Wet Deposition And Trends of Mercury in the U.S. and Canada, 1996-2004

Results from the NADP Mercury Deposition Network (MDN)

David Gay

(coauthors Eric Prestbo, Bob Brunette, Clyde Sweet)

Illinois State Water Survey
University of Illinois
Champaign, IL
dgay@uiuc.edu, (217) 244.0462
http://nadp.sws.uiuc.edu

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

A Cooperative Research Support Program of the State Agricultural Experiment Stations (NRSP-3) Federal and State Agencies and Private Research Organizations

ILLINOIS

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Illinois State WATER Survey (1895)

Goal of this Presentation….

- A *short* introduction to the *Mercury Deposition Network*.
- A description what we know about the deposition of mercury and trends

What is the *Mercury Deposition Network*?

- A Cooperative Research Program
  - Part of National Atmospheric Deposition Network (NADP)
  - 93 sites (one more next few weeks)
  - Federal, State, Local and Tribal Governments members, private organizations
  - Measuring wet deposition of mercury
- *Our Charge:*
  - *to determine if trends exist in wet deposition of mercury over time*

Federal Members

NOAA

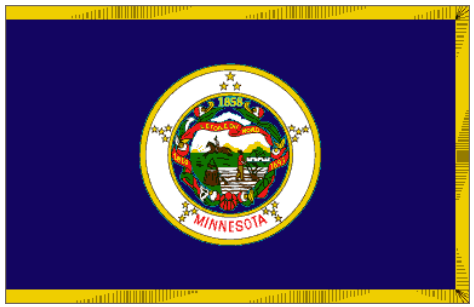
USGS
science for a changing world

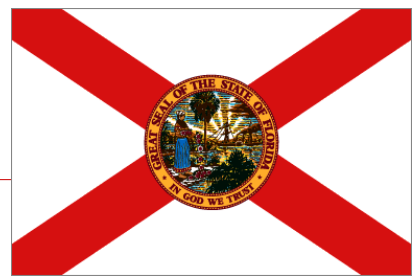
The National Park Service

U.S. FISH & WILDLIFE SERVICE

EPA United States Environmental Protection Agency

States and Tribal Organizations





Other Governments and Organizations

Environnement Canada

bp

Service météorologique du Canada
SMC

MSC
Meteorological Service of Canada

Environnement Québec

Why Monitor Mercury in Precipitation?

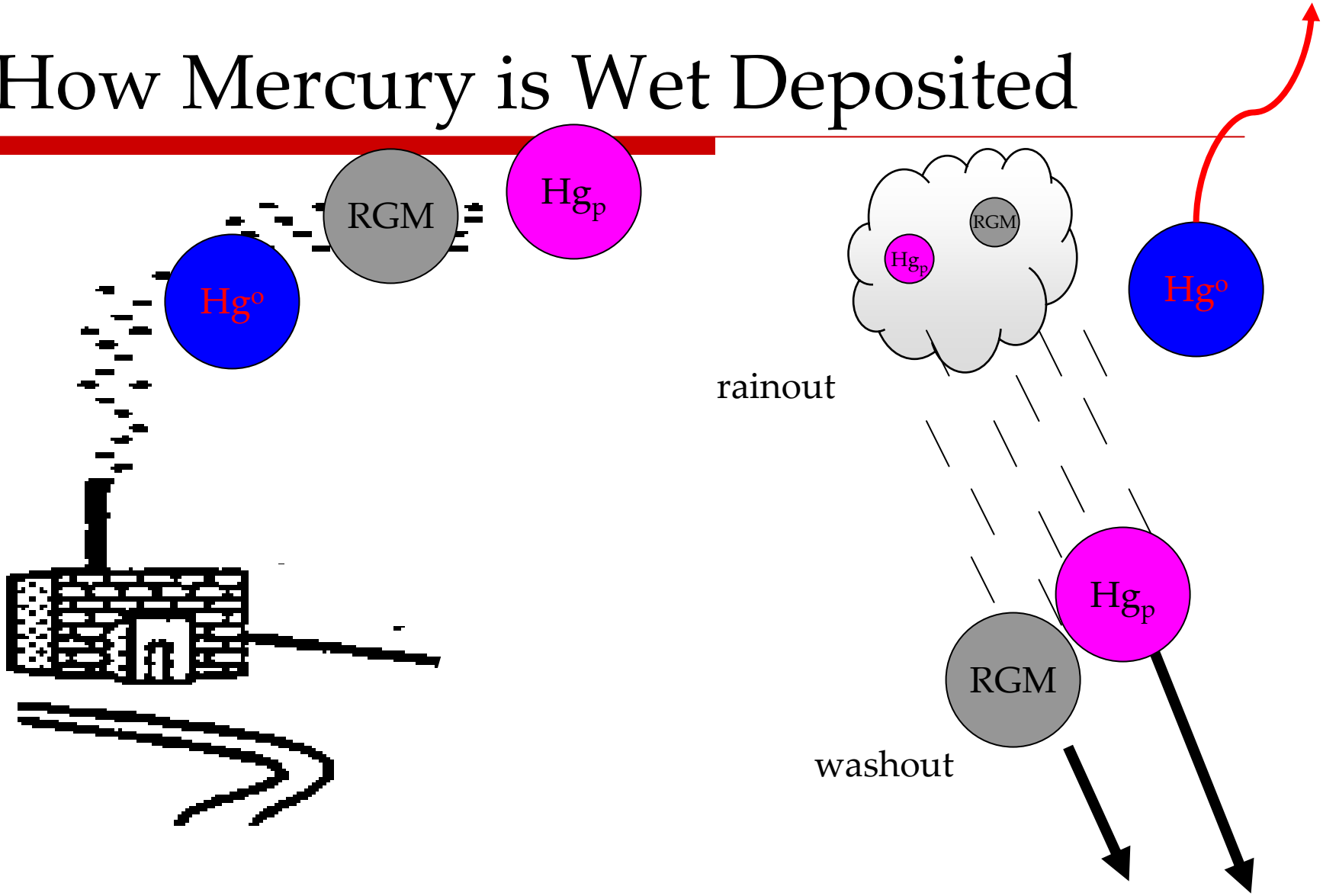
Why monitor for Mercury in Precipitation?

- Atmospheric transport and deposition is the dominant pathway to most aquatic ecosystems.
  - Between 40 and 75% of the mercury input to lakes and streams is by wet deposition
  - probably less in the West.

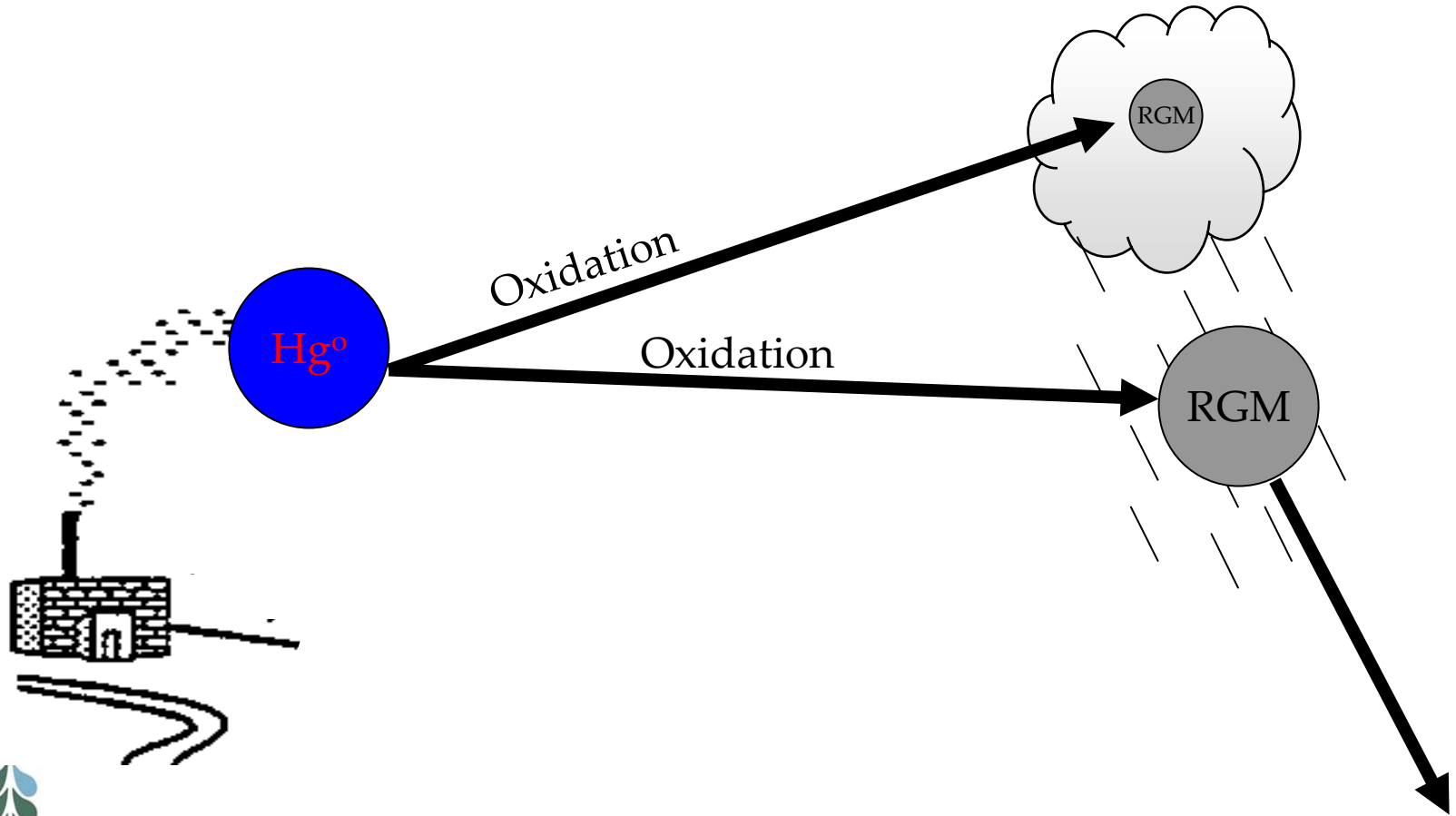
(Sorensen et al., 1997; Scherbatskoy et al., 1997; Lamborg et al., 1995; Mason et al., 1997; Landis and Keeler, 2002)

- "New" mercury is more likely converted to organic form than "old" mercury

How Mercury is Wet Deposited

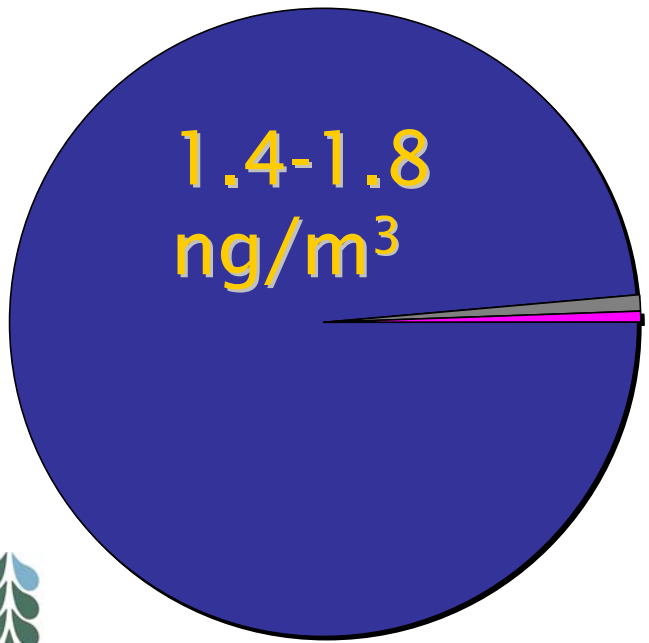


How Mercury is Wet Deposited



Atmospheric Mercury Species Abundance

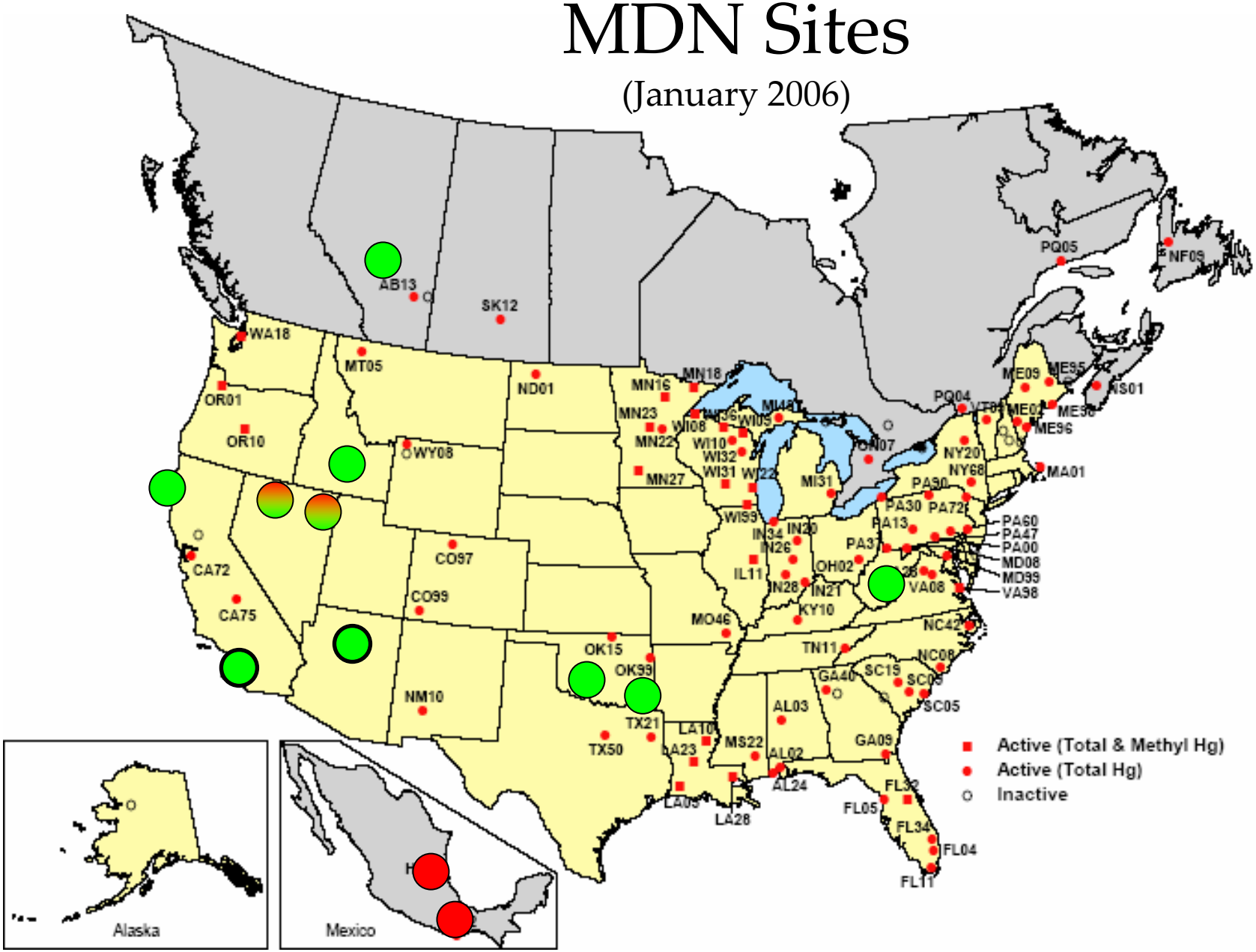
- Hg^0 – Elemental Mercury
- RGM – Reactive Gaseous Mercury
- Hg_p – Particulate Bound Mercury



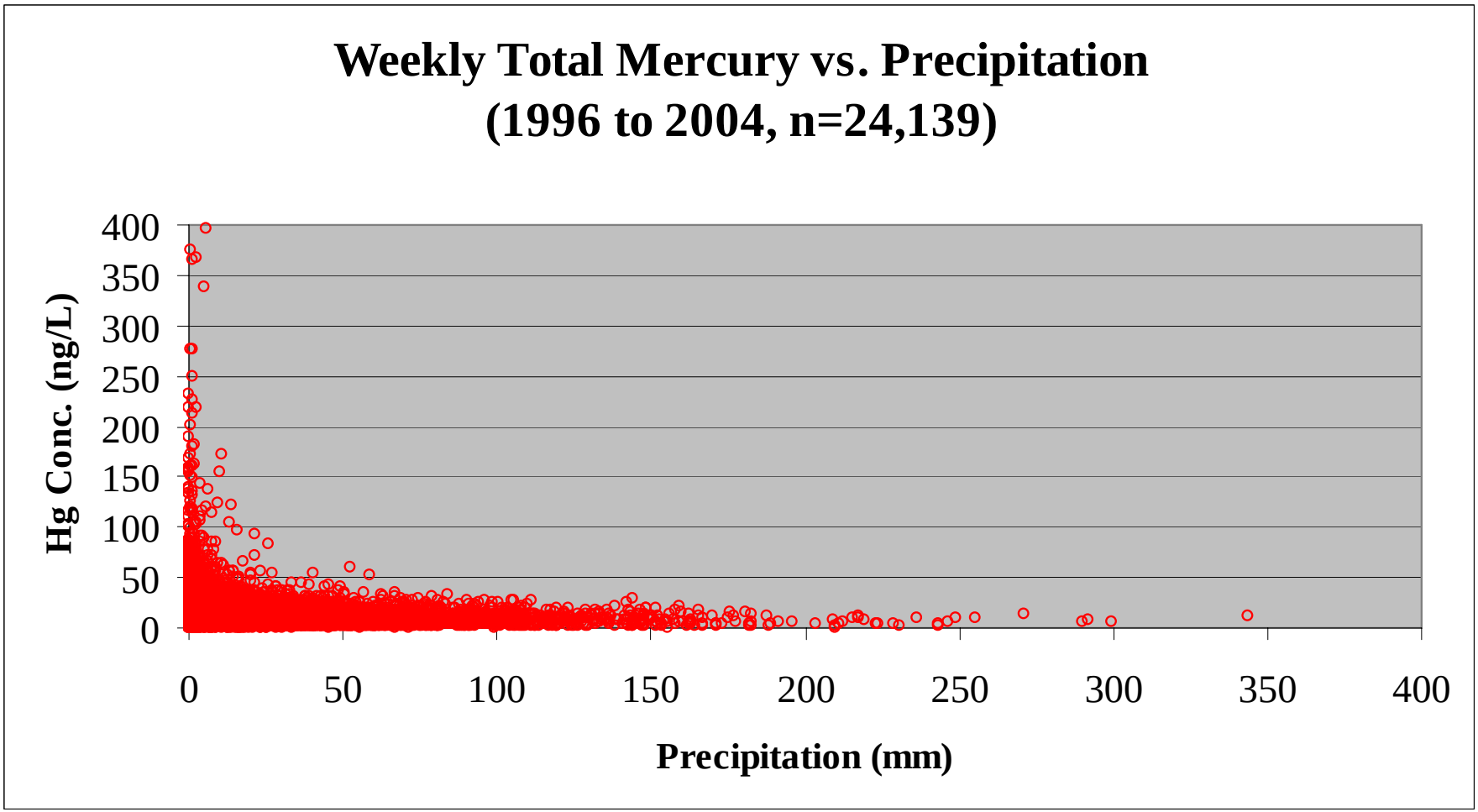
Typical Atm. Mercury Species Abundance

MDN Sites

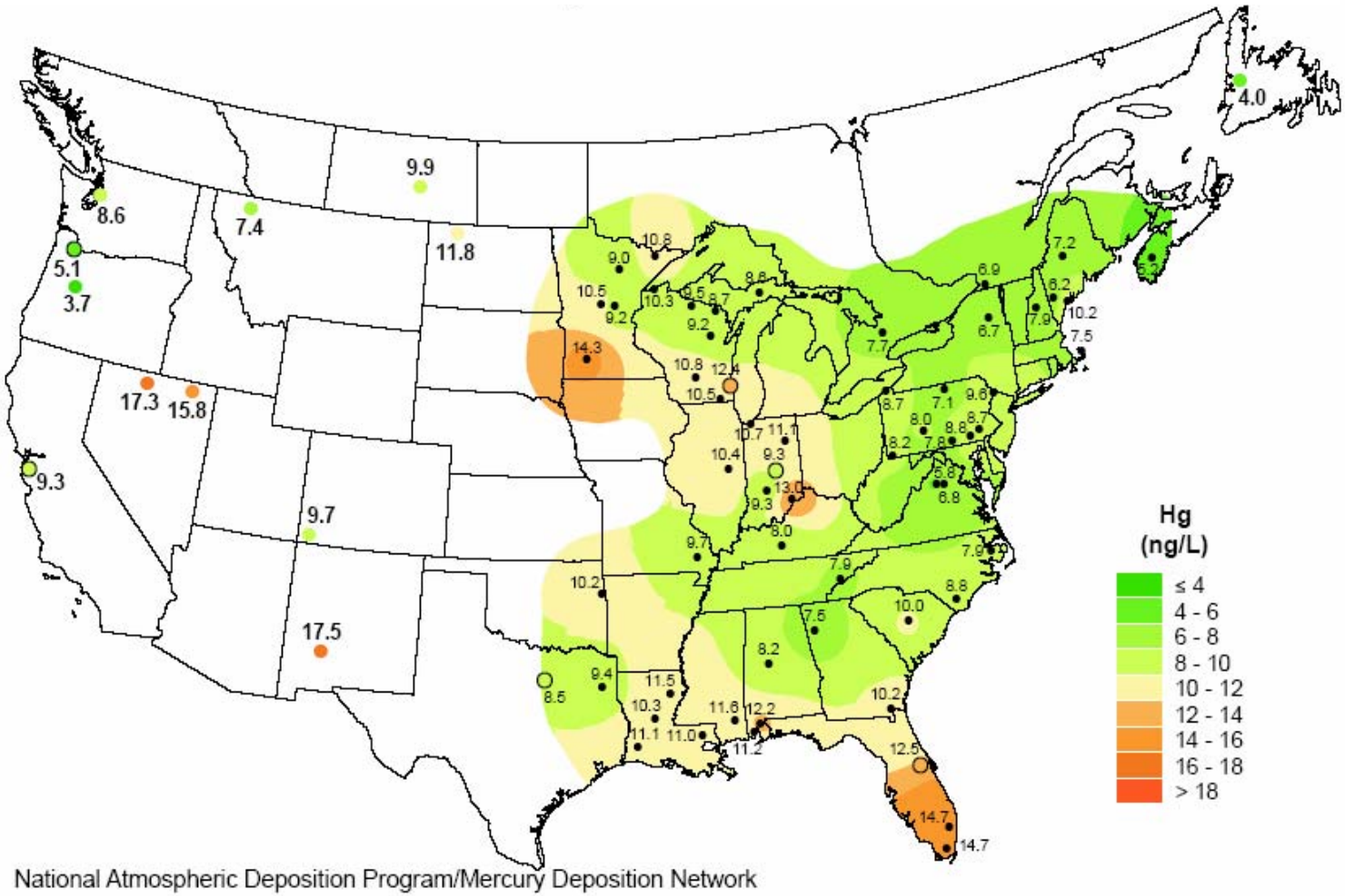
(January 2006)



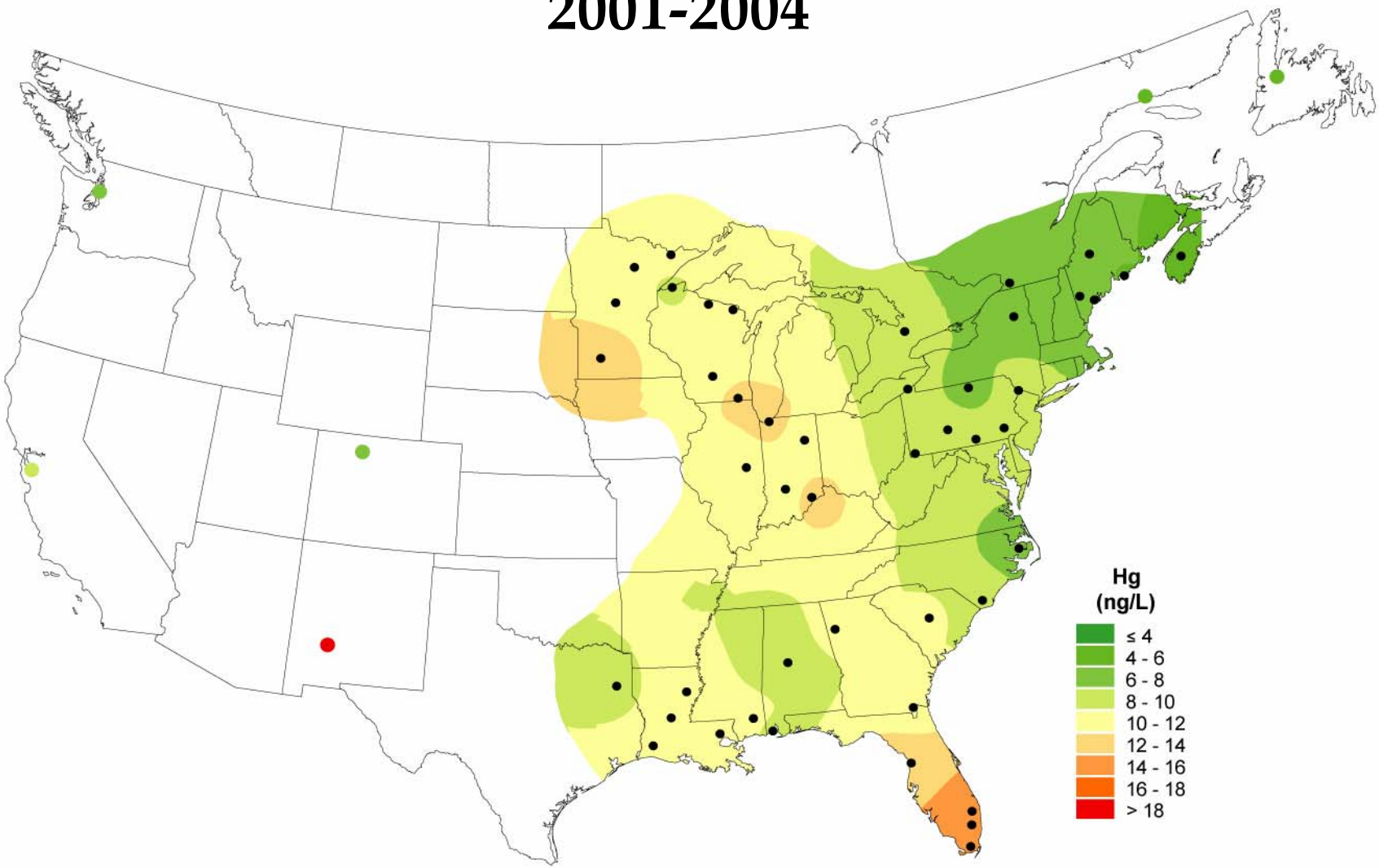
What the Data Show….


Weekly Total Mercury vs. Precipitation
(1996 to 2004, n=24,139)
Hg Conc. (ng/L)
400
350
300
250
200
150
100
50
0
0
50
100
150
200
250
300
350
400
Precipitation (mm)

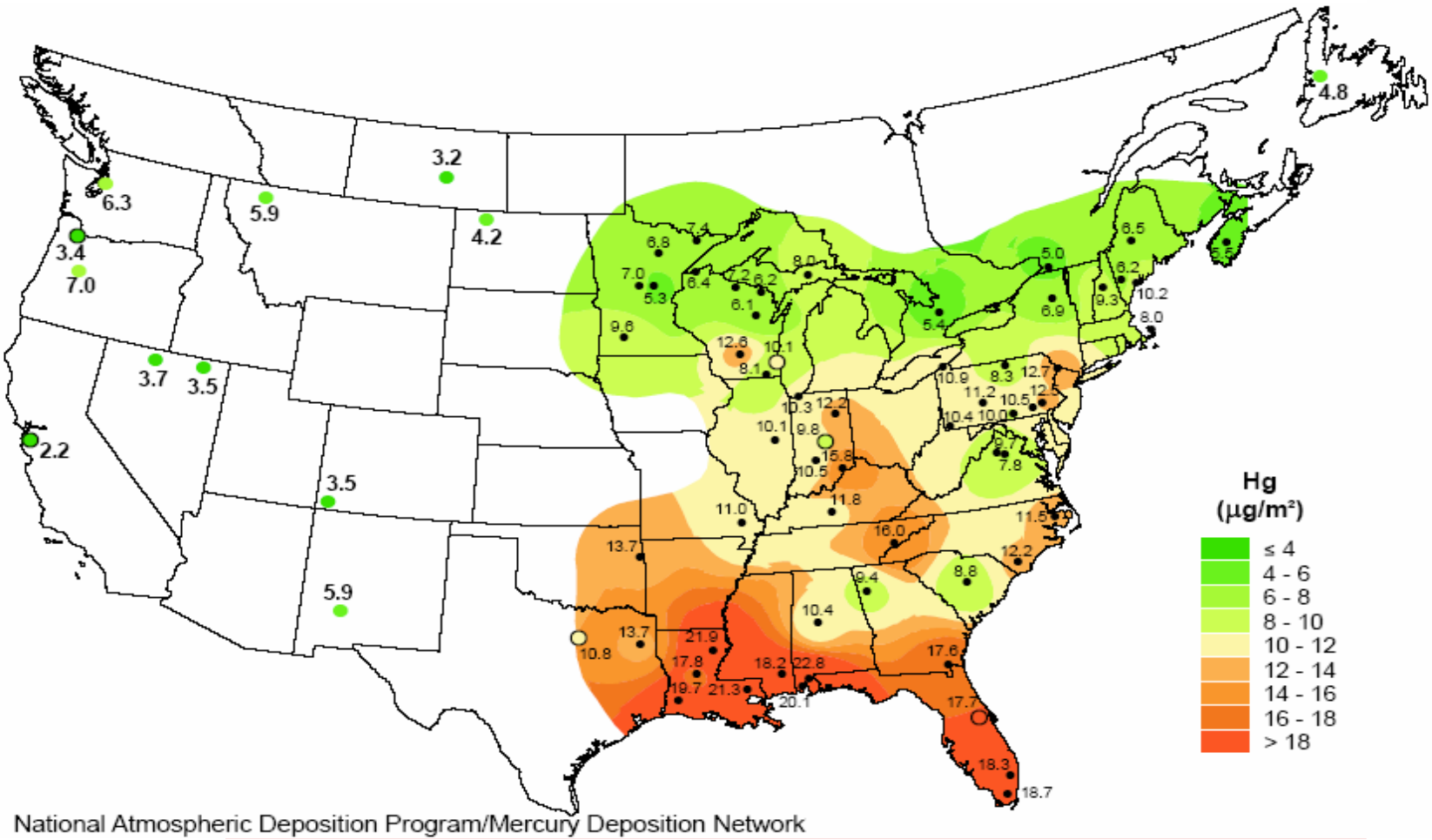
Mercury Concentrations in Precipitation 2004



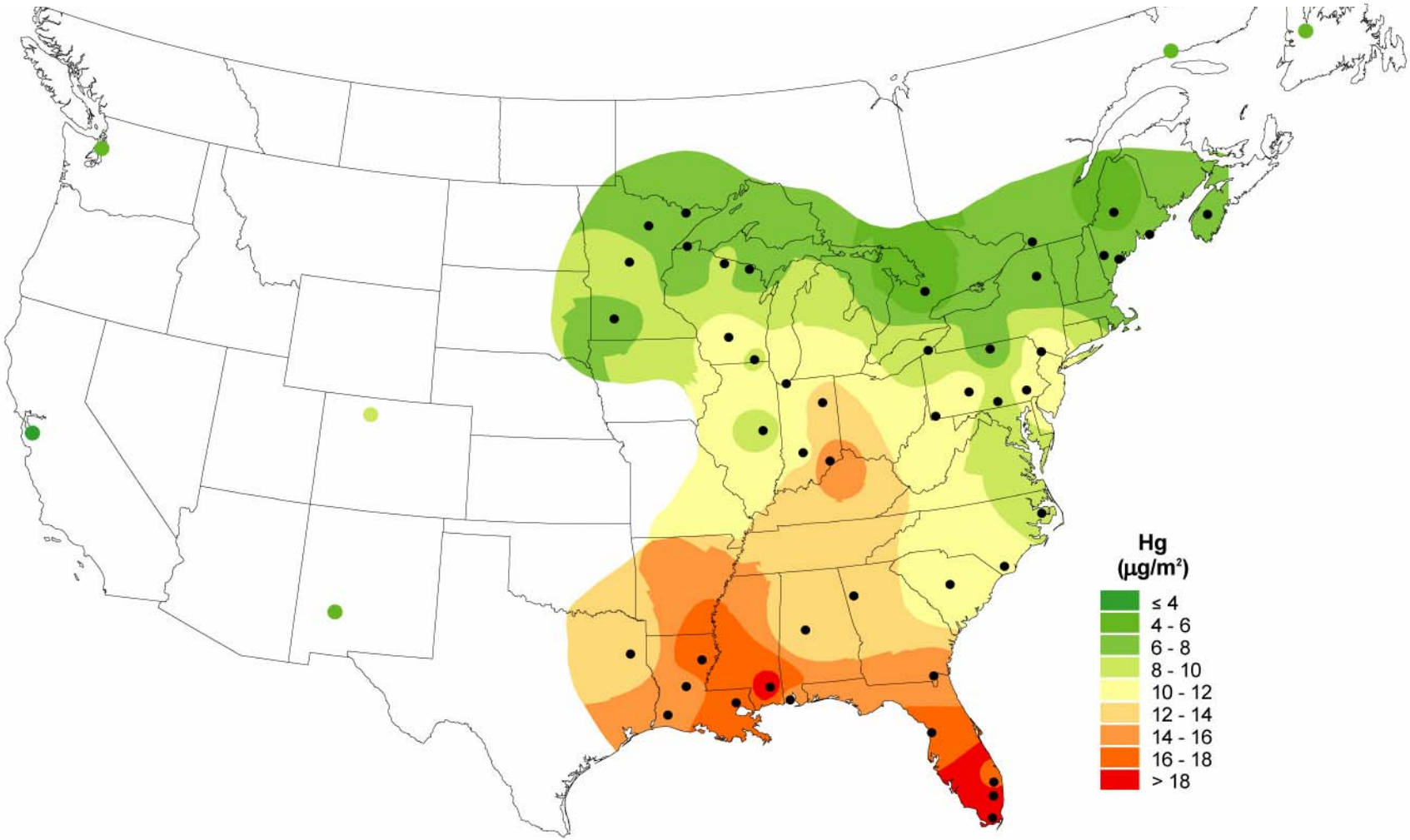
Average Mercury Concentrations in Precipitation 2001-2004



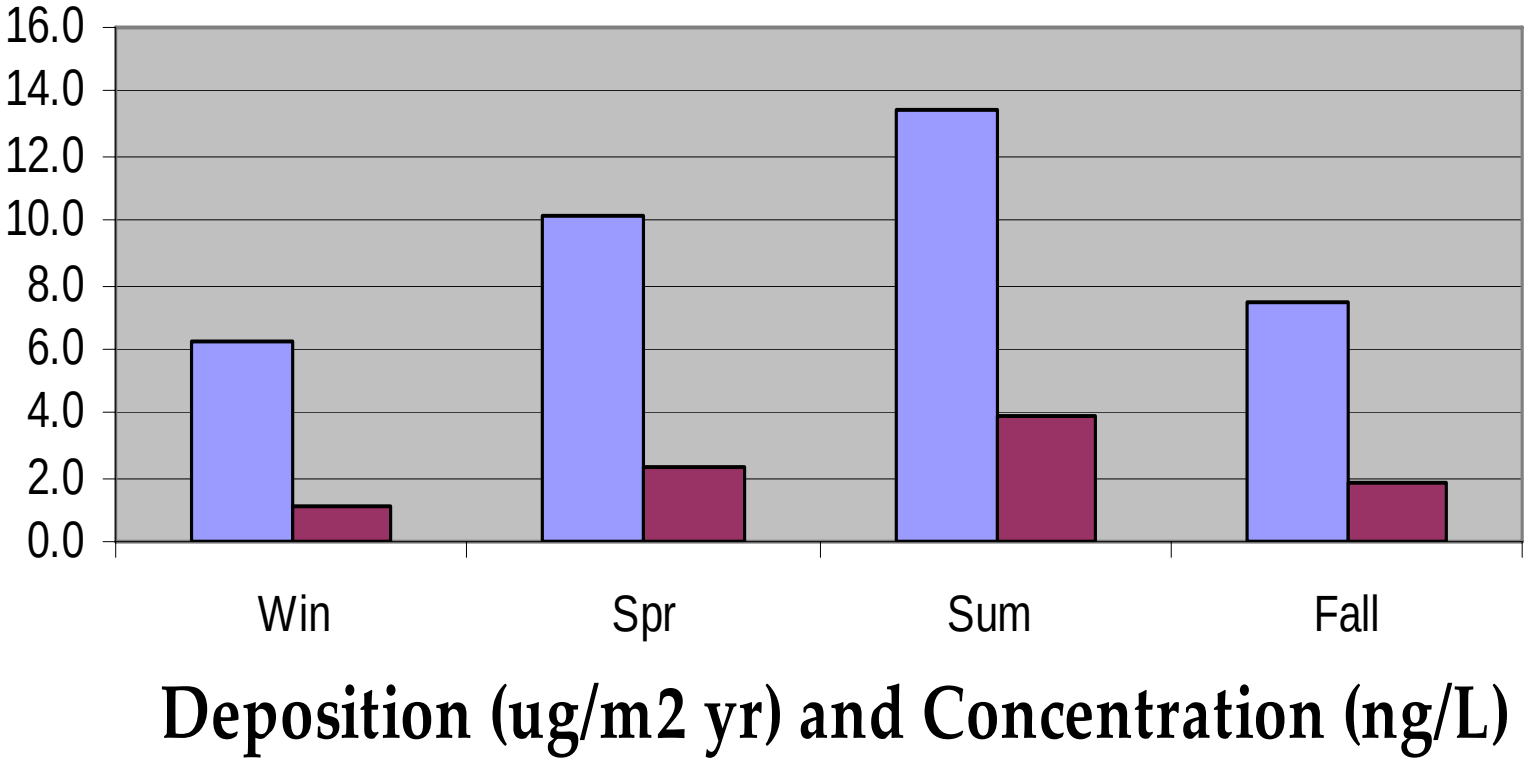
Mercury Wet Deposition
2004



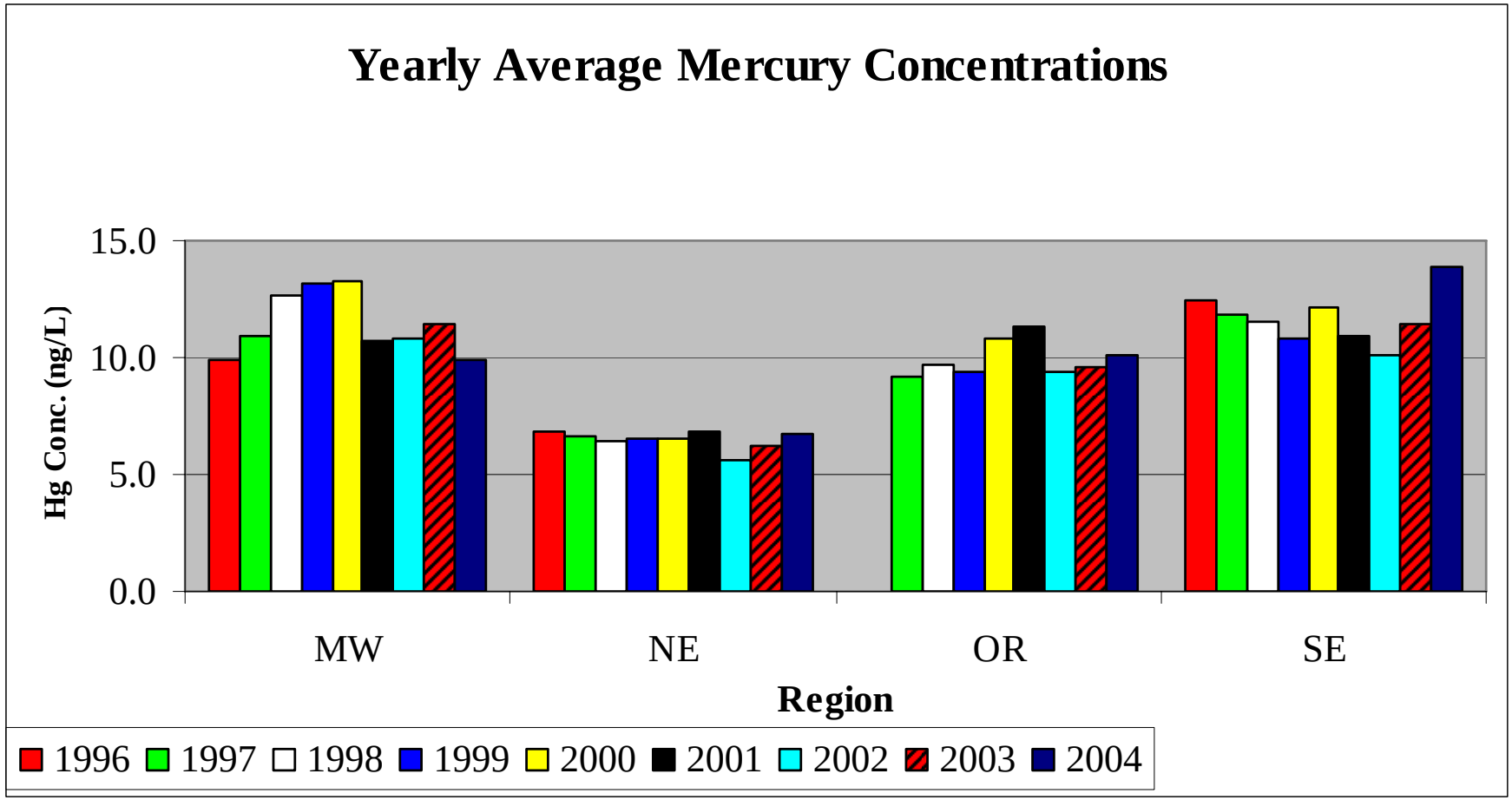
Average Mercury Wet Deposition 2001 to 2004

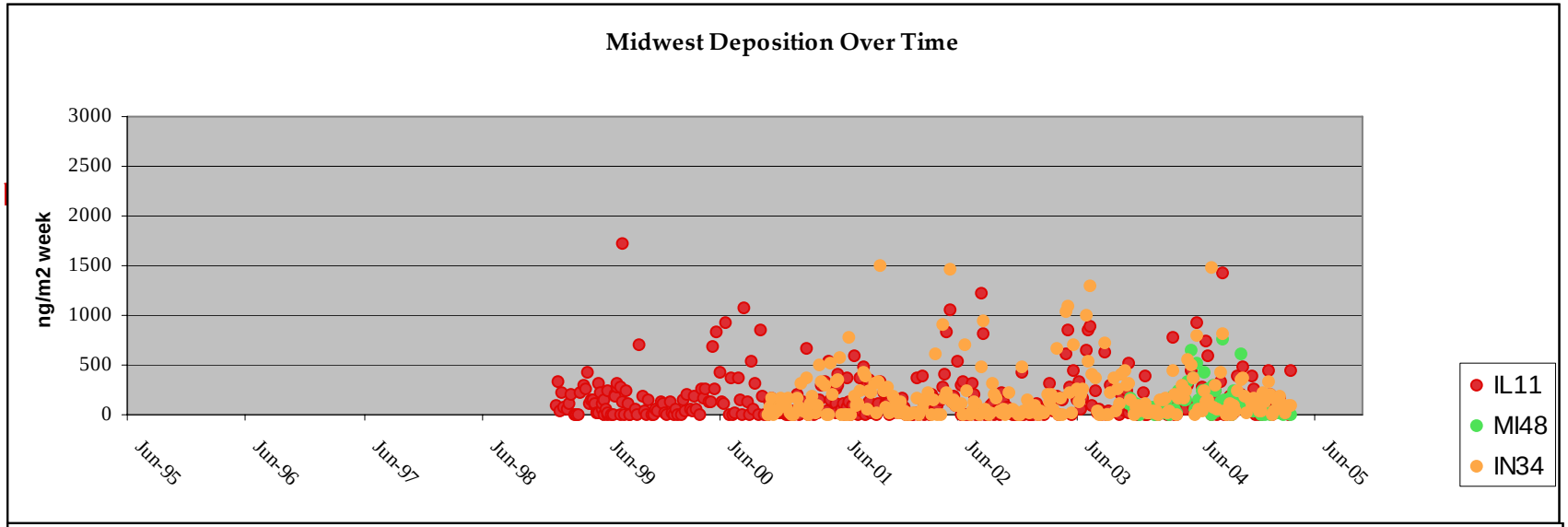


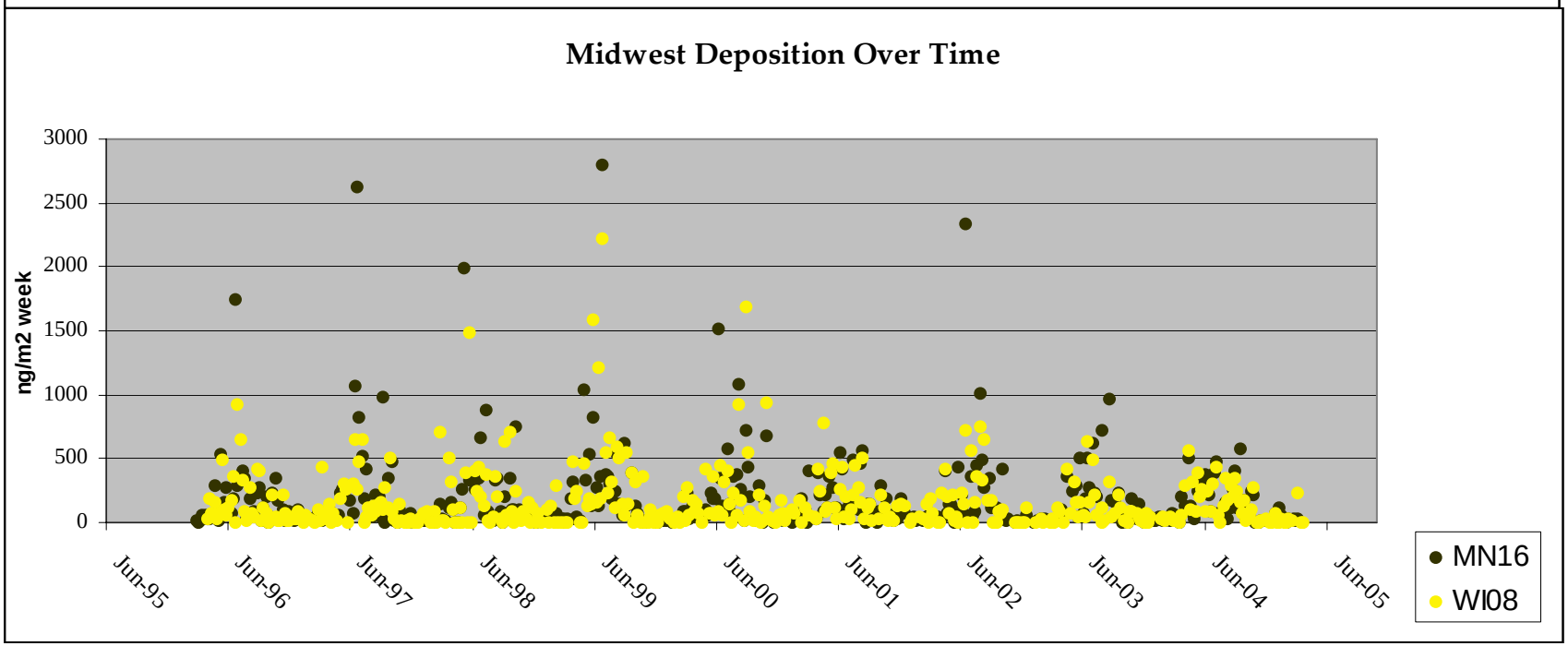
Seasonal Nature of Mercury



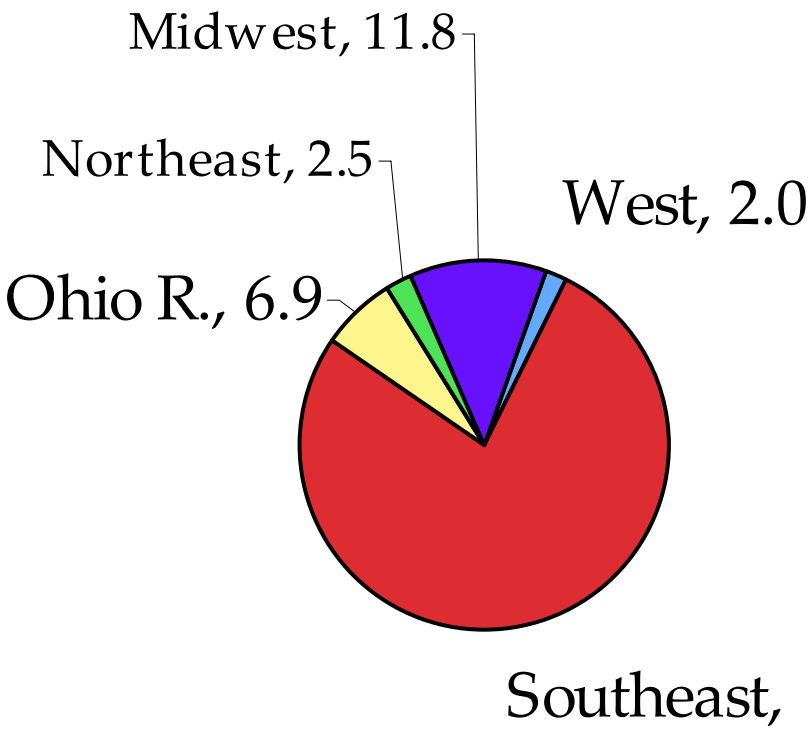
Deposition (ug/m2 yr) and Concentration (ng/L)


Yearly Average Mercury Concentrations
Hg Conc. (ng/L)
15.0
10.0
5.0
0.0
MW
NE
OR
SE
Region
1996
1997
1998
1999
2000
2001
2002
2003
2004


Midwest Deposition Over Time
ng/m2 week
3000
2500
2000
1500
1000
500
0
Jun-95
Jun-96
Jun-97
Jun-98
Jun-99
Jun-00
Jun-01
Jun-02
Jun-03
Jun-04
Jun-05
IL11
MI48
IN34


Midwest Deposition Over Time
ng/m2 week
3000
2500
2000
1500
1000
500
0
Jun-95
Jun-96
Jun-97
Jun-98
Jun-99
Jun-00
Jun-01
Jun-02
Jun-03
Jun-04
Jun-05
MN16
WI08

Large Deposition Events By Region
(> 1500 ug/m2, in percent)



Trends In Wet Deposition

Trend Methods

- Seasonal Kendall Test for Trends
- Seasonal Kendall Slope Estimator

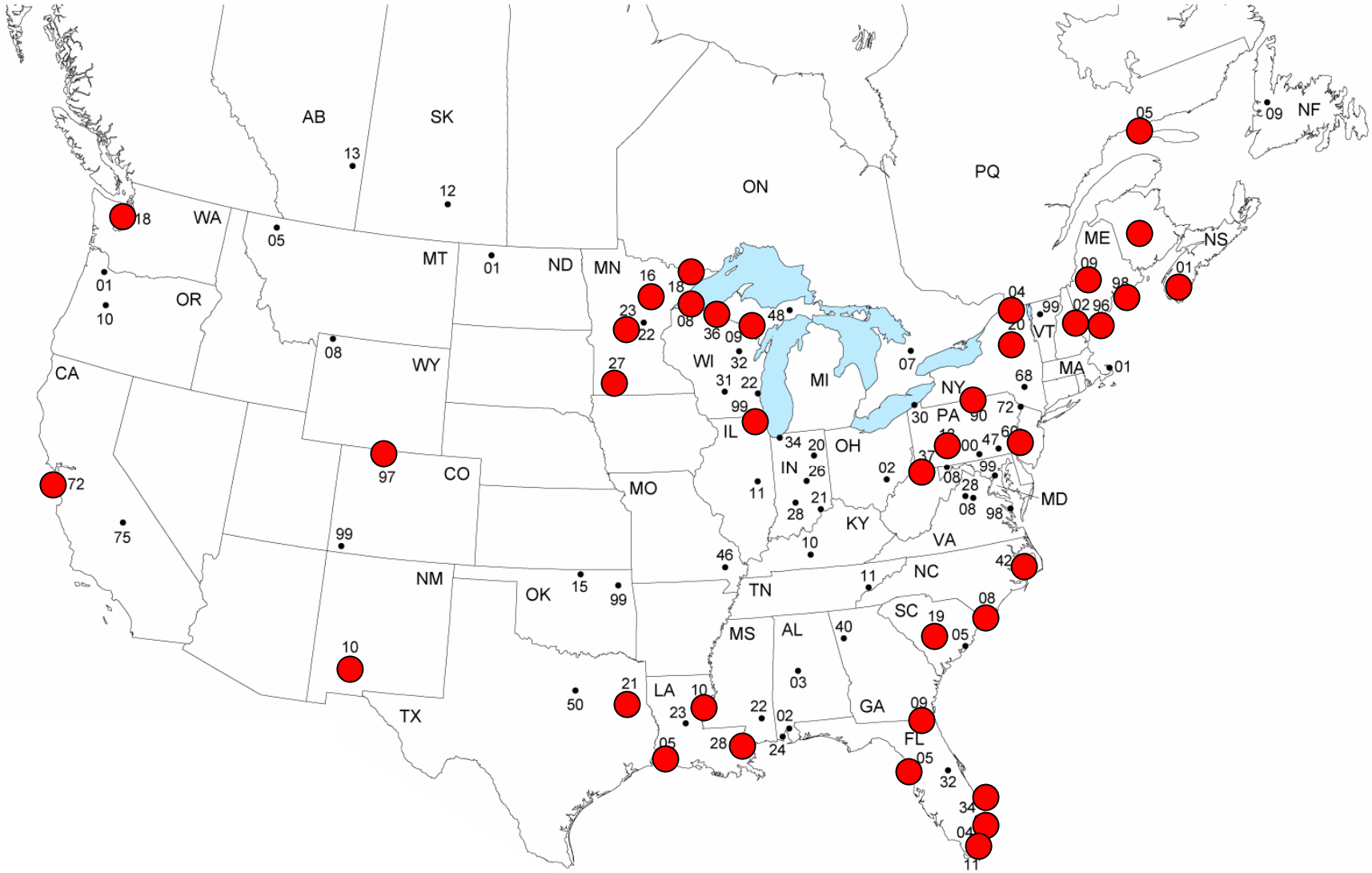
  - From the "Mann Kendall" as extended by van Belle and Hughes, 1984
  - non-parametric, normality not assumed
  - allows for seasonality and multiple stations
  - allows for missing data
  - from "Statistical Methods for Environmental Pollution Monitoring", R. O. Gilbert, 1987

  - Examines differences over time
    - Difference (obs1 – obs2) > 0, then =+1
    - < 0, then =-1
    - = 0, then = 0

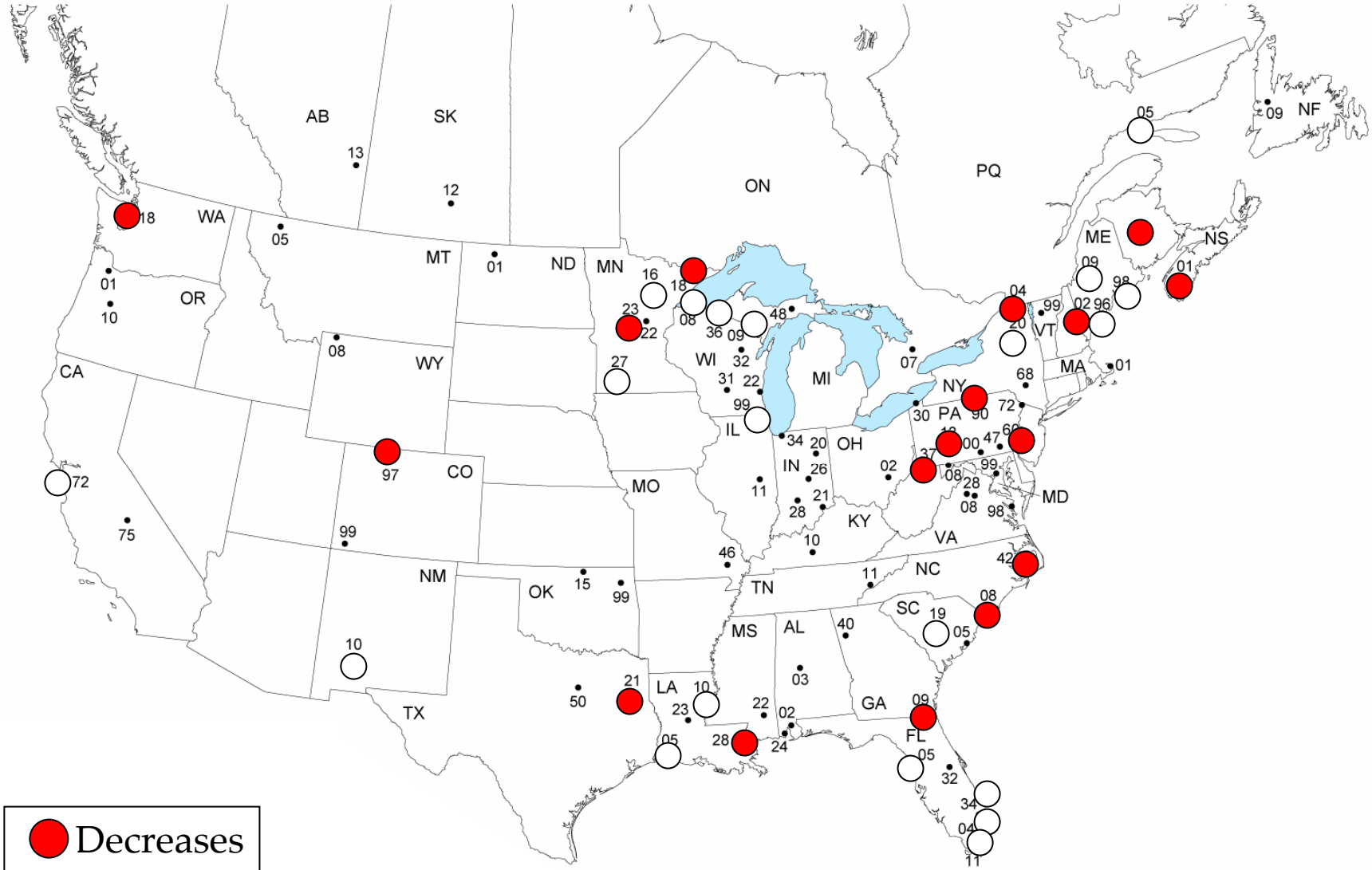
Conditions For Trend Observations

- 39 of 52 valid observations for 5 years at least
- Urban sites removed from regions
- Run seasonally (seasonal signal)
- "Trace" rain events removed
  - subppt < 0.128 mm
  - highly variable concentration

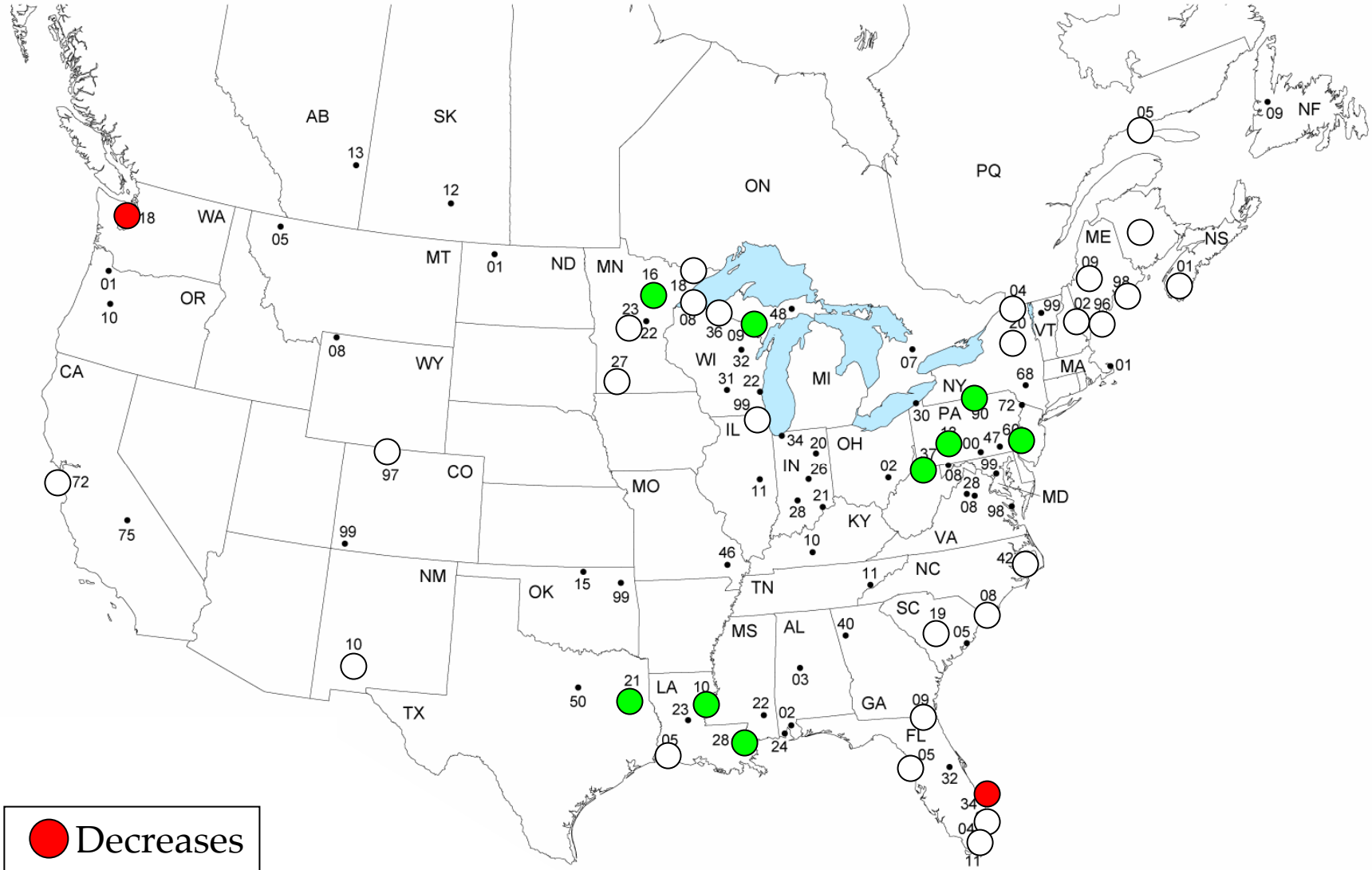
Sites Meeting Test Conditions for Trends



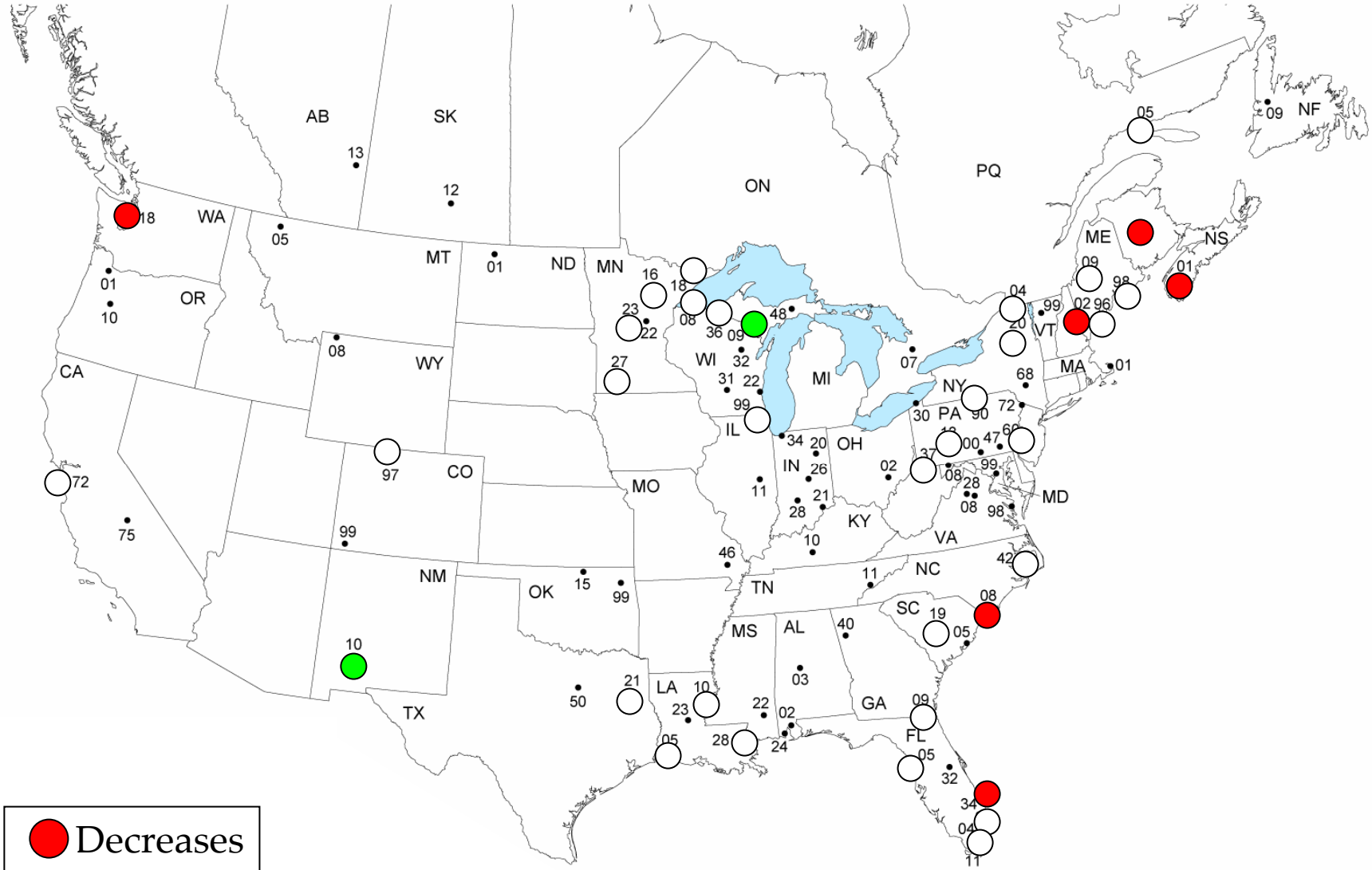
All Seasons Mercury Concentration Trends



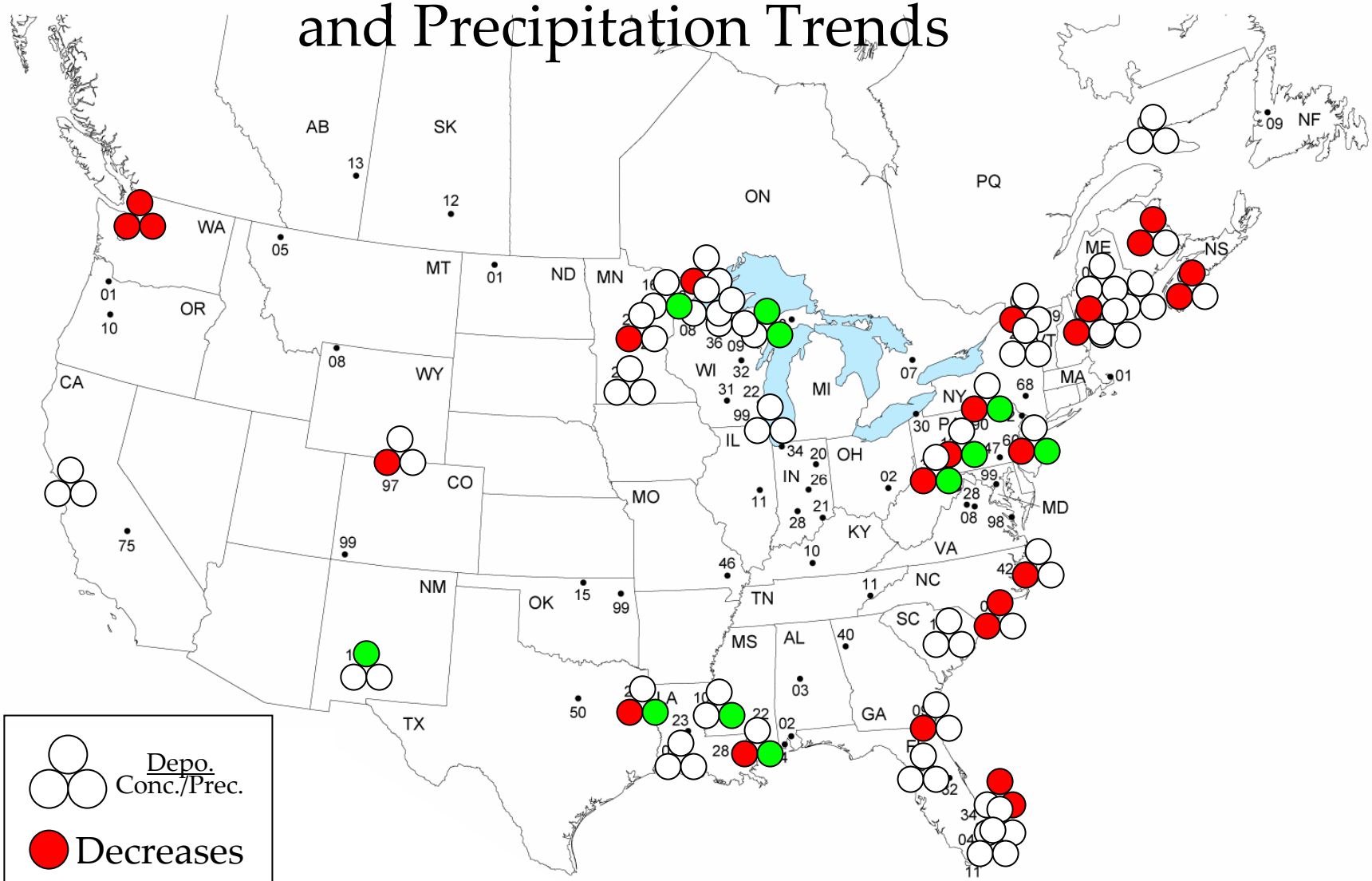
All Seasons Precipitation Trends



All Seasons Mercury Deposition Trends

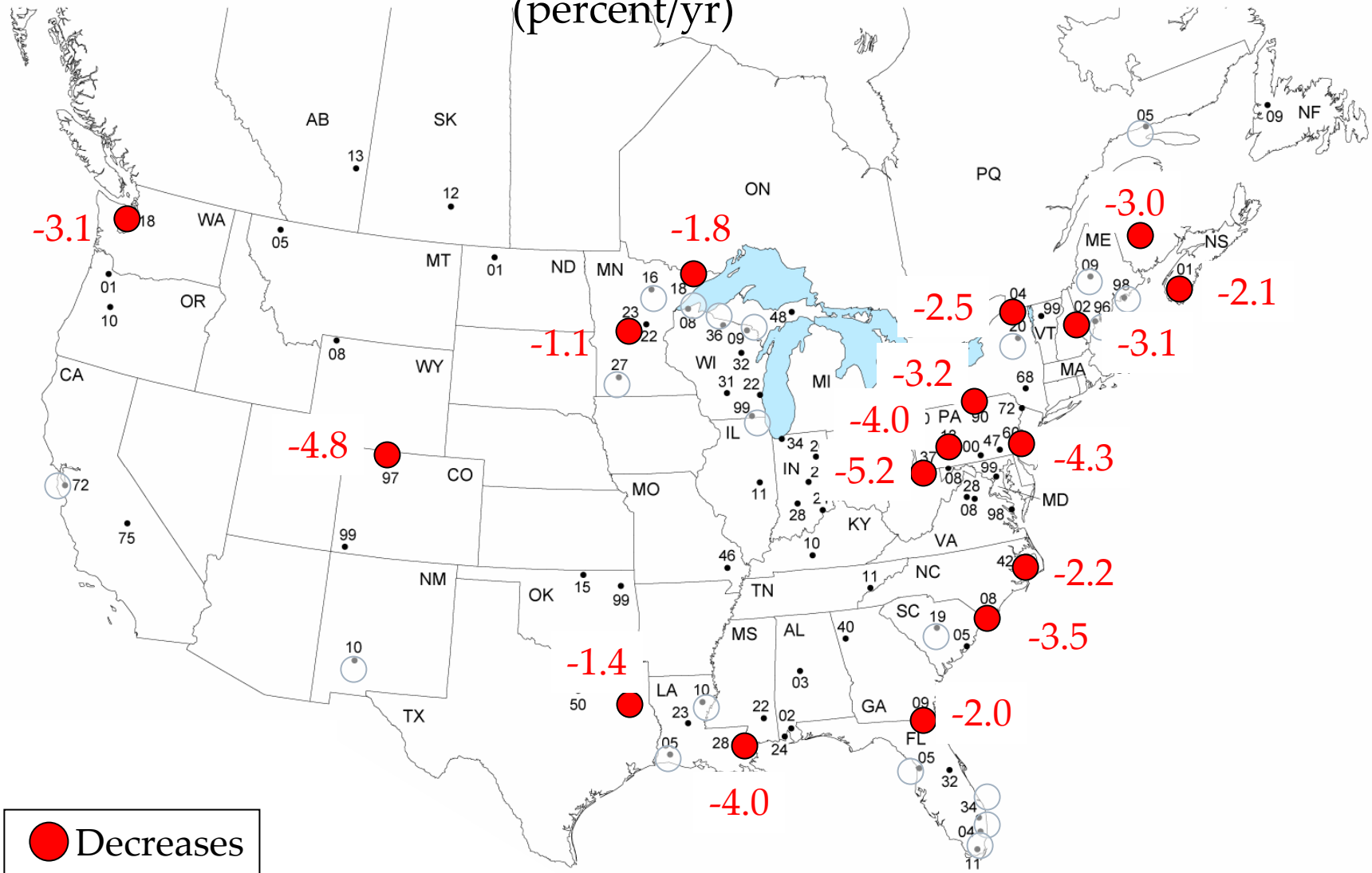


All Seasons Mercury Concentration, Deposition, and Precipitation Trends



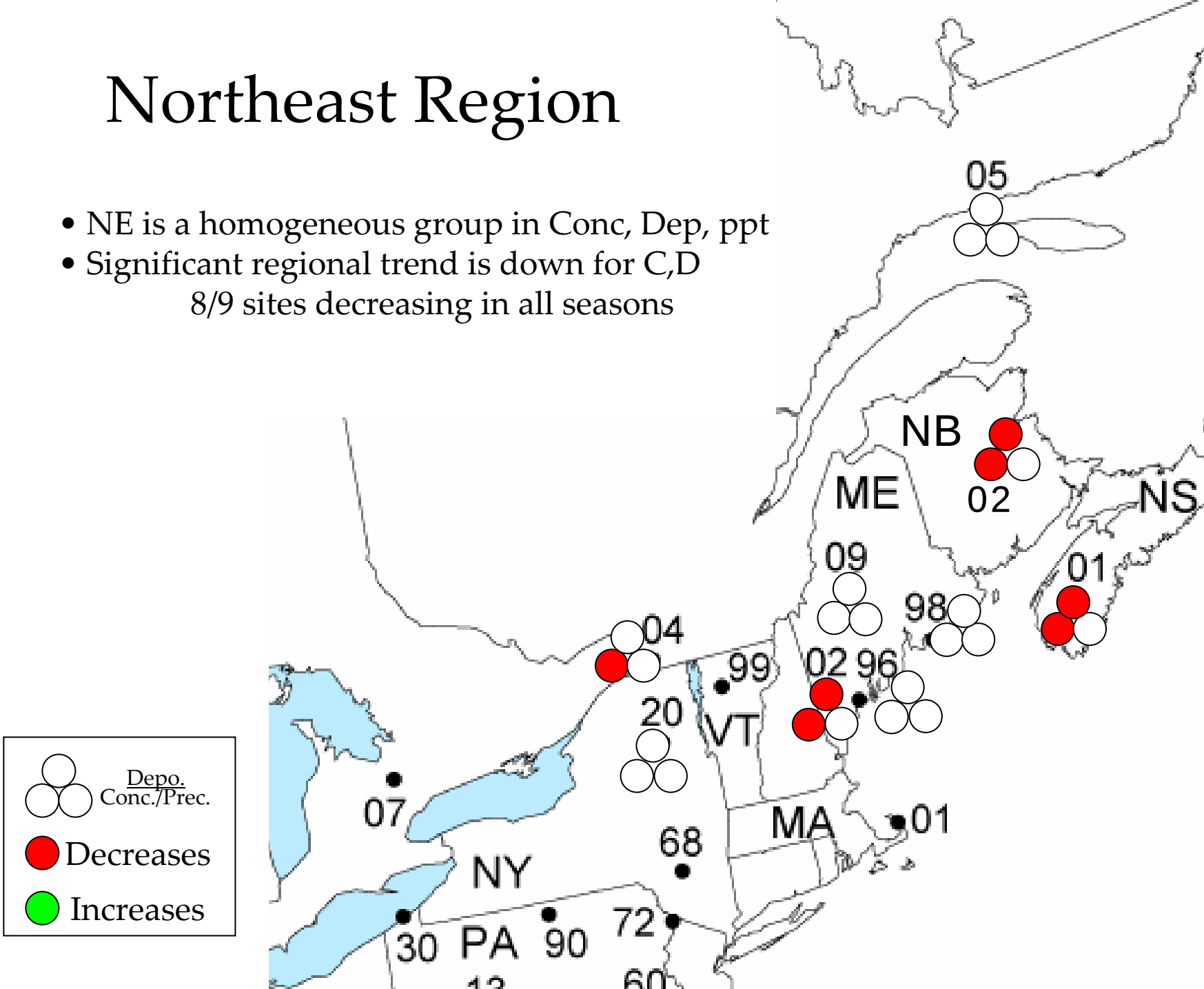
Mercury Concentration Trend Slopes

(percent/yr)



Northeast Region

- NE is a homogeneous group in Conc, Dep, ppt
- Significant regional trend is down for C,D
  8/9 sites decreasing in all seasons



Dry Deposition

- Very few measurements
- Modeled dry deposition

- Proposed MDN Initiative starting…

Summary

- Mercury concentration and deposition have reasonably consistent patterns over eastern US and Canada
- Trends, particularly in concentration, are negative for the majority of the country (1996 to 2004)
- No regional trends for the upper Midwest
  - Mixed concentration changes, particularly in Winter

Wet Deposition And Trends of Mercury in the U.S. and Canada, 1996-2004

Results from the NADP Mercury Deposition Network (MDN)

David Gay

(coauthors Eric Prestbo, Bob Brunette, Clyde Sweet)

Illinois State Water Survey
University of Illinois
Champaign, IL
dgay@uiuc.edu, (217) 244.0462
http://nadp.sws.uiuc.edu

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

A Cooperative Research Support Program of the State Agricultural Experiment Stations (NRSP-3) Federal and State Agencies and Private Research Organizations

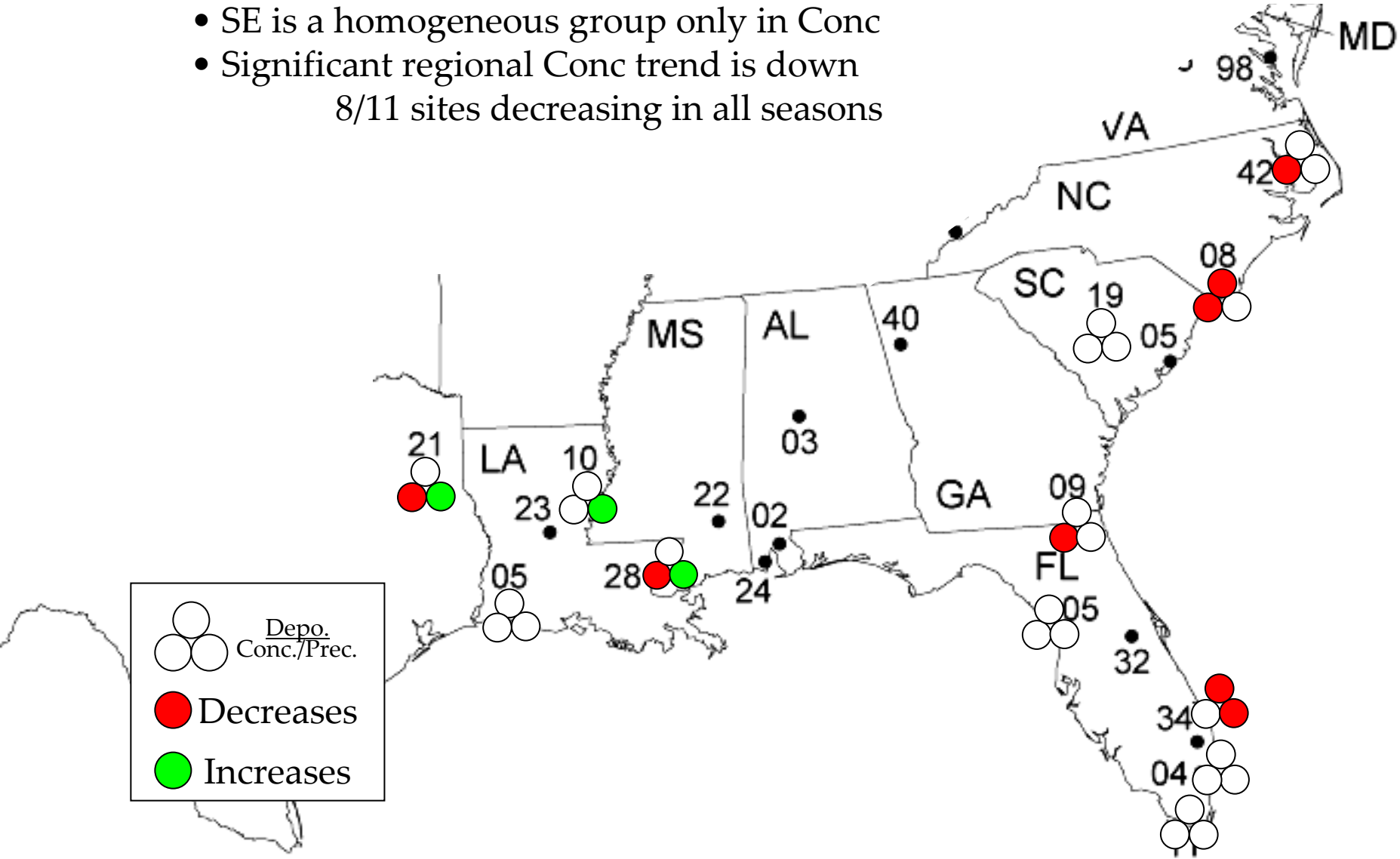
ILLINOIS

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

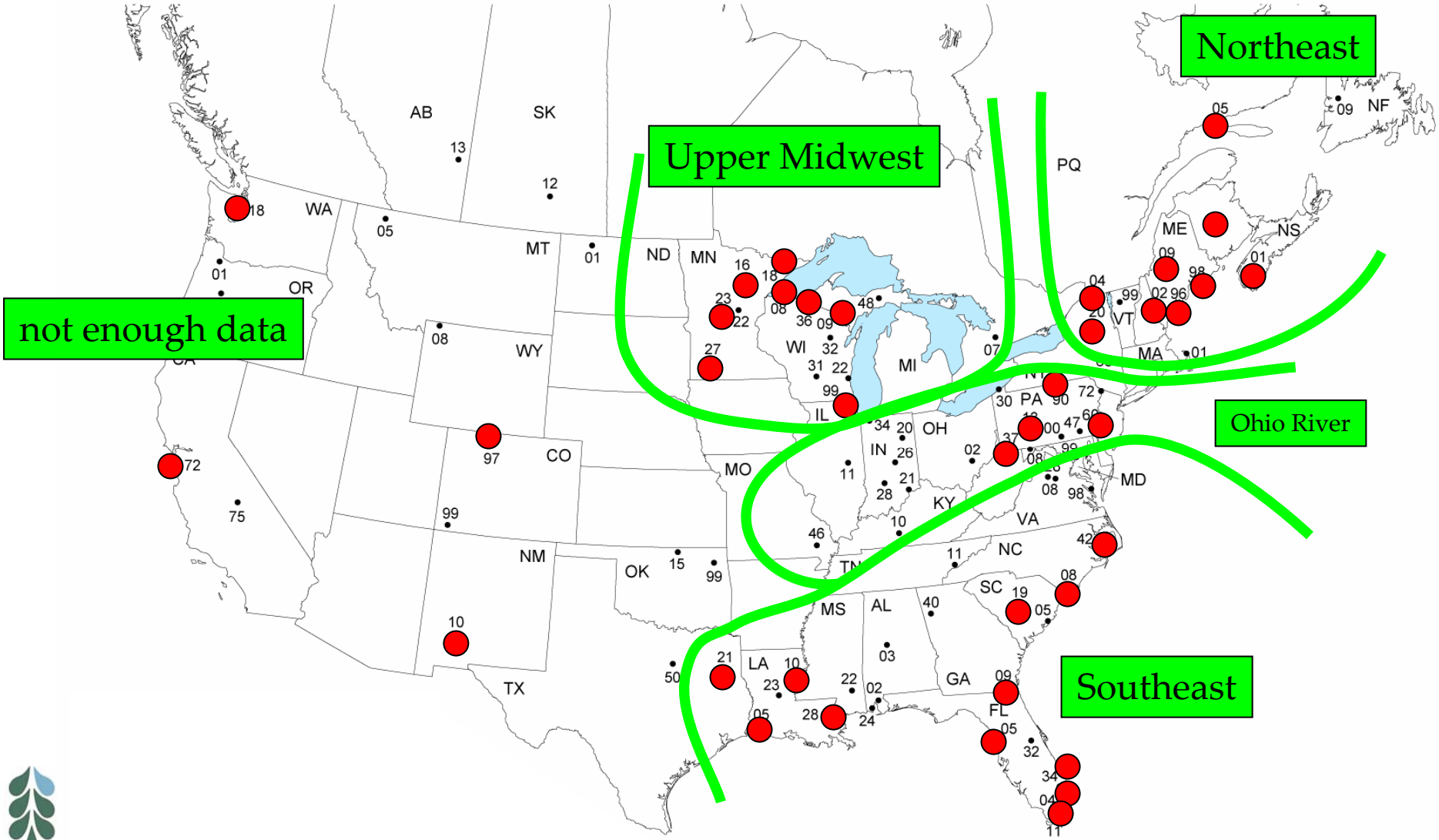
Illinois State WATER Survey (1895)

Southeast Region

- SE is a homogeneous group only in Conc
- Significant regional Conc trend is down
  8/11 sites decreasing in all seasons



Regions and Sites Tested for Trends

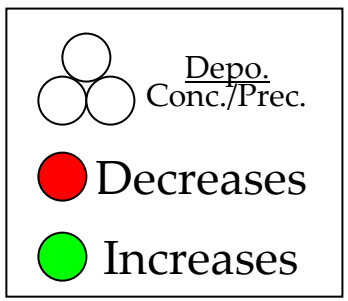


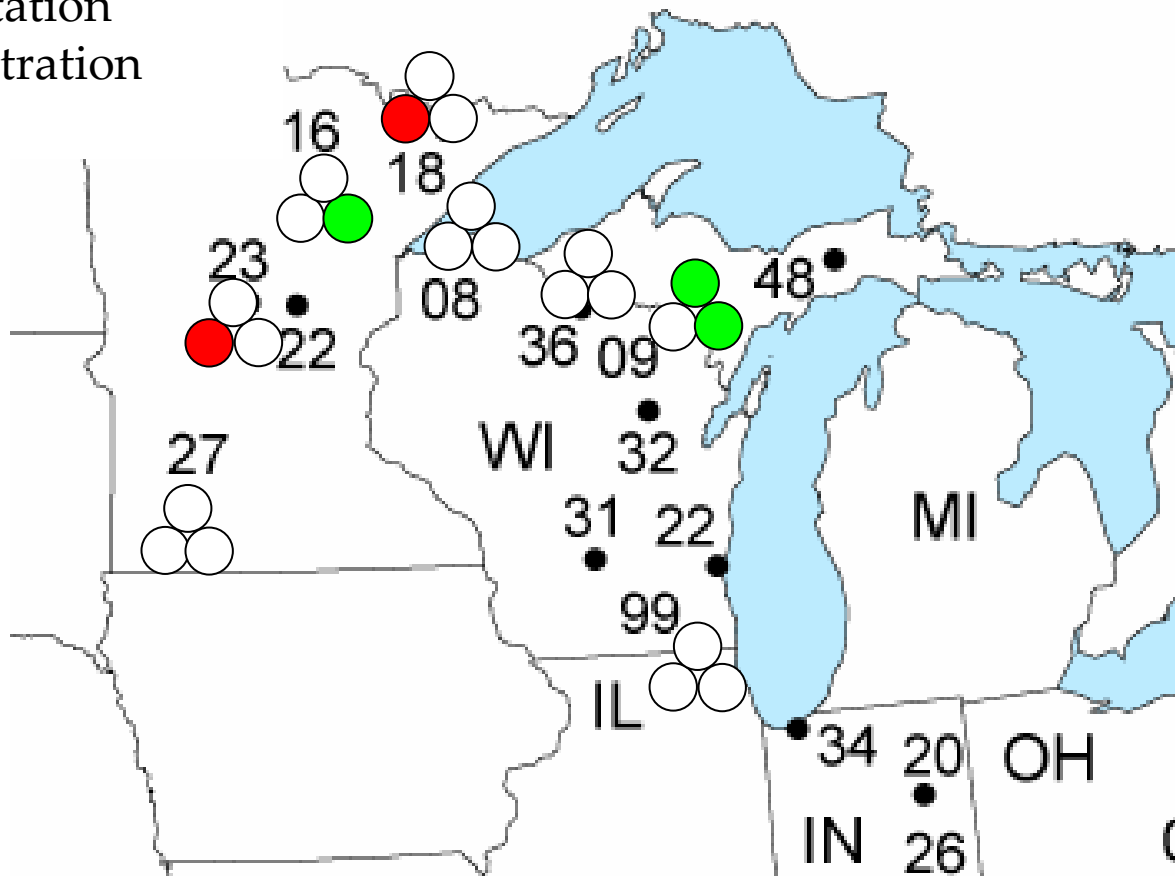
Upper Midwest Region

- MW is a homogeneous group in Dep, ppt
- Concentration, stations independent
  - seasonal differences present

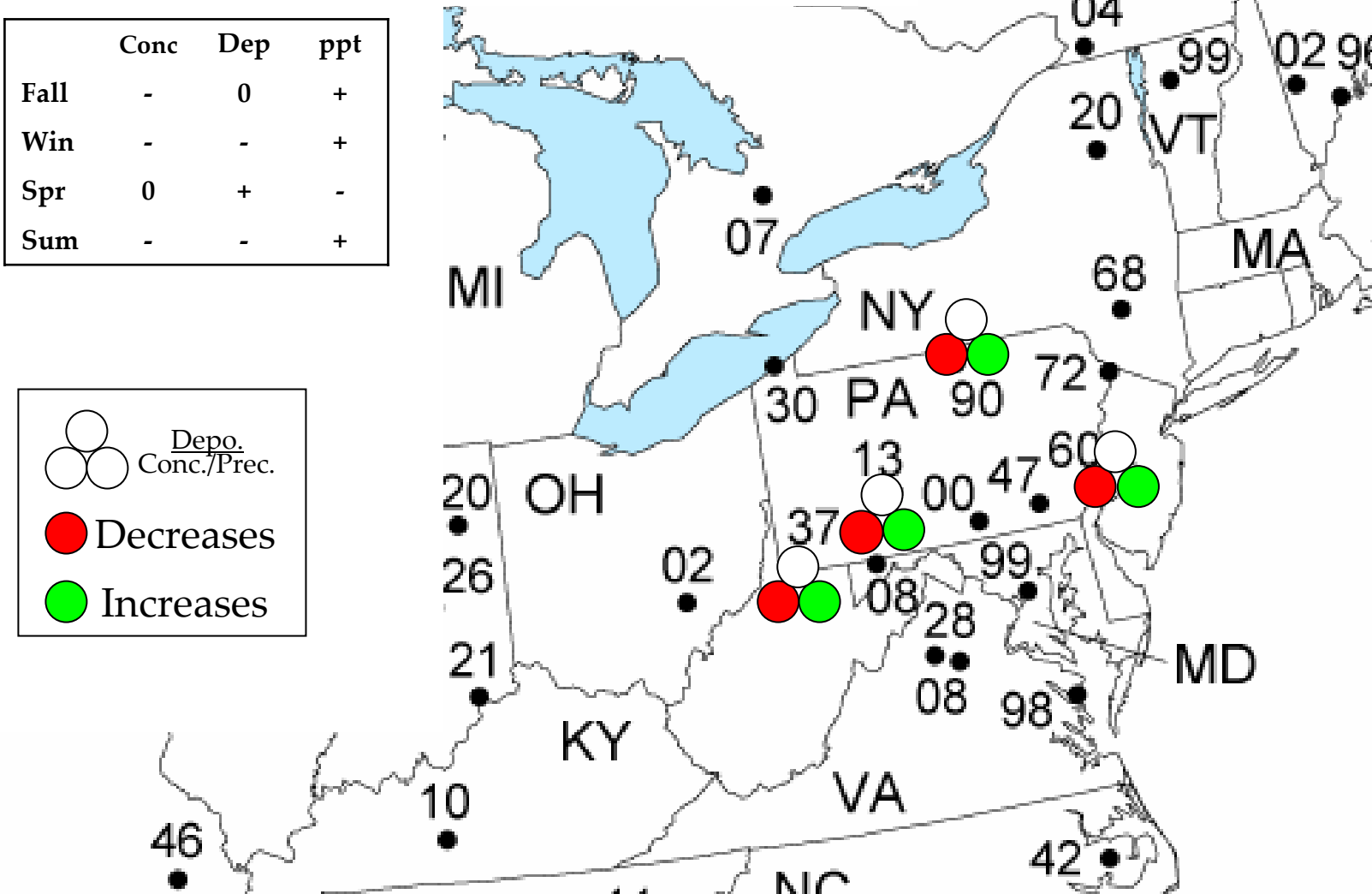
- NO regional trend in Deposition
- NO regional trend in precipitation
- NO regional trend in Concentration

	Seasonal Conc
Fall	-
Win	+
Spr	-
Sum	0





Ohio River Region

- OR (Penn) is a homogeneous group for Conc, Dep, ppt
- But no significant regional trends
- Seasons are showing different changes:

	Conc	Dep	ppt
Fall	-	0	+
Win	-	-	+
Spr	0	+	-
Sum	-	-	+