# Florida Atmospheric Deposition Monitoring and Modeling Component of the Statewide TMDL Study

*Mercury TMDL Stakeholders Meeting*
*October 15, 2007*

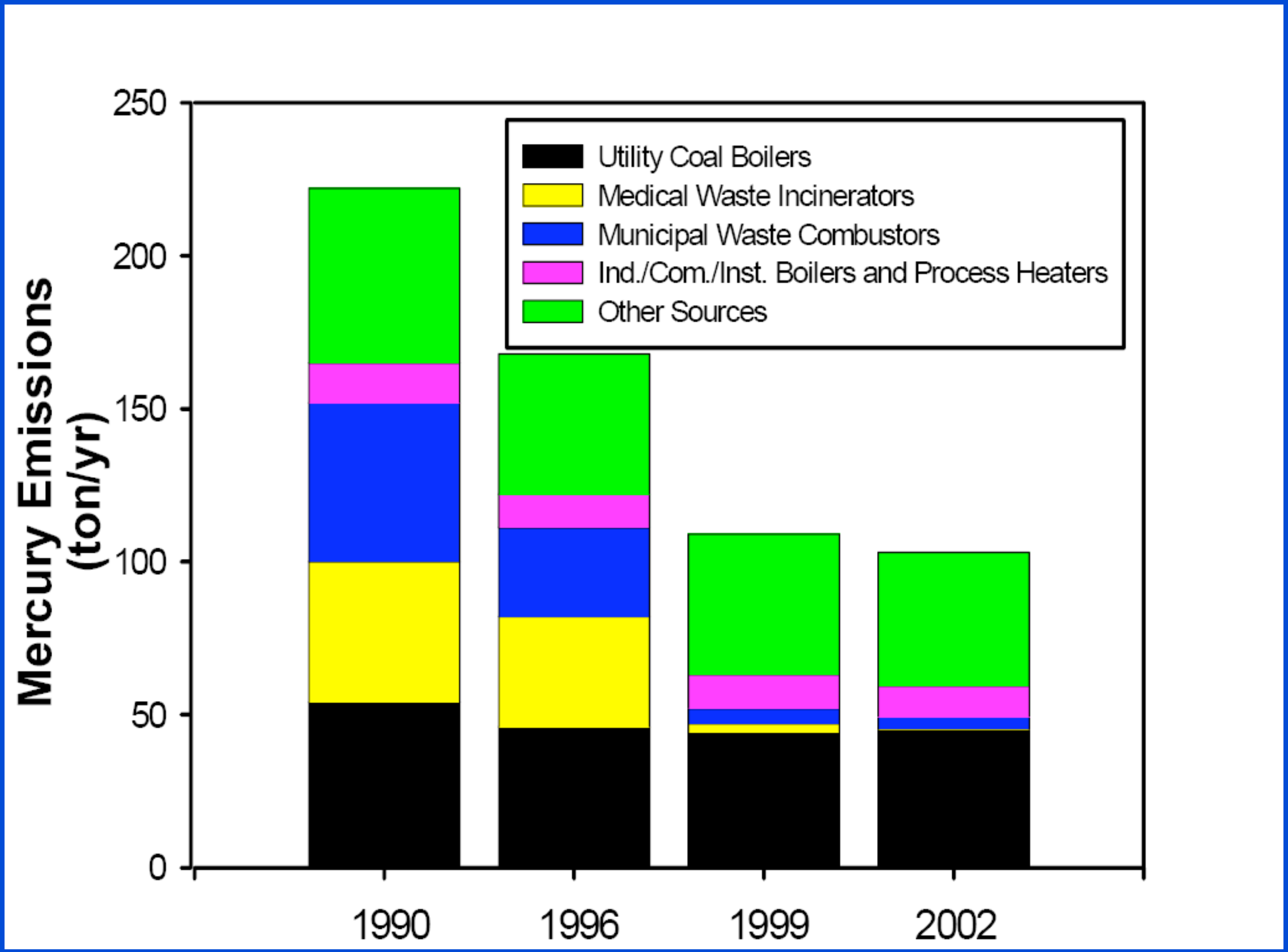
# Atmospheric Loadings and Source Apportionment

1. Objectives
2. Background
3. Sources of Mercury to the Environment
4. Cycling of Mercury and Speciation
5. Approach to Estimating Deposition
   - Total Wet Deposition
   - Dry Deposition by Mercury Species
   - Sources of Deposition
     - Atmospheric Supersite Approach
     - Monthly Intensives
6. Summary

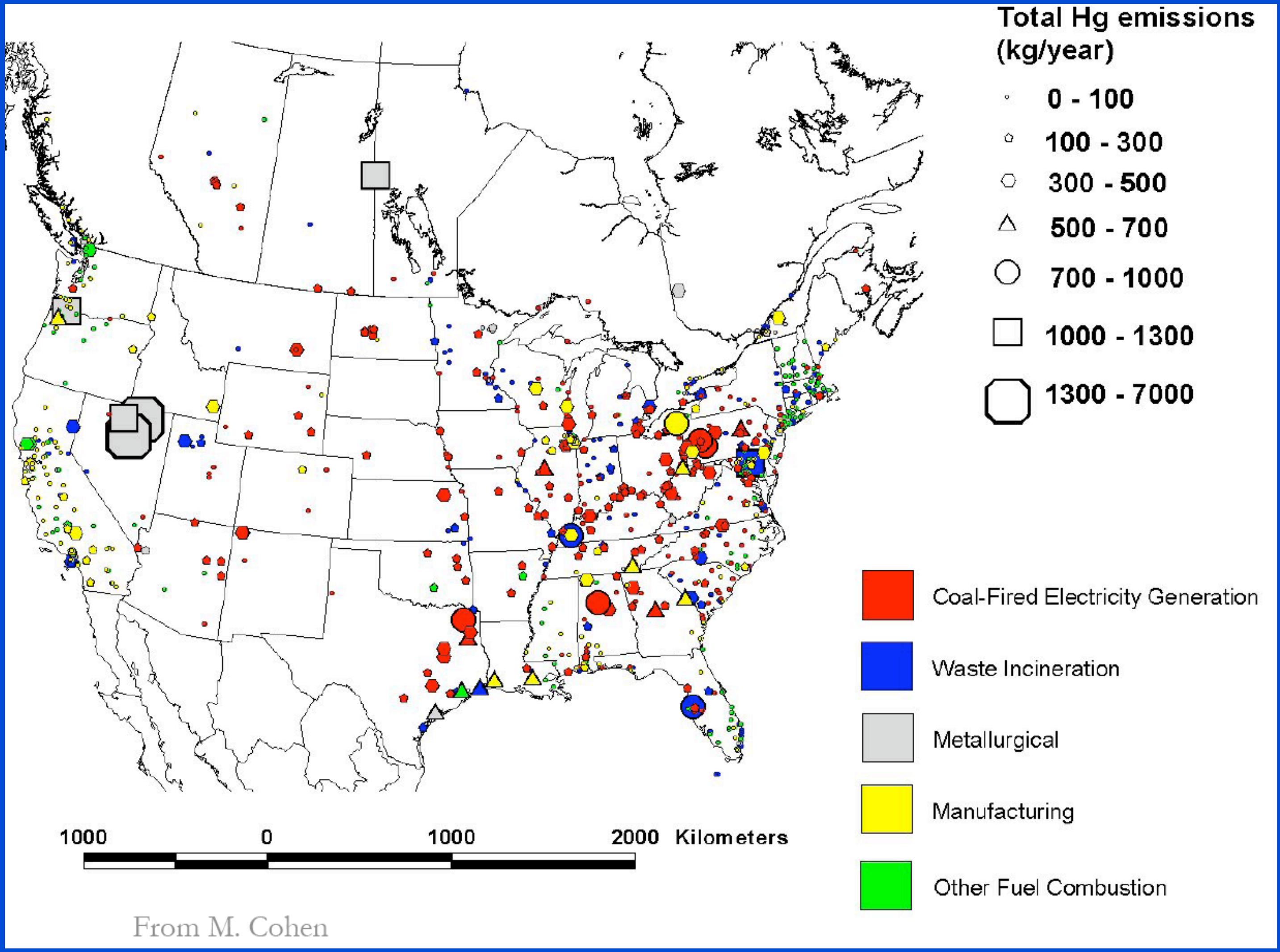
# Atmospheric Study Objectives

- Provide monthly atmospheric loadings (wet and dry deposition) for mercury, nitrogen, and phosphorous for the State of Florida.
- Allocate these loadings to the sources that contributed them with associated uncertainties.

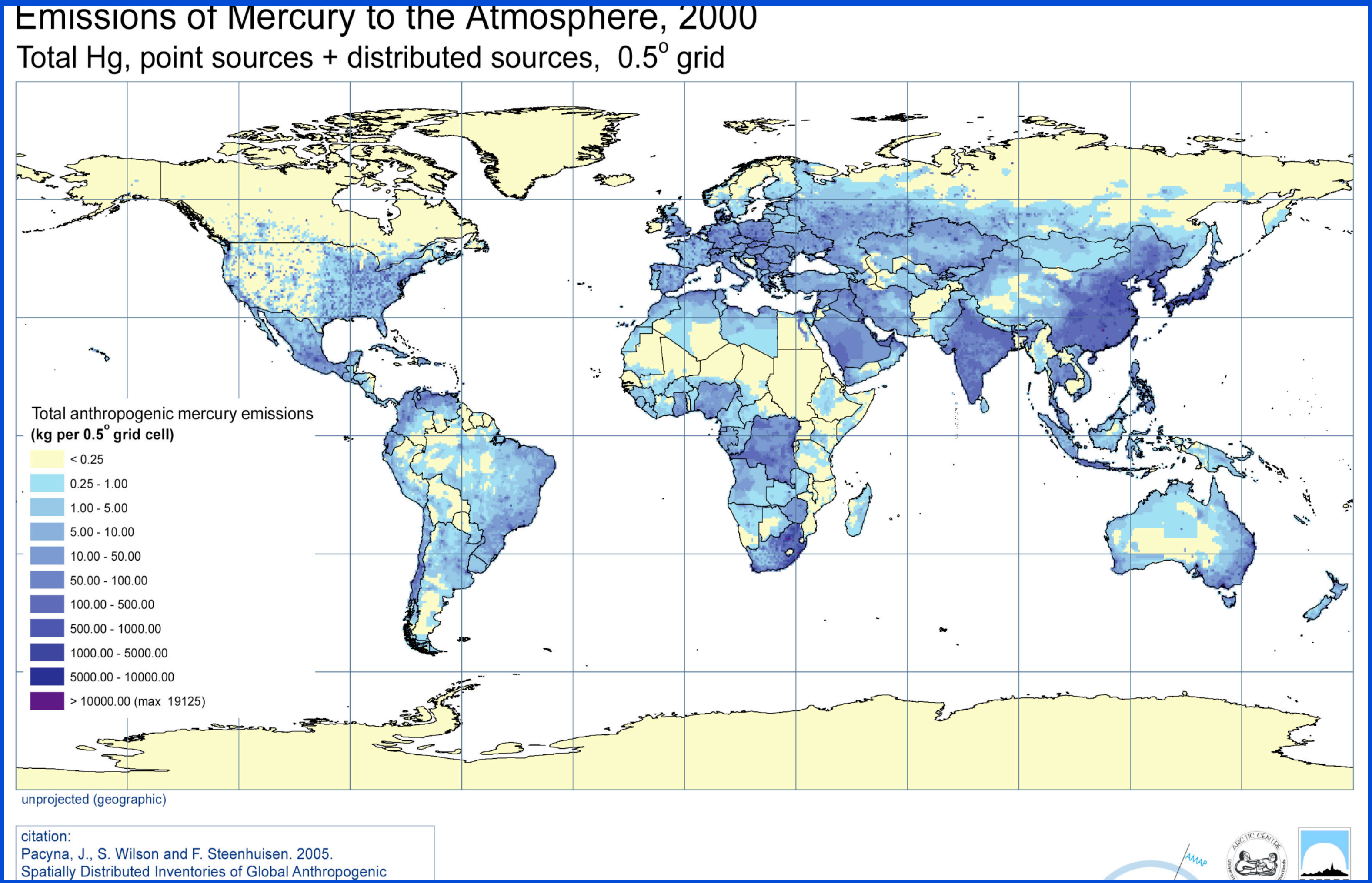
# U.S. Mercury Emissions



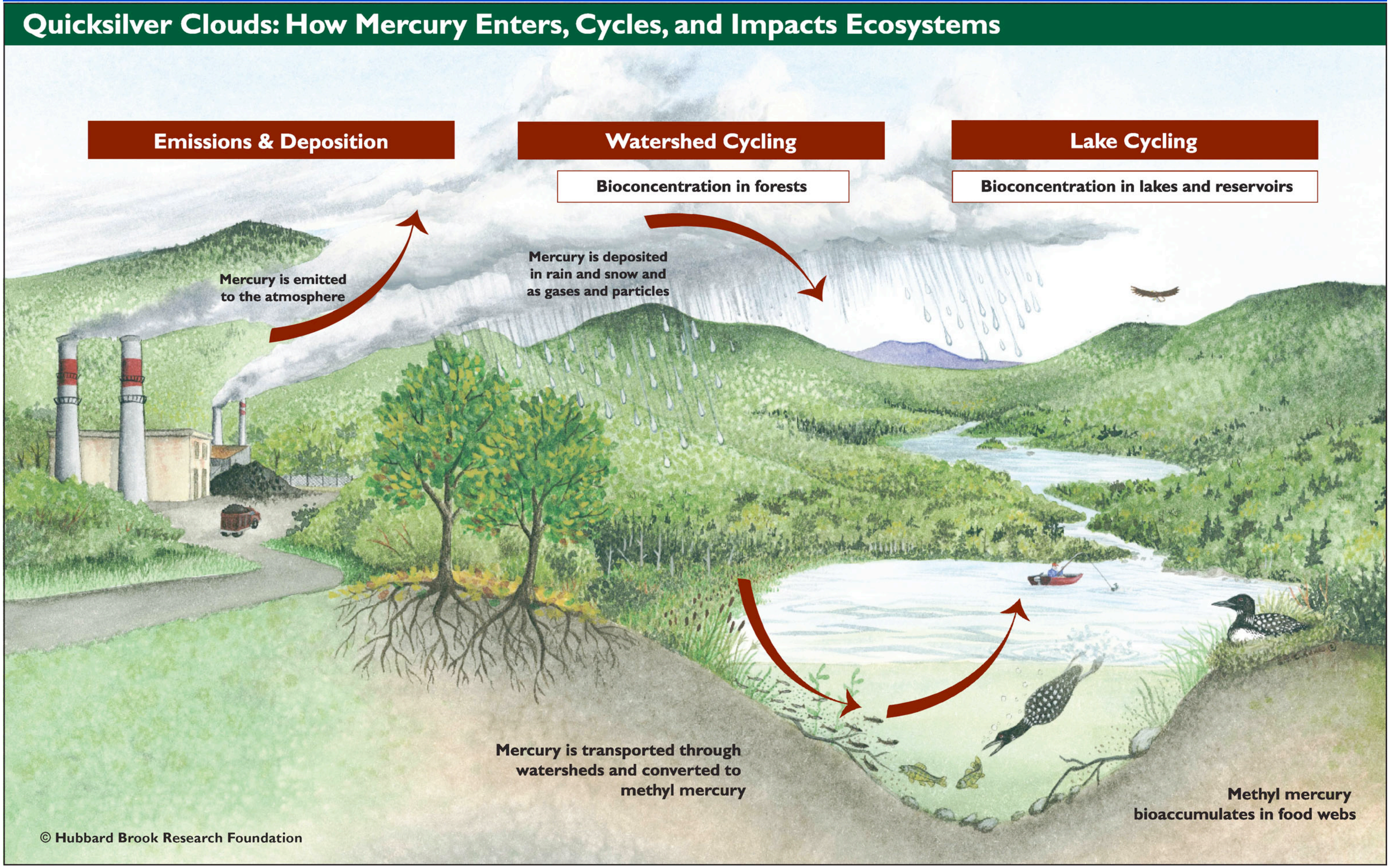
# Location of Major Hg Point Sources



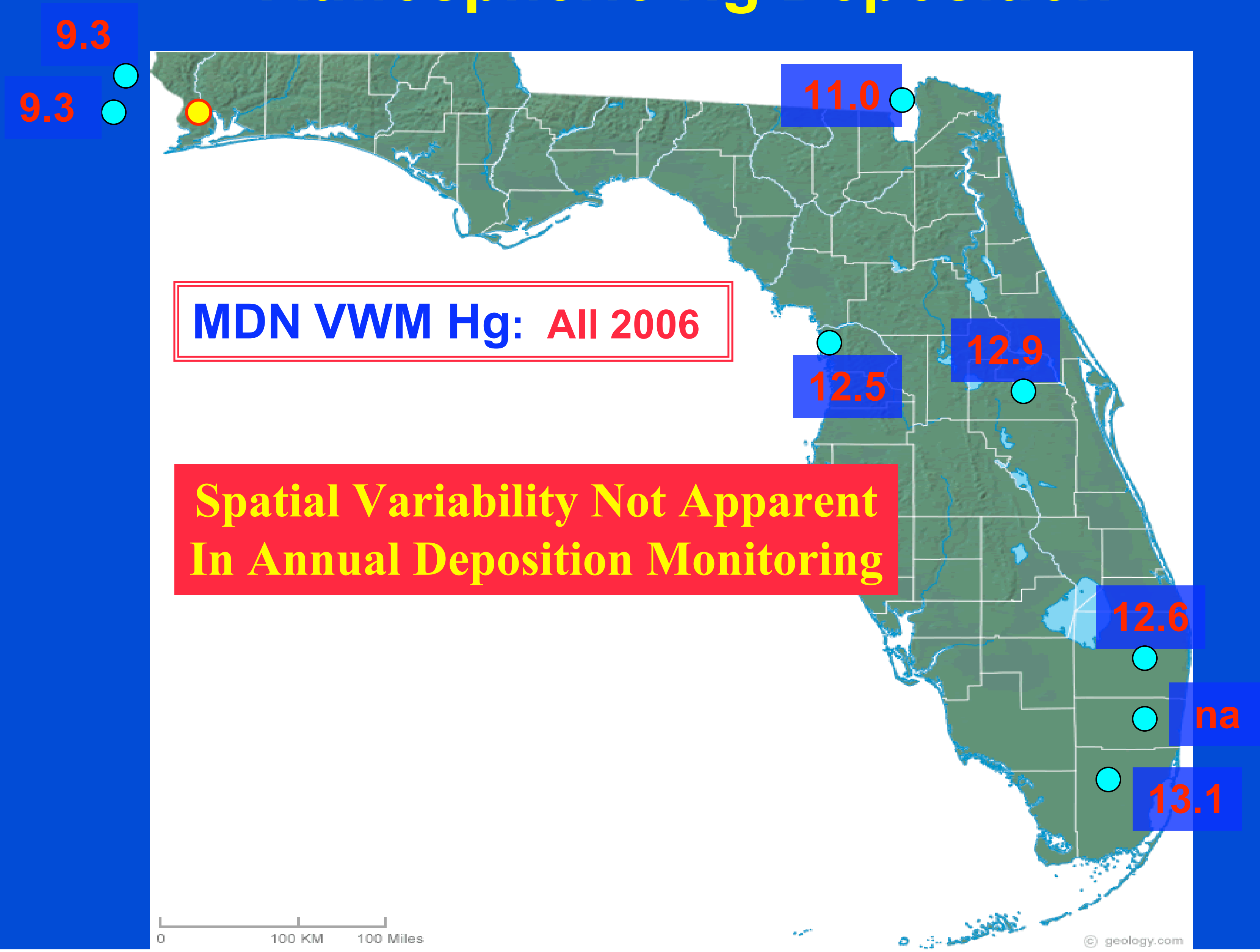
# Spatial Distribution of Global Mercury Emissions



# How Does Mercury Get from the Air to Fish?



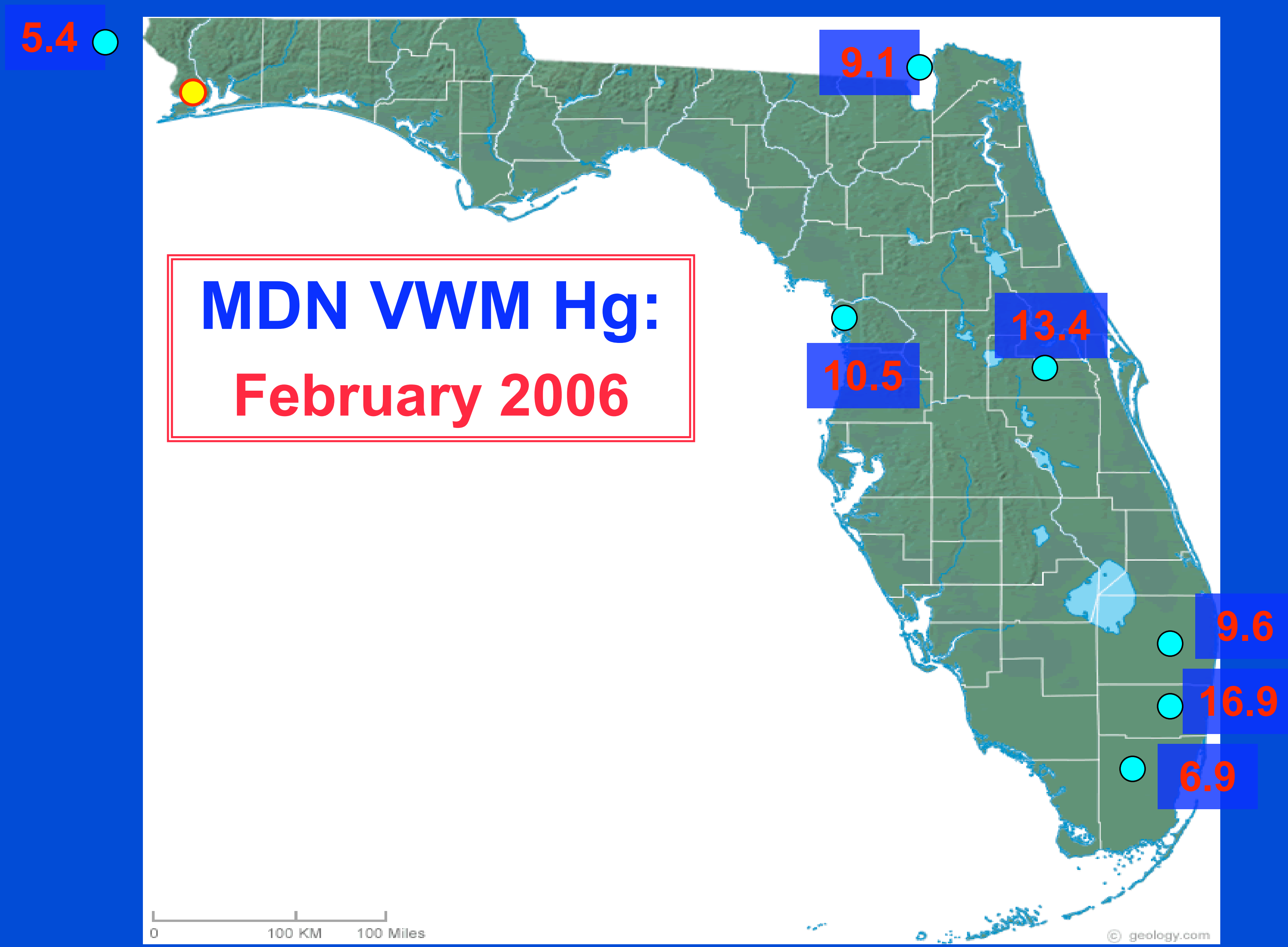
# Spatial Variability in Atmospheric Hg Deposition



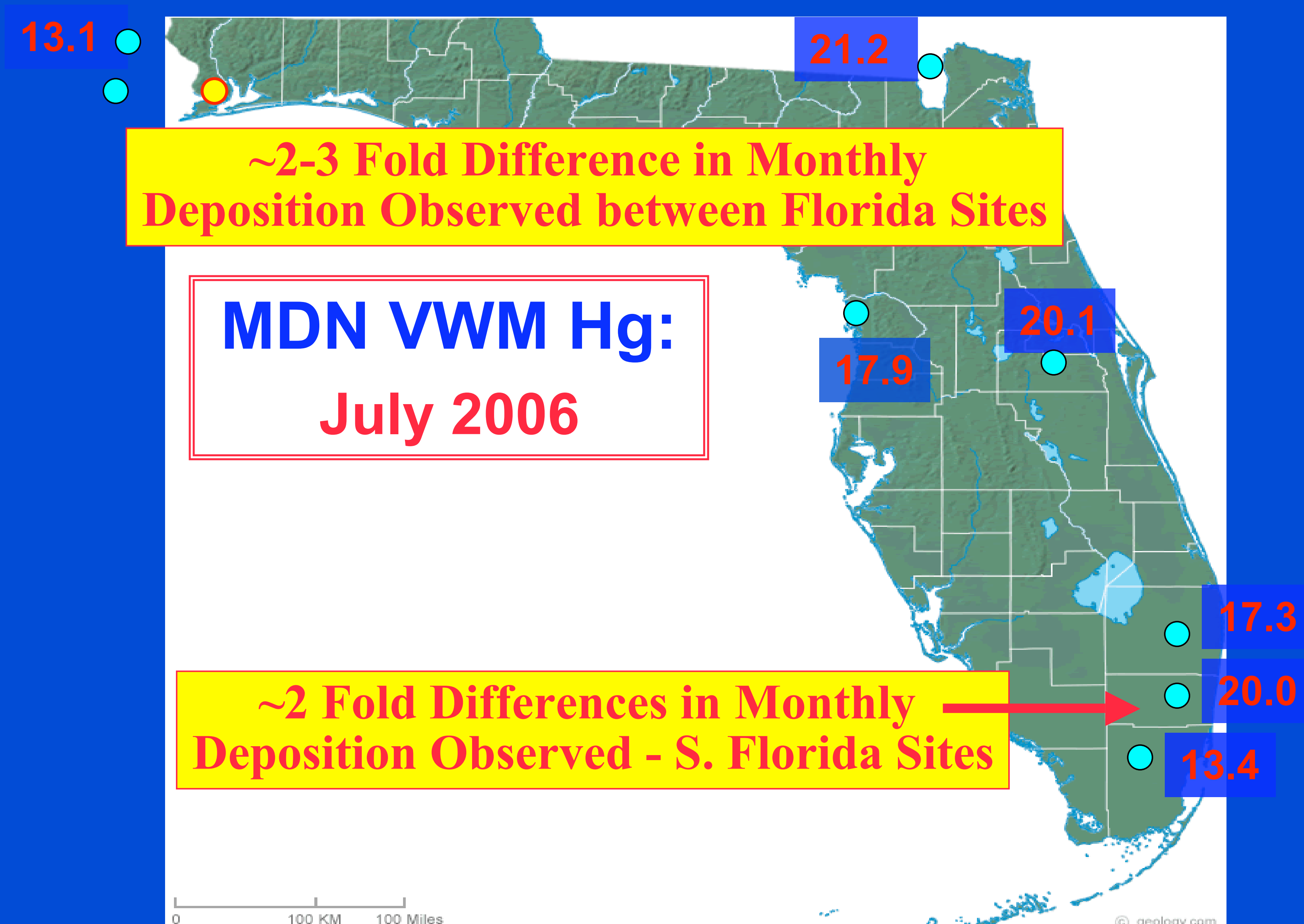

**MDN VWM Hg: All 2006**

**Spatial Variability Not Apparent In Annual Deposition Monitoring**

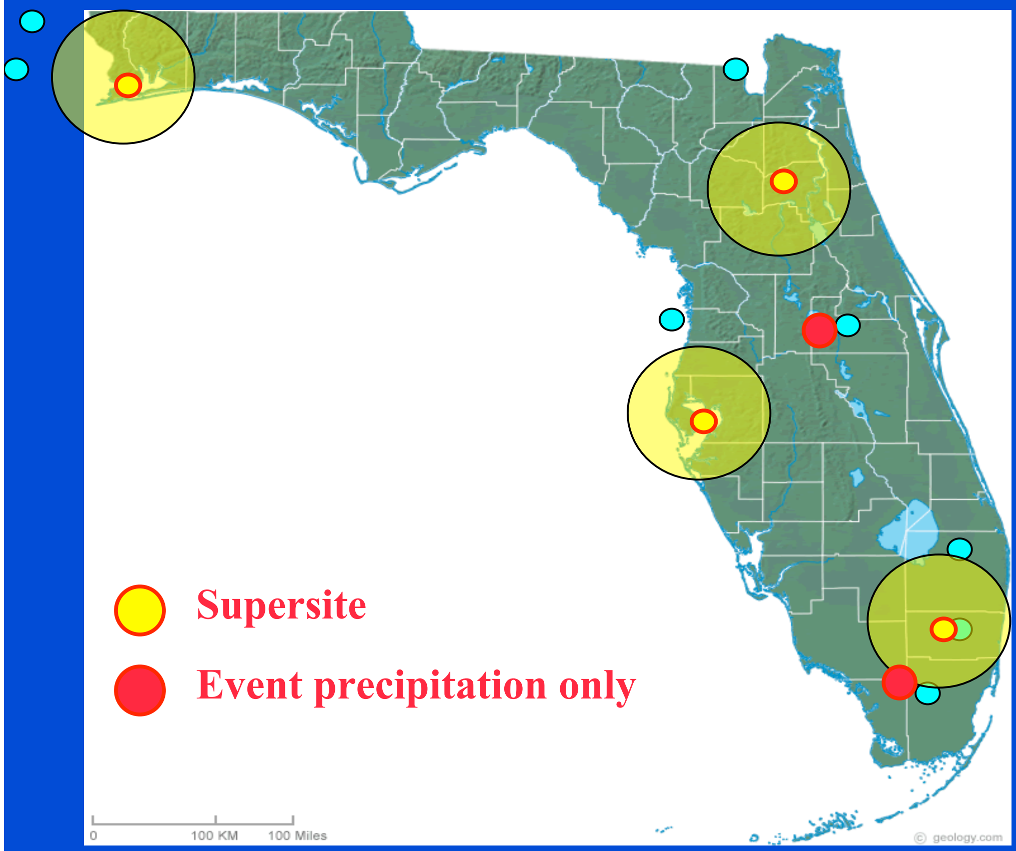
# Seasonal Patterns in Deposition



# Seasonal Patterns in Deposition



# Florida TMDL
# Atmospheric Deposition Supersites




**Four Comprehensive Sites**

Continuous ambient including:

-Speciated mercury (Tekran System)

-Criteria gases (CO, NOx, $SO_2$, $O_3$)

-PM components (Major Ions, TE)

**Daily-Event Precipitation**

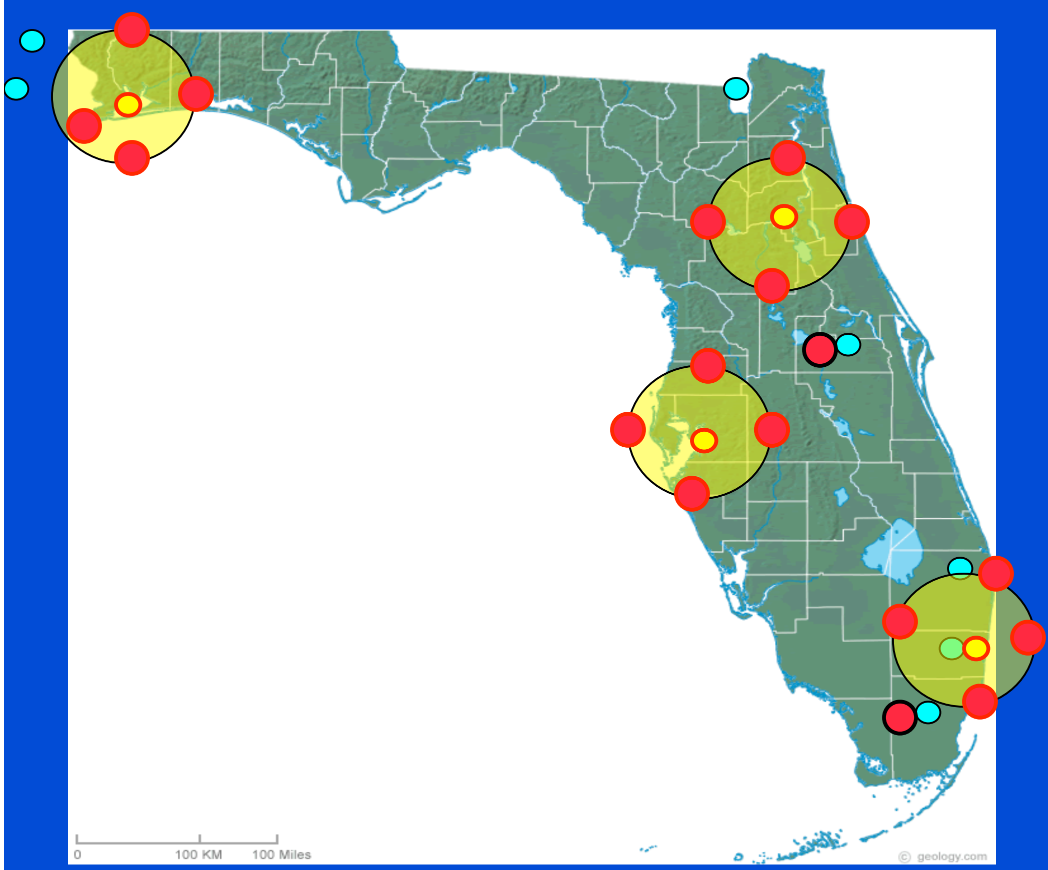
-Detailed chemistry including:
mercury, trace elements, major ions

**Integrated Gas/Aerosol Characterization**

-major ions including N species

-size distributions

# TMDL Atmospheric Deposition
## Combined Supersite-Intensive Approach




**Four Comprehensive Sites**

-Add daily dry deposition surfaces

-Add hourly trace element

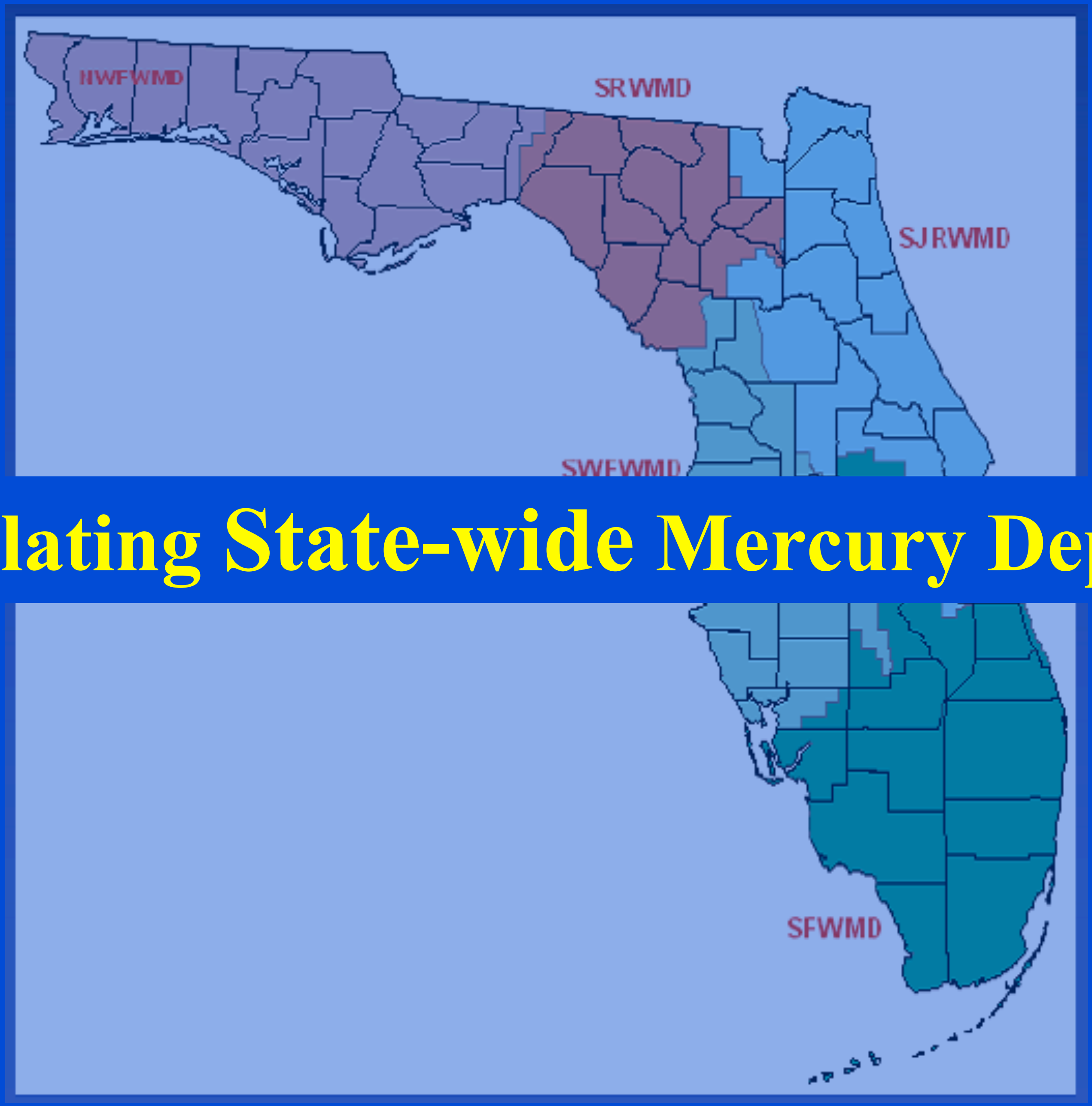
**Intensive Monitoring Sites**

- Event precipitation
- Detailed chemistry
- Dry deposition surrogate surfaces
- Detailed meteorology

# Importance of Seasonal Intensives

**Provide temporal and process level information that is critical for reducing uncertainties in source allocation and deposition calculations:**

**Multi-site wet and dry deposition measurements are critical for elucidating the spatial patterns in the loadings for each ecoregion;**

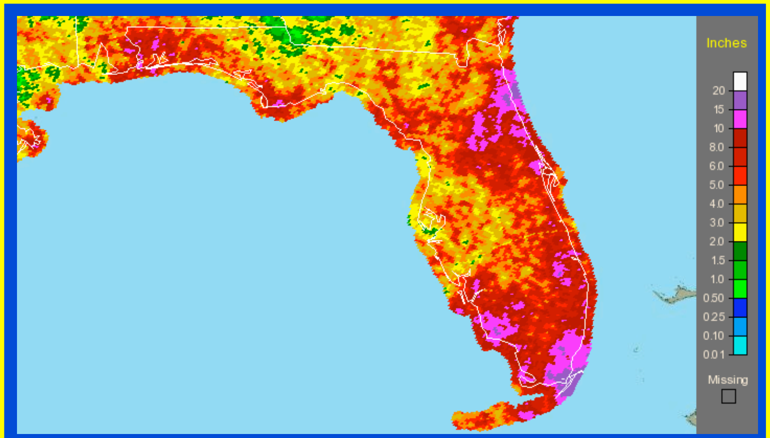



# Calculating State-wide Mercury Deposition

# Monthly Wet Deposition Loadings

Daily "event" rainfall sampling

Calculate gridded monthly volume-weighted mean concentrations (total and by source type)




Obtain gridded monthly statewide rainfall totals derived from National Weather Service Multi-Sensor Precipitation Estimator (MPE)

Gridded statewide values for wet deposition (total and by source type)

# Monthly Dry Deposition Loadings

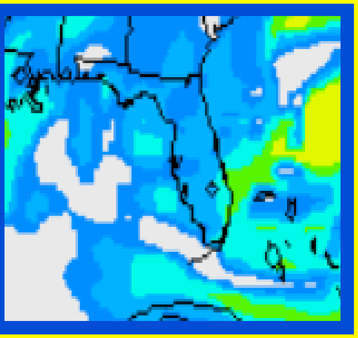

**Meteorological Monitoring**

**Continuous and Intensive Ambient Pollution Monitoring**

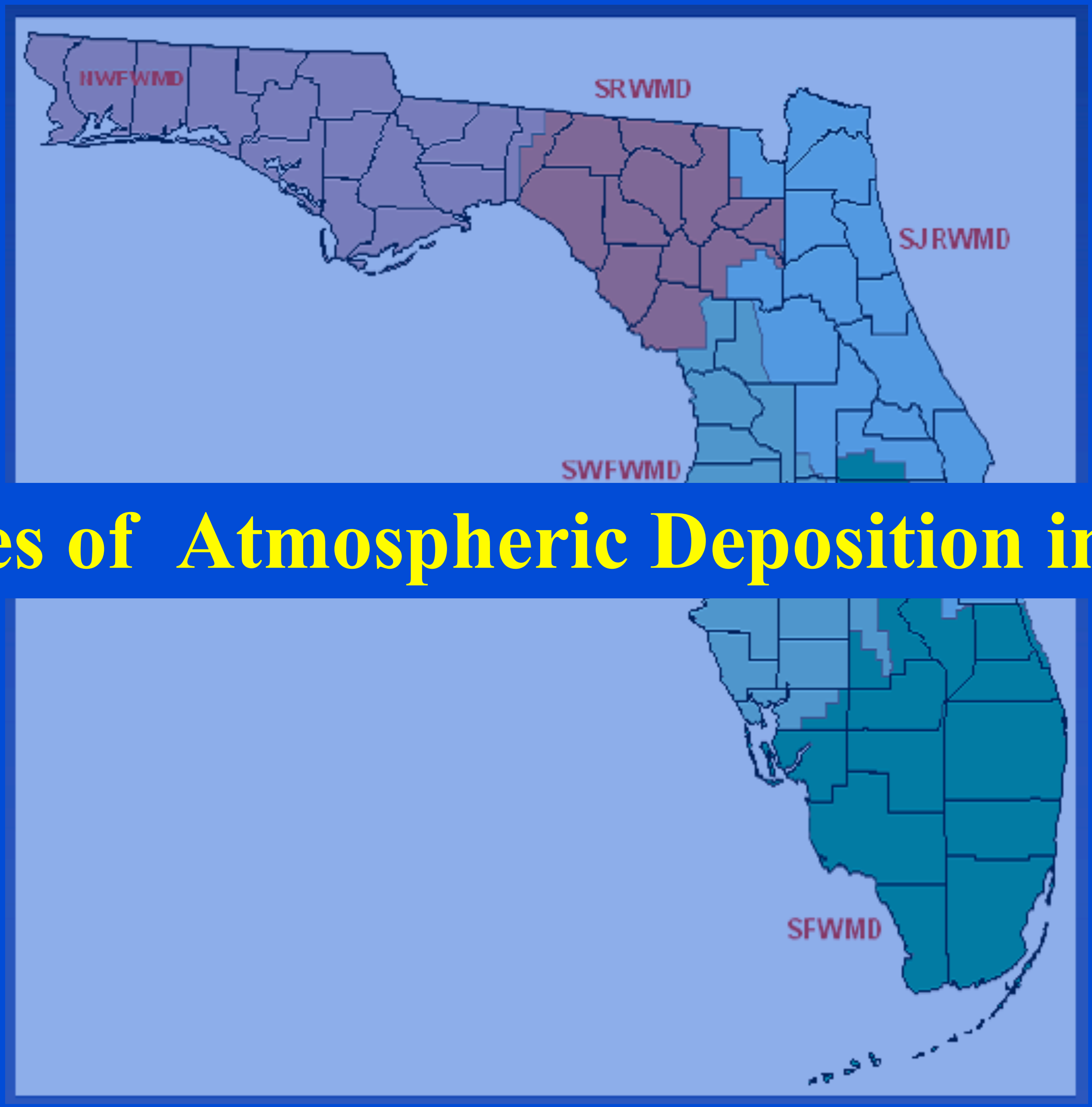
Use inferential model to calculate monthly dry deposition (total and by source type)

Receptor modeling/ source apportionment to produce gridded concentration fields

Final deliverable:
Gridded-statewide dry deposition
(total and by source type)



# Sources of Atmospheric Deposition in state



# Source Apportionment Approach

- **Source apportionment relates sources and environmental concentrations**

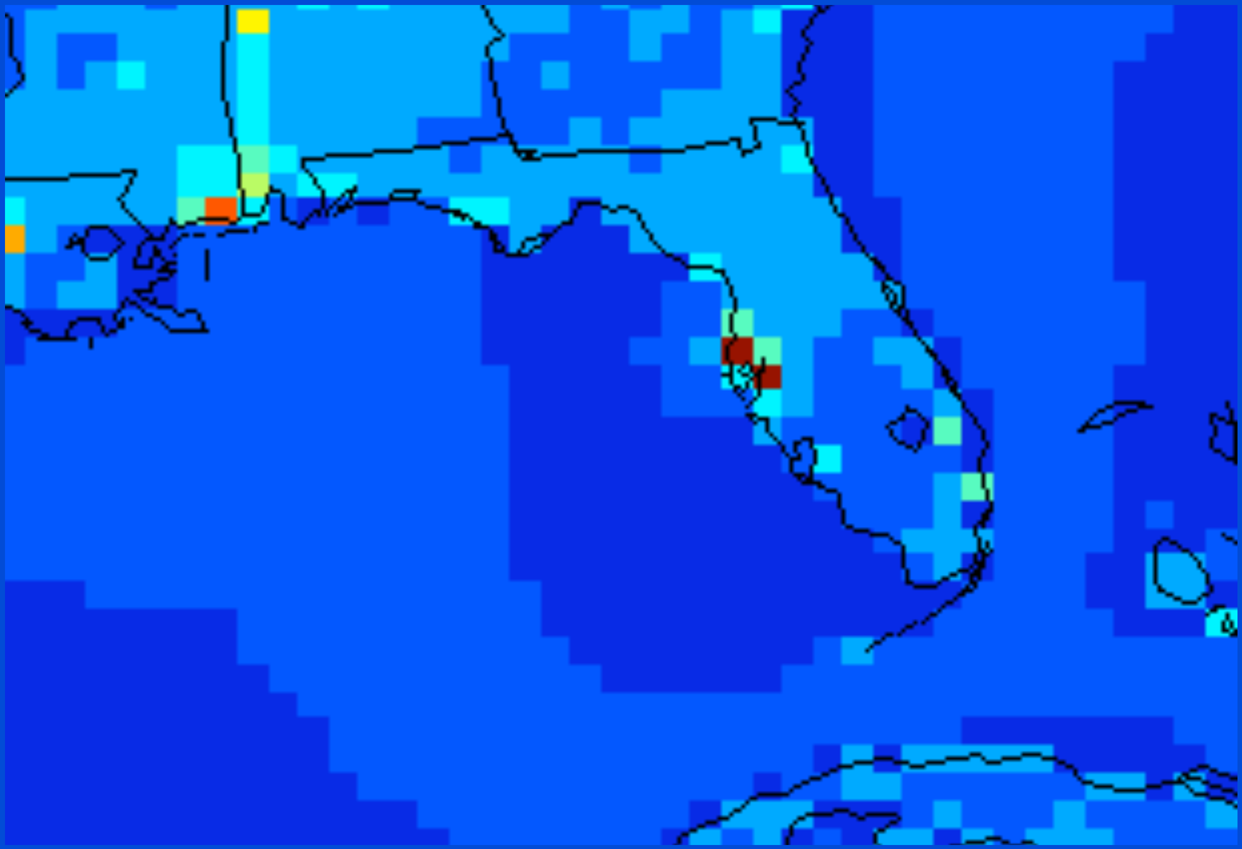
**Deterministic Modeling (e.g., CMAQ)**

- **Requires emission inventory, chemistry and meteorology.**
- **Models emission source impacts on predicted concentrations.**

**Receptor Modeling(e.g., PMF)**

- **Requires comprehensive environmental measurements.**
- **Statistically identifies sources impacting measured concentrations.**

# CMAQ Estimated Dry Deposition



CMAQ provides gridded atmospheric loadings of Hg by species as a function of source inputs.

Slide courtesy of Russ Bullock (USEPA)

# Receptor-Oriented Modeling

- Source Apportionment can be performed on multiple spatial scales
- Modeling Requires Comprehensive Monitoring including:
  - Automated Ambient Speciation Measurements
  - Event Precipitation
  - Quantification of full-suite of tracer species
- Coordinated Monitoring Strategy

# Multivariate Receptor Modeling

- Identify major "factors" by statistical analysis of an element measurement matrix
- Relate "factors" to source type using tracer compounds
- Example tracer compounds
  - Coal Combustion – S, Se
  - Oil Combustion – Ni, V
- Requires many samples (150 +)
- Ohio Study
  - Applied both positive matrix factorization (PMF) and UNMIX models
  - Estimated source contributors to measured wet Hg deposition

# Ohio Mercury Study

- **Sate-of-the-art measurement/analyses**
  - Aerosols - Integrated and Continuous
  - Wet Deposition - Daily Event
  - Criteria Gases - Continuous
  - Meteorology - Continuous
- **Receptor Modeling**
  - PMF and UNMIX

# Summary

Delineate atmospheric source inputs of mercury, nitrate, and phosphorous to each ecoregion in the state;

Identify and quantify the source contributions to the atmospheric inputs to each ecoregion;

Perform "supersite" comprehensive monitoring at four sites located in four ecoregions of the state to provide input data for robust source apportionment estimates and for dry deposition calculations at each site;

Perform "Intensive" monitoring studies around each supersite to provide process level data and uncertainty estimates for the areas which may have the largest spatial gradients;