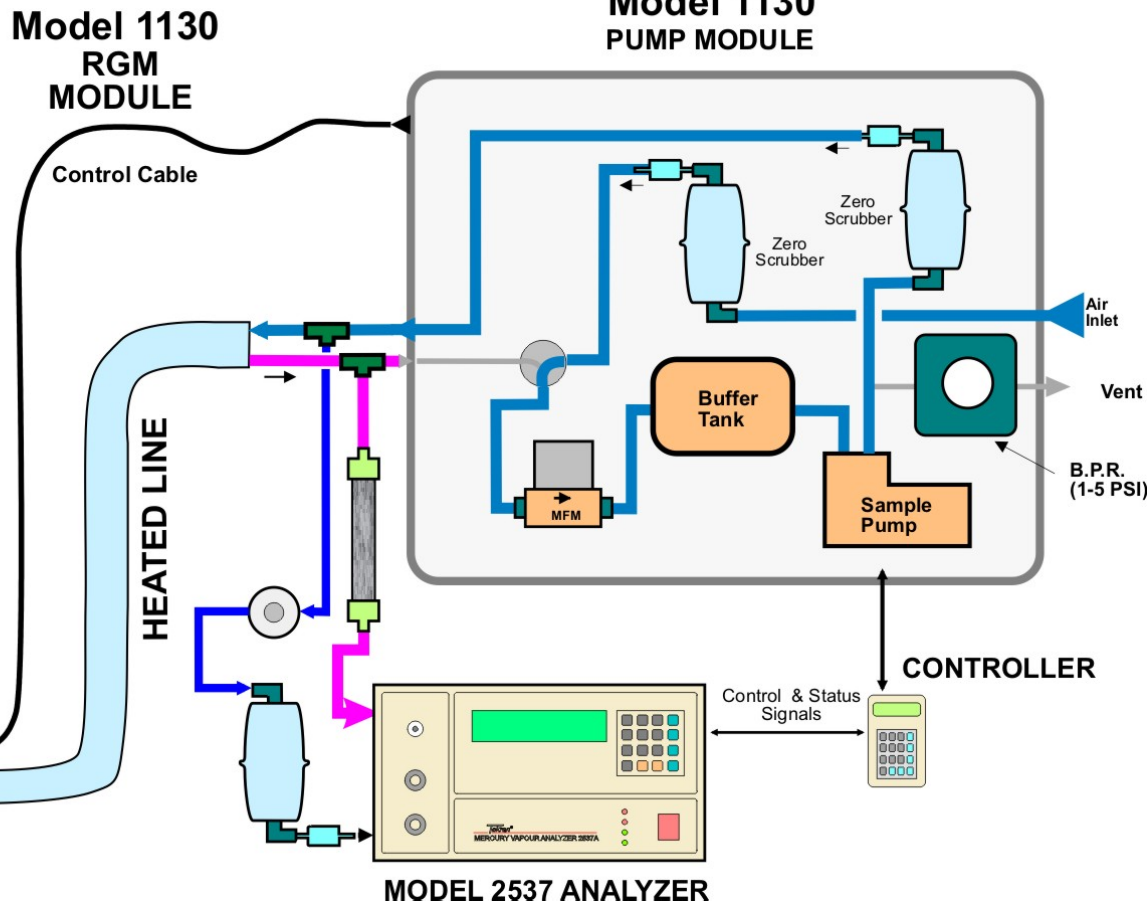
**Model 1135
PARTICULATE
MODULE**

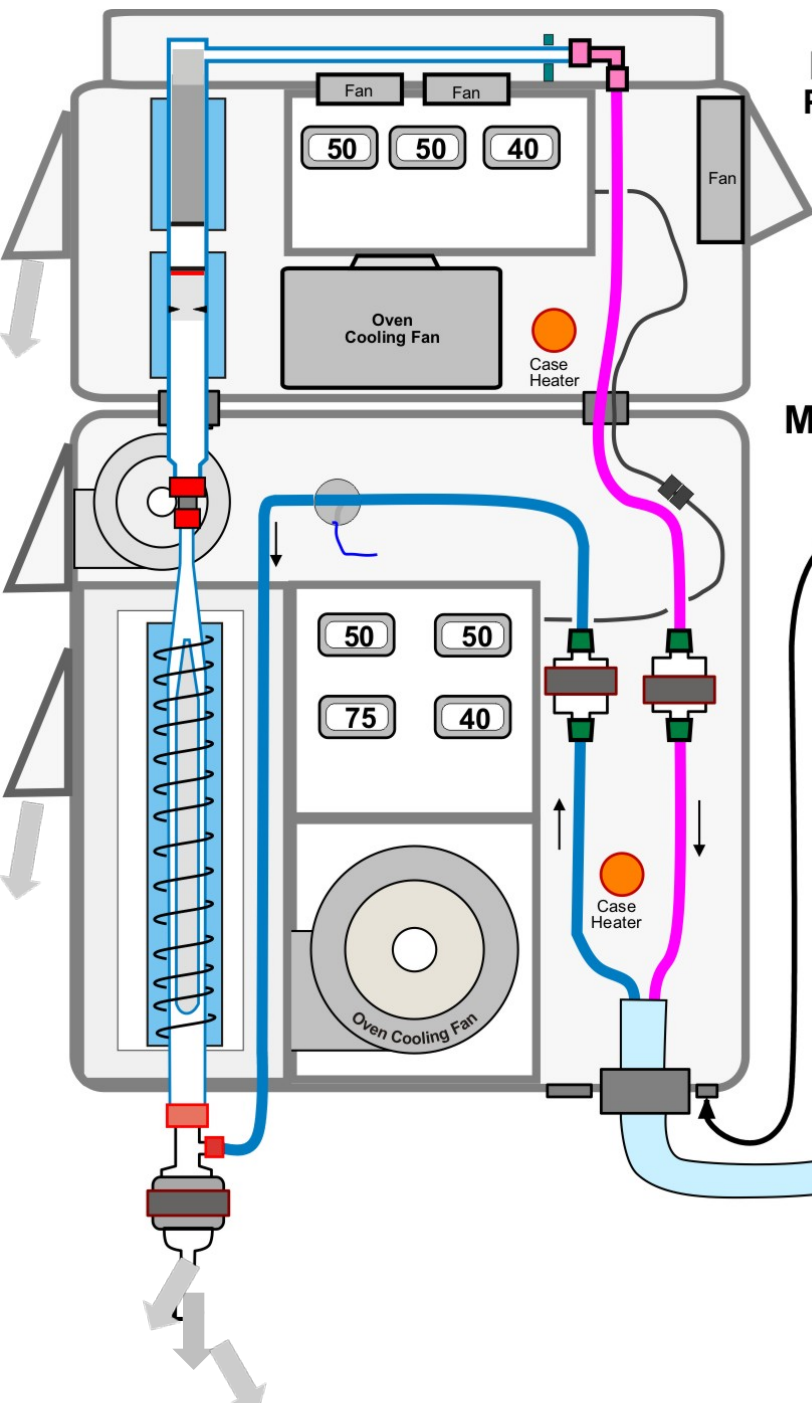
**Model 1130
RGM
MODULE**

Step 5: RGM-Ht2

- ★ Elemental Hg (Hg^0)
- ★ Oxidized Hg (Hg^{II})
- ★ Particulate Hg (Hg_p)

**Model 1130
PUMP MODULE**





Model 1135 PARTICULATE MODULE

Step 3: Wait

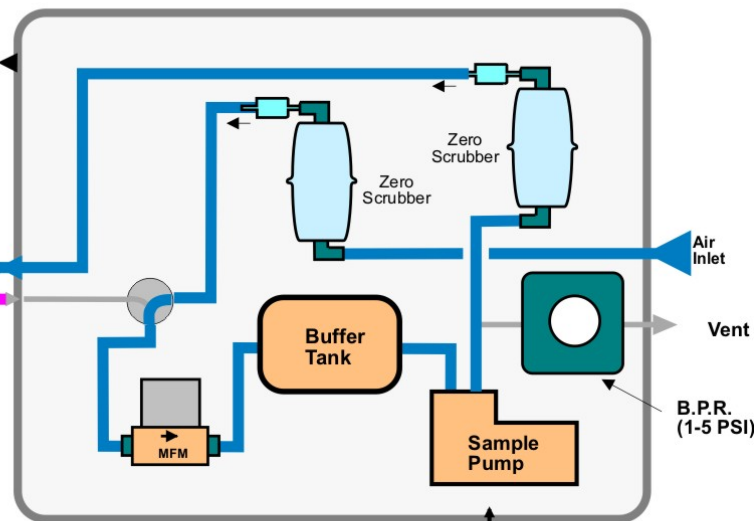
- ★ Elemental Hg (Hg^0)
- ★ Oxidized Hg (Hg^{II})
- ★ Particulate Hg (Hg_p)

Model 1130 RGM MODULE

Control Cable

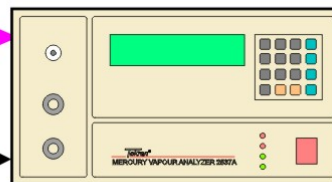
HEATED LINE

Model 1130 PUMP MODULE

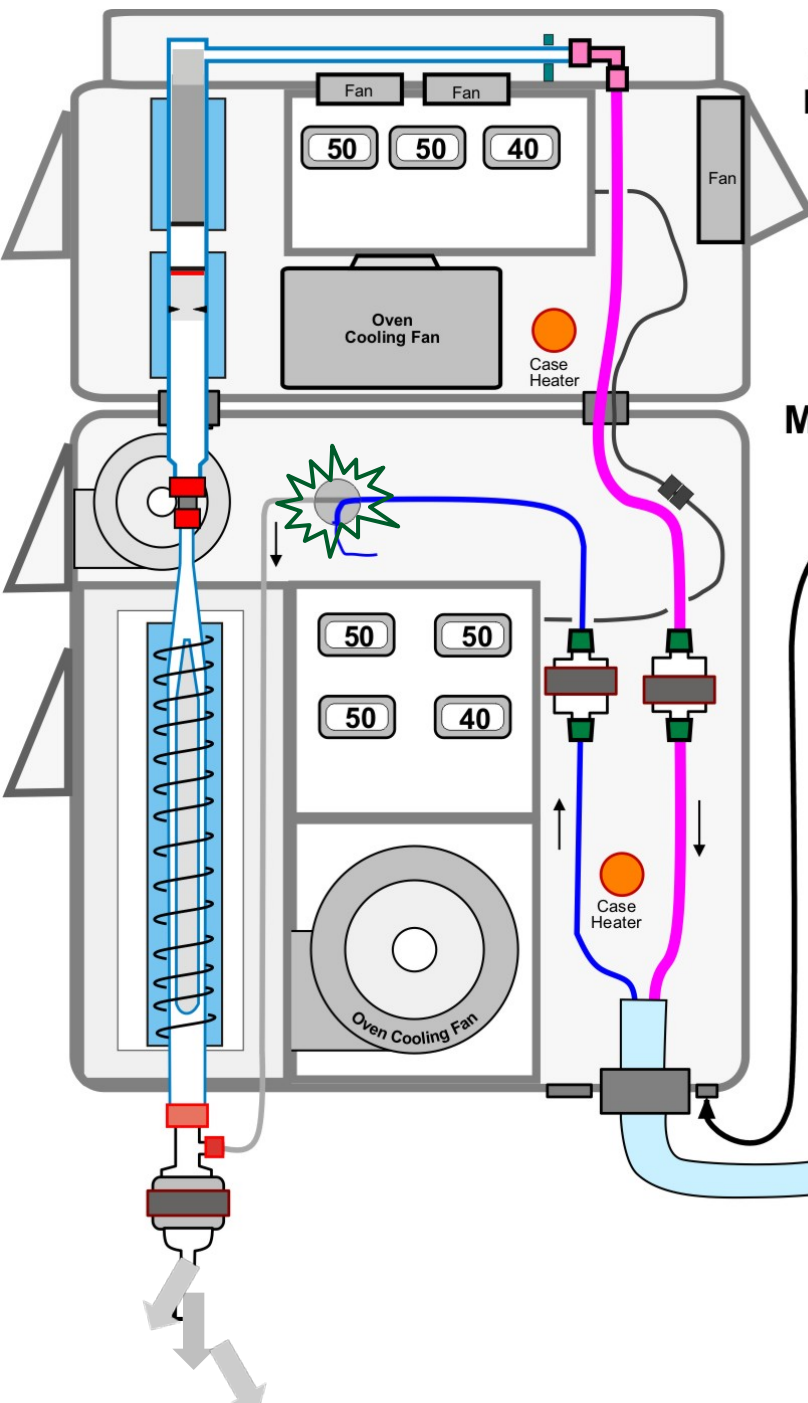


CONTROLLER

Control & Status Signals



MODEL 2537 ANALYZER



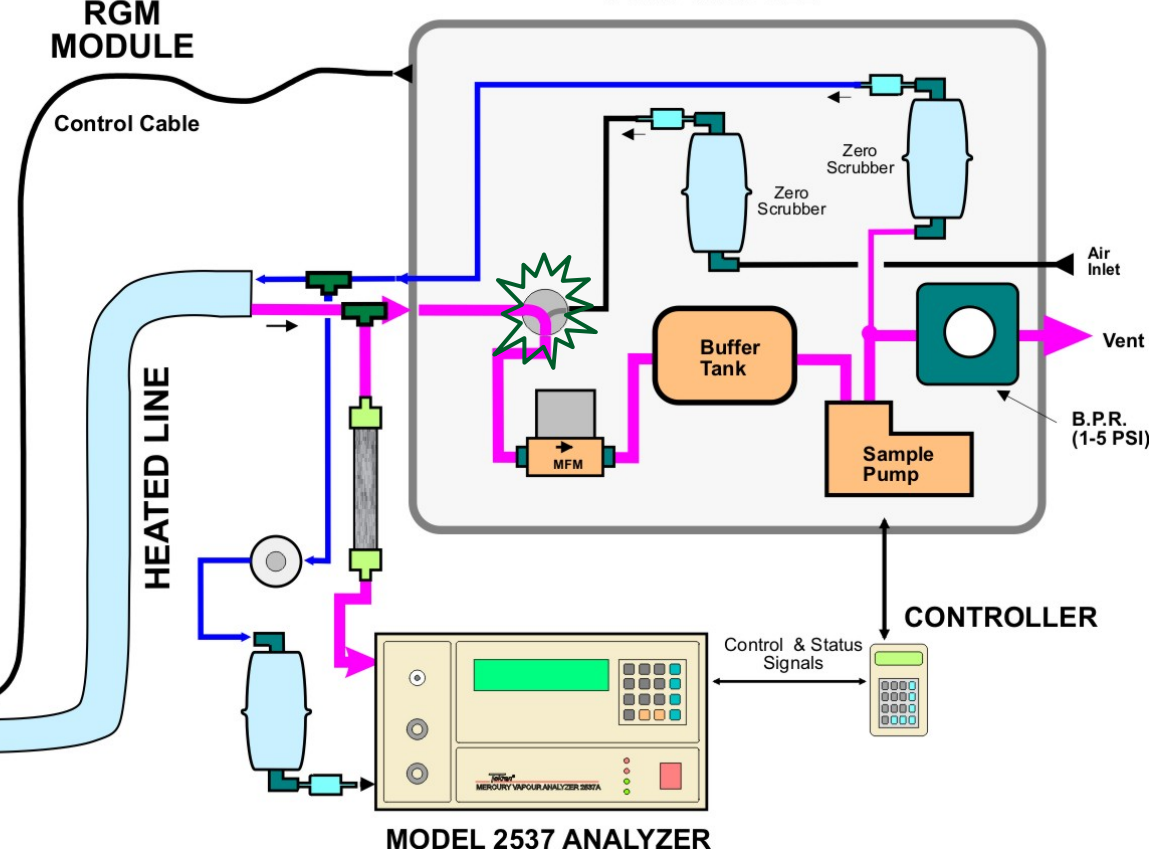
Model 1135 PARTICULATE MODULE

Step 0: Sample

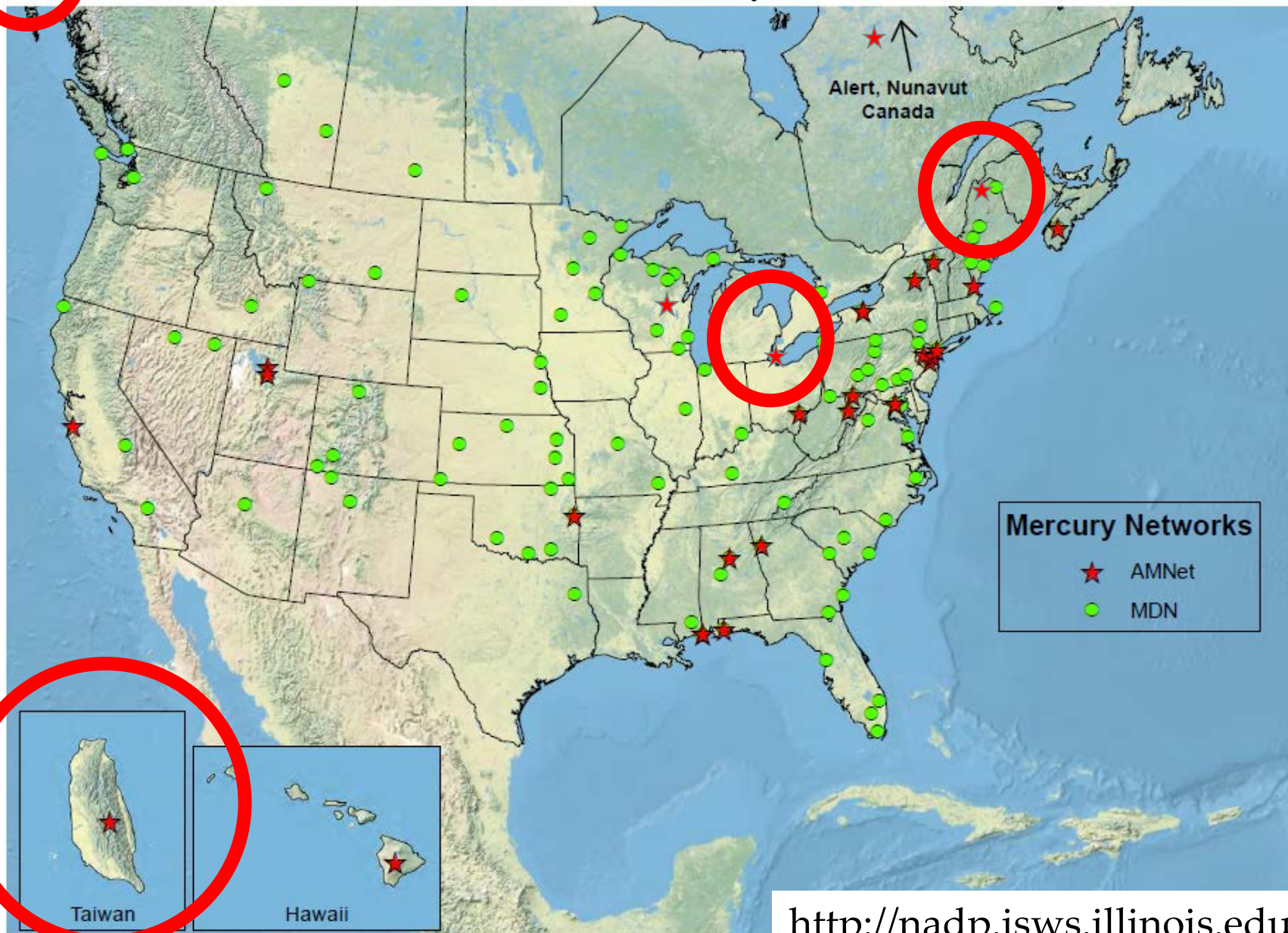
- ★ Elemental Hg (Hg^0)
- ★ Oxidized Hg (Hg^{II})
- ★ Particulate Hg (Hg_p)

Model 1130 RGM MODULE

Model 1130 PUMP MODULE



NADP's Mercury Networks





What AMNet Provides

- SOP's to keep measurements consistent
- Troubleshooting
 - Phone and email support
- Network Equipment Depot
 - Wide variety of parts available
- Data evaluation and quality assurance
 - Automated flag program
 - Site Liaison evaluates all data
- Site audits to evaluate performance

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
- Same QA system used by GMOS, developed by AMNet

Check

Warning

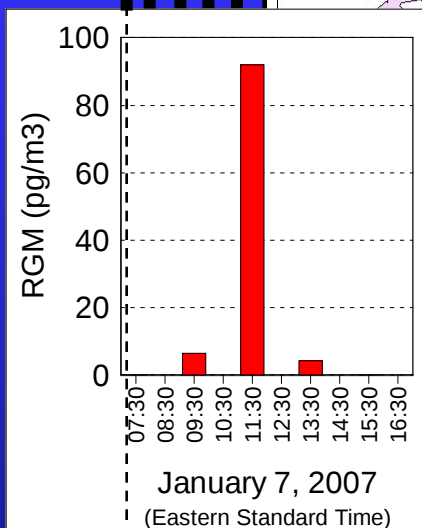
Control

Data Availability

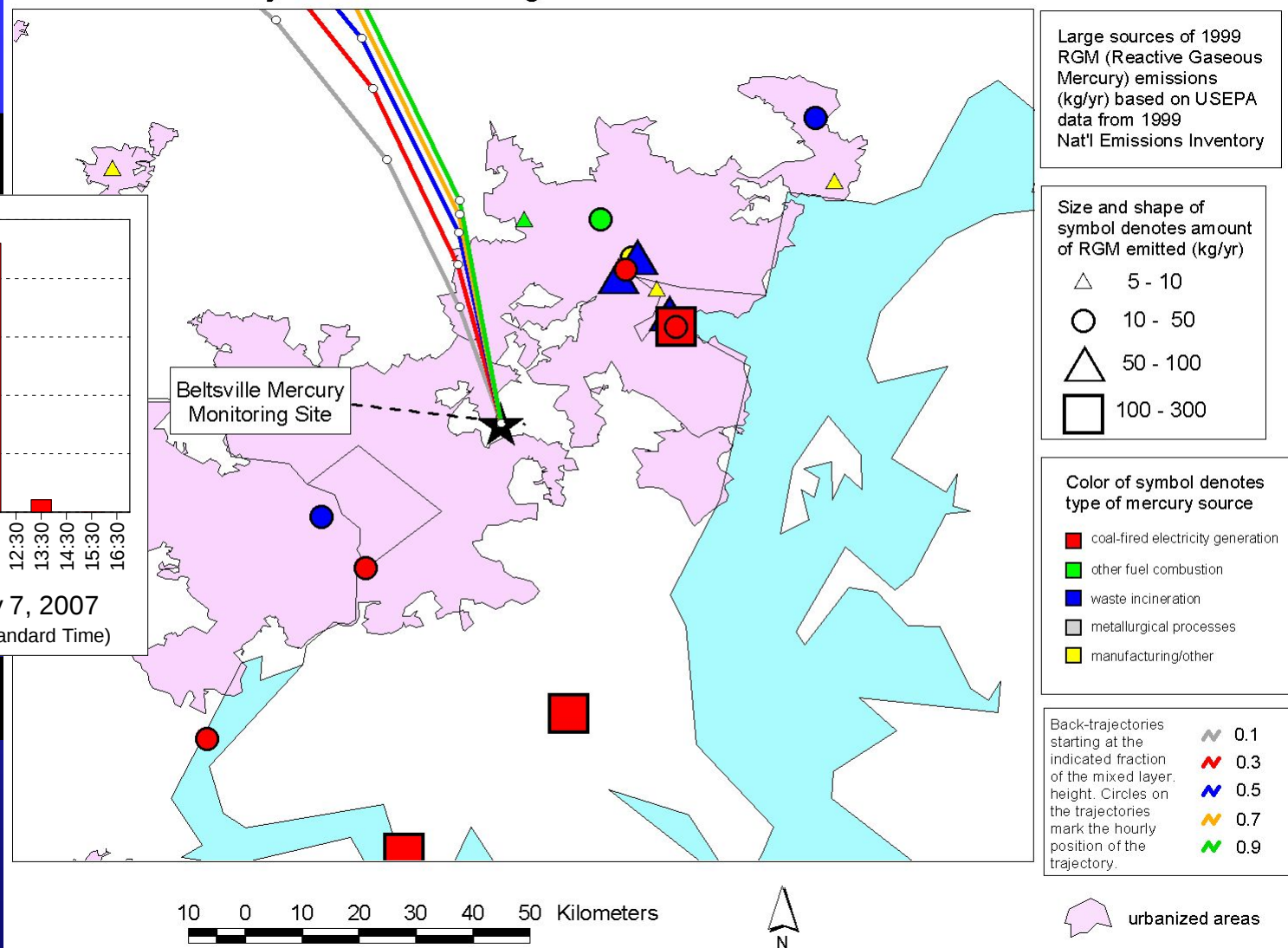
- 98 site years of data available
 - Only validated data available
 - GEM averaged to hourly, 2-hourly GOM & PBM_{2.5}
- Through December 2013,
 - 291,000 valid observations
 - of GEM, of GOM, and of PBM_{2.5}
 - 2009 - current, ongoing
- Available: <http://nadp.isws.illinois.edu>

Impacts of mercury emitting sources

Back Trajectories Arriving at 1/07/2007 07:00 EST

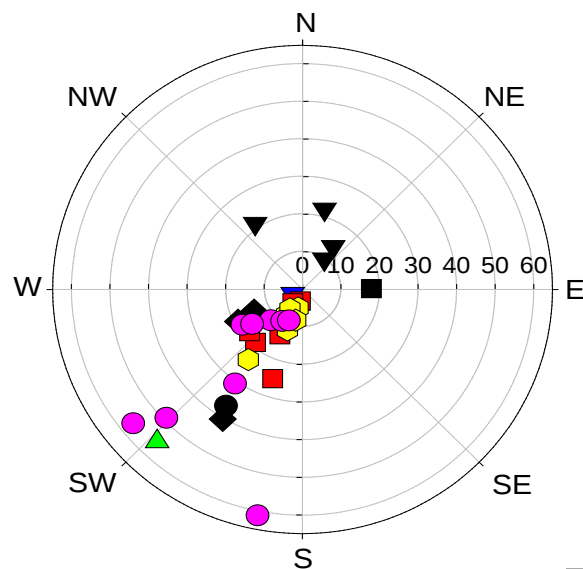


NOAA, 2011

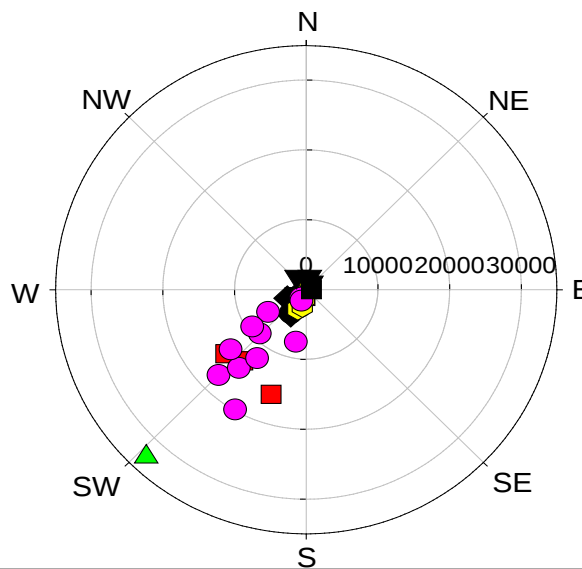


Sometimes, we see evidence of local and regional “plume” impacts

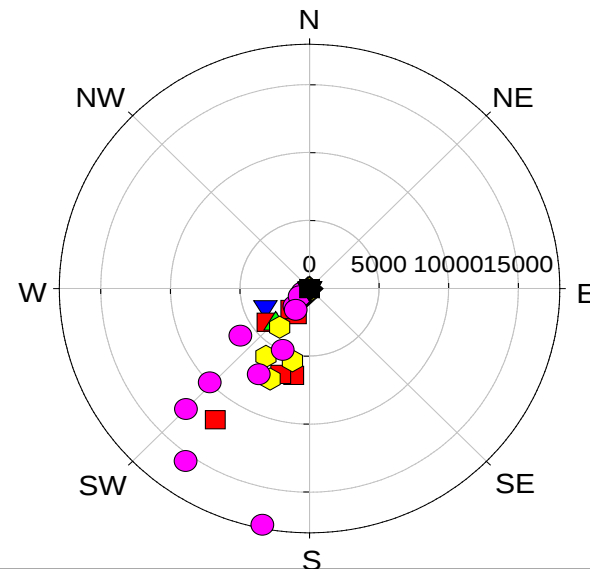
(a) Hourly Hg^0 (ng m^{-3})



(b) RGM (pg m^{-3})



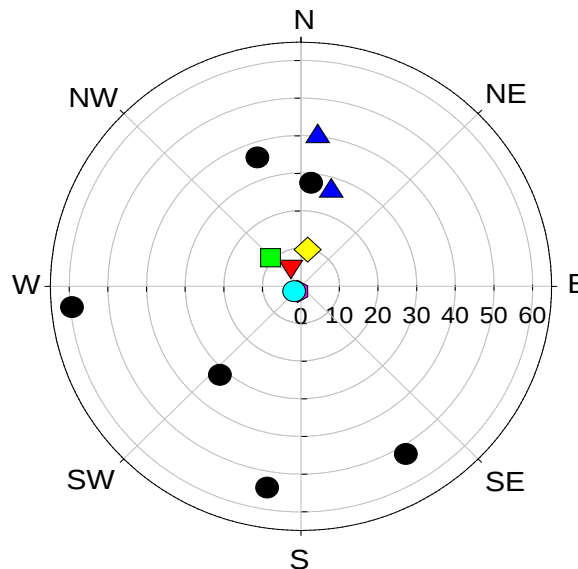
(c) PHg (pg m^{-3})



Mercury Species

- Cluster #1
- ▼ Cluster #2
- Cluster #3
- ◆ Cluster #4
- ▲ Cluster #5
- ◊ Cluster #6
- Cluster #7
- ▼ Cluster #8
- Cluster #9

(d) Mercury Emitters (km)



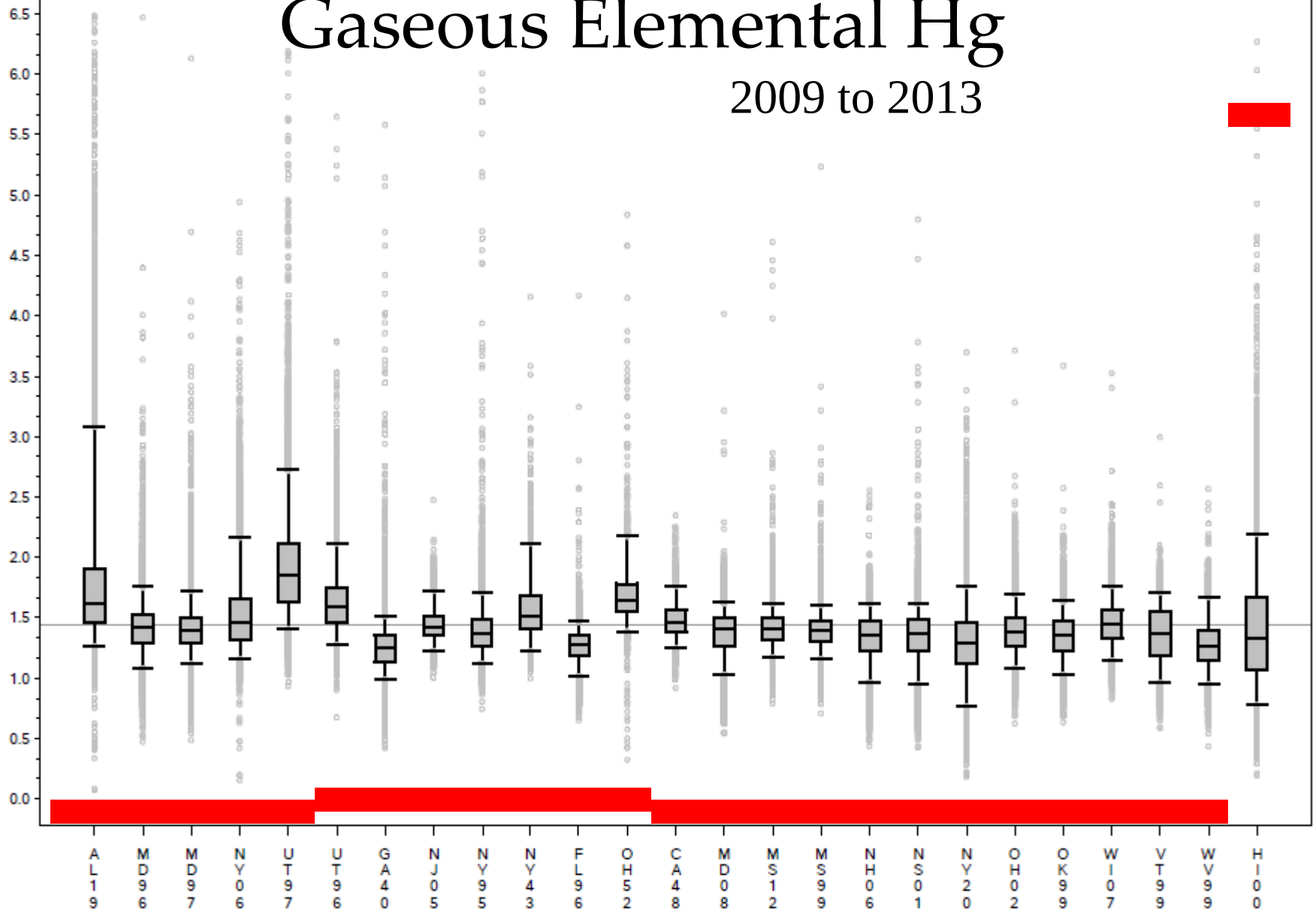
Mercury Emitters

- Coal Fired Power Plants
- ▼ Medicinals & Botanicals
- Industrial Inorganic Chemicals
- ◊ Blast Furnaces and Steel Mills
- ▲ Petroleum Refining
- Zinc Refining
- Refuse Incineration

Gaseous Elemental Hg

2009 to 2013

Hourly Concentrations, ng/cubic meter



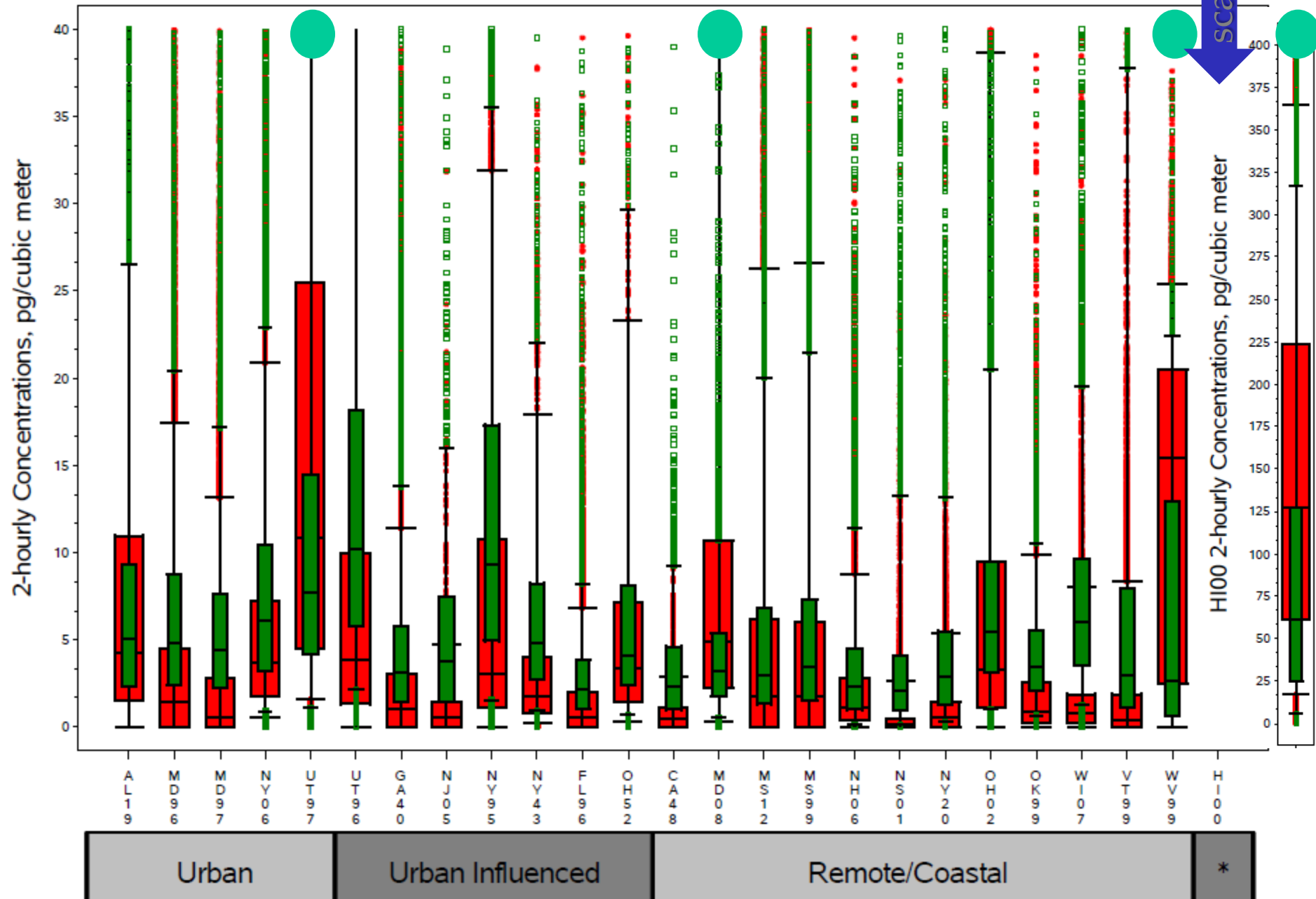
Urban

Urban Influenced

Remote/Coastal

*

PBM and GOM (2009 – 2013)



Proposed: Estimate Dry Deposition

- Weekly GOM, PBM, and GEM (downward)
- flux (F) = air concentration $\times$ dry deposition velocity (V_d)

$$F = V_{\text{deposition}} * \text{Concentration}_{\text{air}}$$

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



Environment
Canada

Environnement
Canada

Tekran Mercury Analyzers

Who has heard of Tekran?

Who owns a Tekran?

Does anyone operate a Tekran?

Future Goals APMMN

Open discussion

Acknowledgements

A special thanks to VEA for organizing
and hosting this meeting
EPAT for additional support

