# The National Atmospheric Deposition Program (NADP)

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National Atmospheric Deposition Program

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# Mission of the National Atmospheric Deposition Program (NADP)

- Provide data on the exposure of managed and natural ecosystems and cultural resources to acidic compounds, nutrients, mercury, and base cations in precipitation.
- Remain one of the nation's premier cooperative research support programs, serving science and education and supporting communication and informed decisions on air quality issues affecting ecosystems and human health.

# A Cooperative Research Program

All decisions made by scientific consensus of supporting agencies and individuals

(equal vote, regardless of affiliation)

- Field Equipment
- Analytical Procedures
- Data Analysis

National Atmospheric Deposition Program

# Some of our Funders

## (100+ total agencies)

Federal Agency Members

Tribal Organizations

Universities

US States

Other Organizations

# National Atmospheric Deposition Program (NADP) Stations

NTN – National Trends Network (acidic precipitation), since 1978

MDN – Mercury Deposition Network (mercury in precipitation), since 1995

AIRMoN – Atmospheric Integrated Research Monitoring Network (acidic precipitation events), since 1992

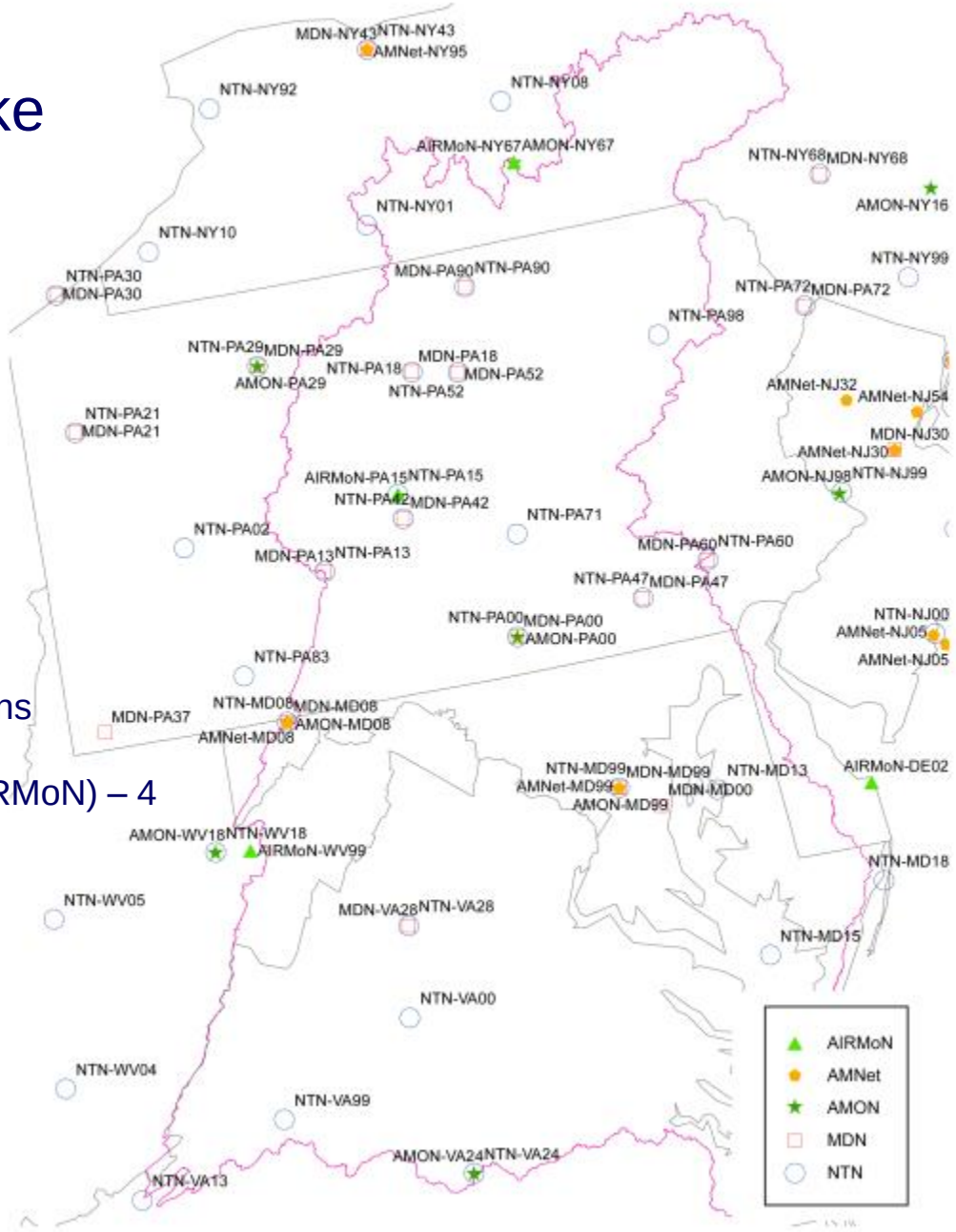
AMNet – Ambient Mercury Network (gaseous mercury), since 2009

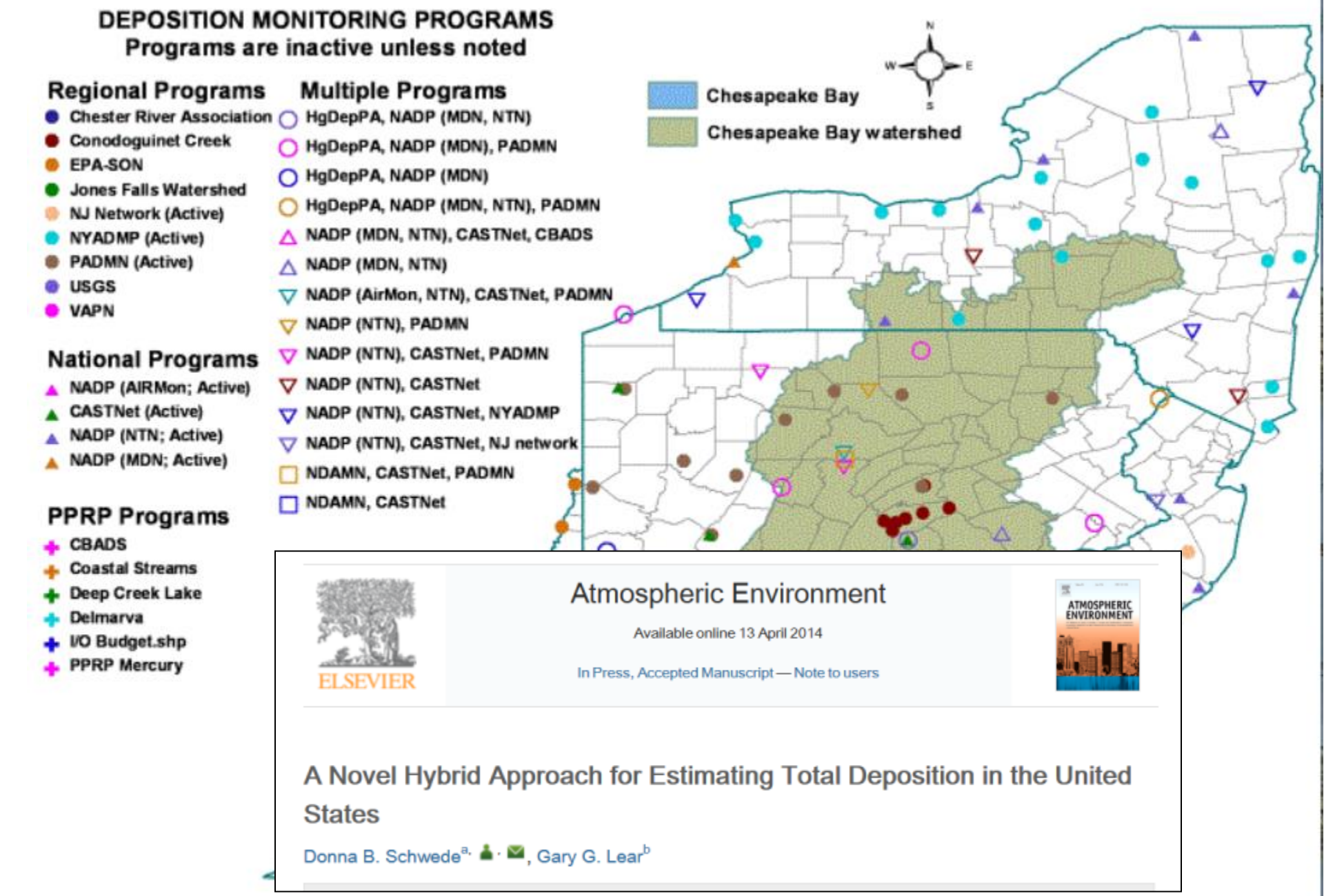
**AMoN – Ammonia Monitoring Network (gaseous ammonia), since 2007**


Not Shown:
Argentina (NTN)
Taiwan (AMNet)

# NADP Monitoring Locations in Chesapeake Bay Watershed

National Trends Network (NTN) ~24 stations
Mercury Deposition Network (MDN) – 12
Atmos. Integrated Research Mon. Net. (AIRMoN) – 4
Atmos. Mercury Mon. Net. (AMNet) – 2
Ammonia Monitoring Network (AMoN) - 4



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Atmospheric Environment

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In Press, Accepted Manuscript — Note to users



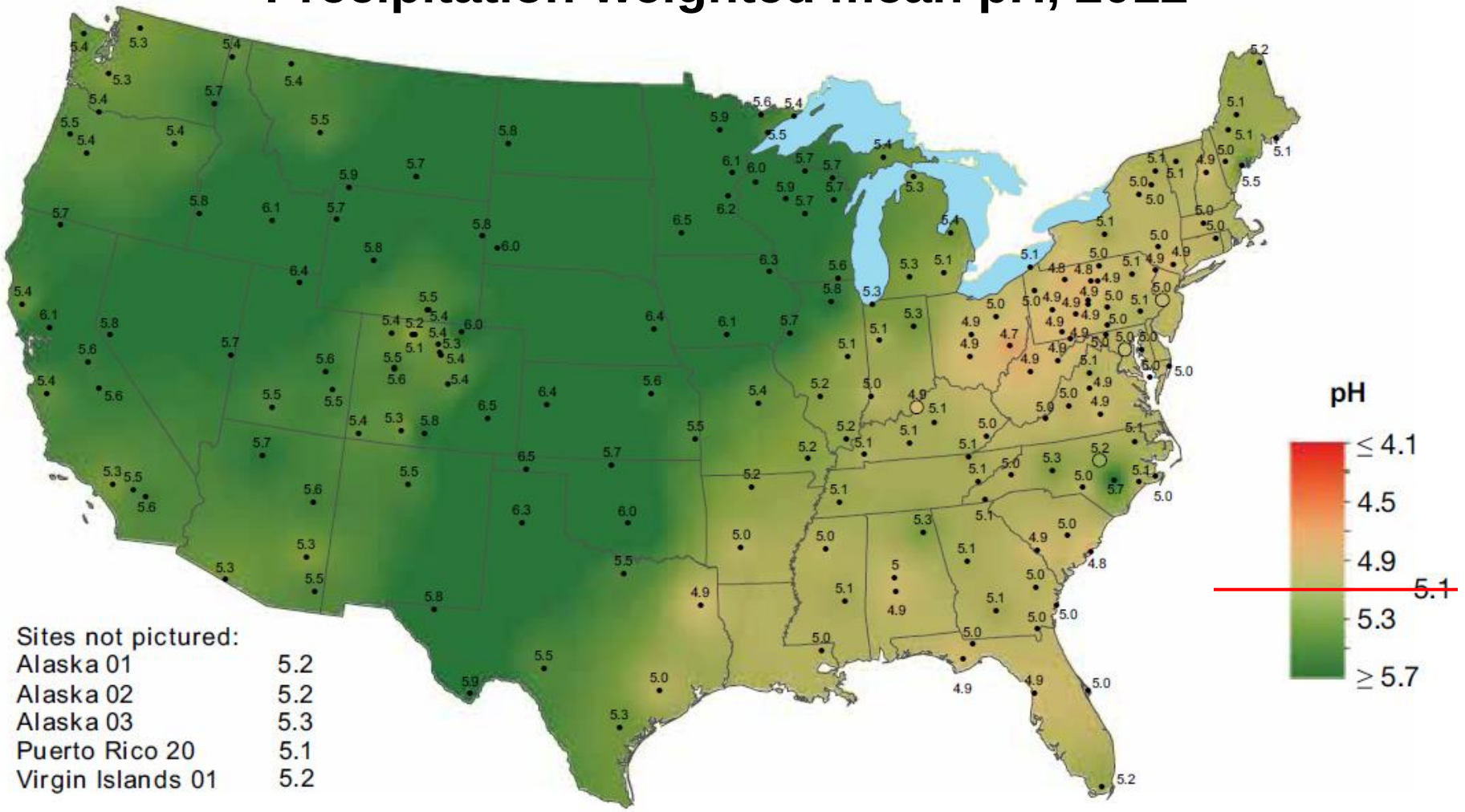

## A Novel Hybrid Approach for Estimating Total Deposition in the United States

Donna B. Schwede[a], Gary G. Lear[b]

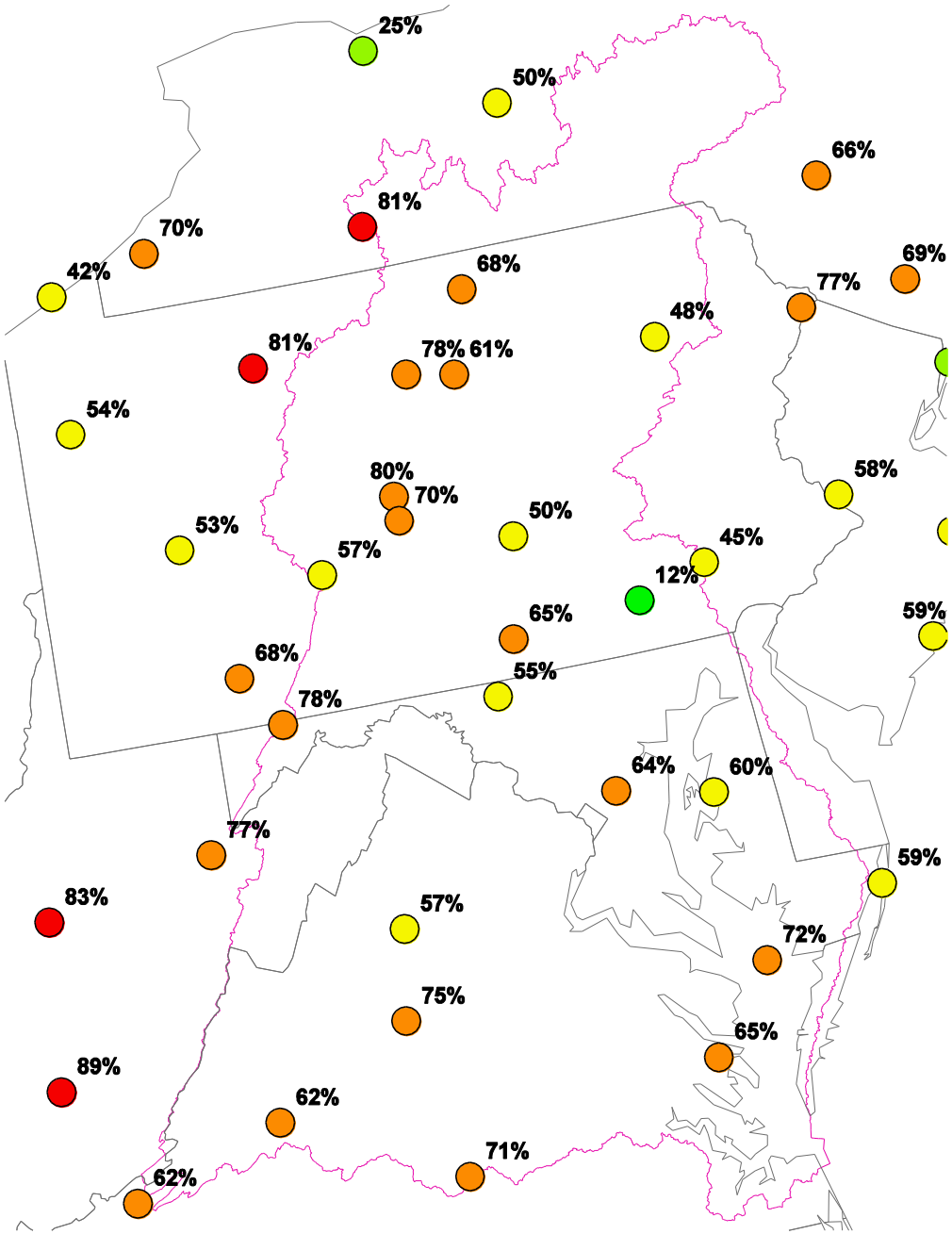
*Source: http://esm.versar.com/pprp/features/Atmosdep/atmosdep.htm*

# Is “Acid Rain” still an issue for the US?

**Precipitation-weighted mean pH, 2012**



# Frequency of Acidic Precipitation (pH < 5.1) in Chesapeake Bay Region, 2010 - 2013

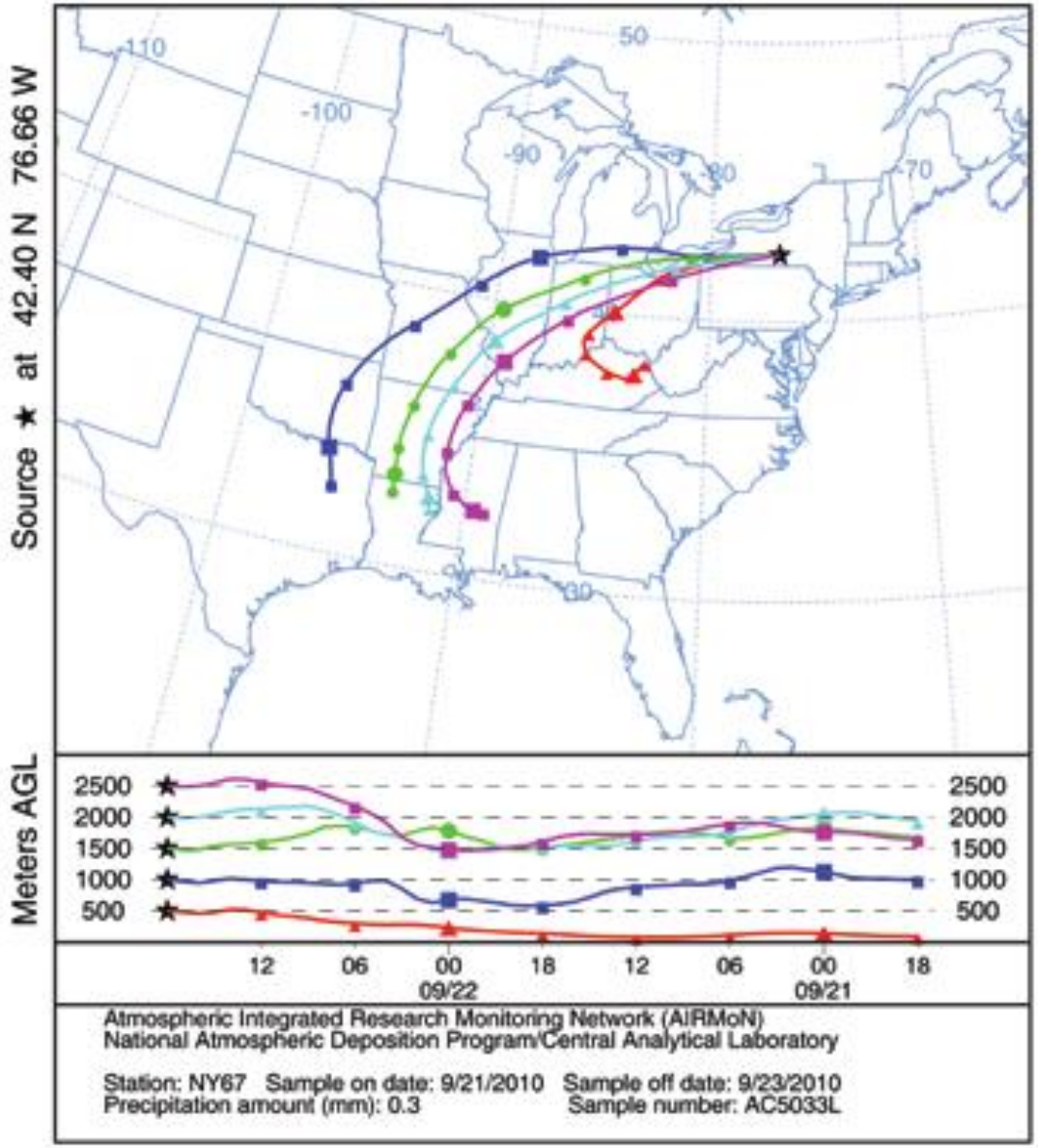


# National Trends Network (NTN)

- Operators collect weekly wet deposition sample from NADP wet-dry collector
- Continuous precipitation record
- Chemical Analysis
  - Acids ($SO_4^{2-}$, $NO_3^-$, $Cl^-$, $Br^-$)
  - Bases ($Ca^{2+}$, $Mg^{2+}$, $K^+$, $Na^+$)
  - Nutrients ($NH_4^+$, $PO_4^{3-}$)
  - pH
  - Specific Conductivity

# The NADP Networks (I)

1. National Trends Network (NTN)
   - Major ions (cations, anions, pH, conductivity)
   - 264 sites + 2 QA
   - ~380,000+ weekly samples since 1978
2. Atmospheric Integrated Research Monitoring Network (AIRMoN)
   - Major ions (cations, anions, pH, conductivity)
   - Refrigerated event samples
   - 6 sites; ~30,000 samples since 1992



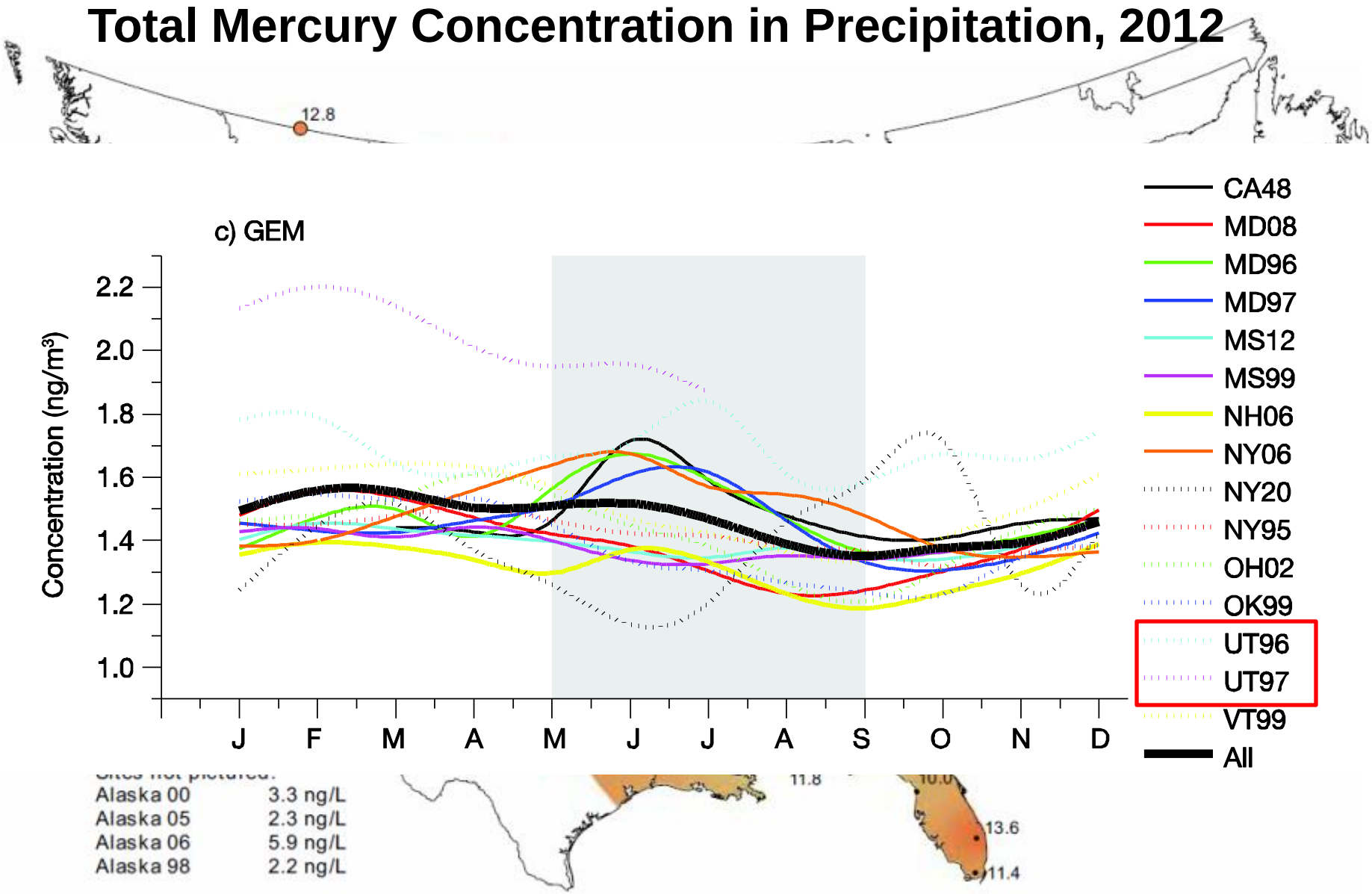

*Example back trajectories from the NOAA/HYSPLIT model.*

# The NADP Networks (II)

3. Mercury Deposition Network (MDN)
   - Mercury, methyl mercury concentrations
   - 110 sites; ~70,000 samples since 1996
4. Atmospheric Mercury Monitoring Network (AMNet)
   - Gas-phase speciated mercury concentrations
   - 23 sites; hourly data since 2006

# Atmospheric Mercury Monitoring Network (AMNet)

# Total Mercury Concentration in Precipitation, 2012



# The NADP Networks (III)

5. Ammonia Monitoring Network (AMoN)
   - Atmospheric ammonia concentrations
   - 64 sites; ~5,500 samples since 2007

# AMoN Average Concentration 2012

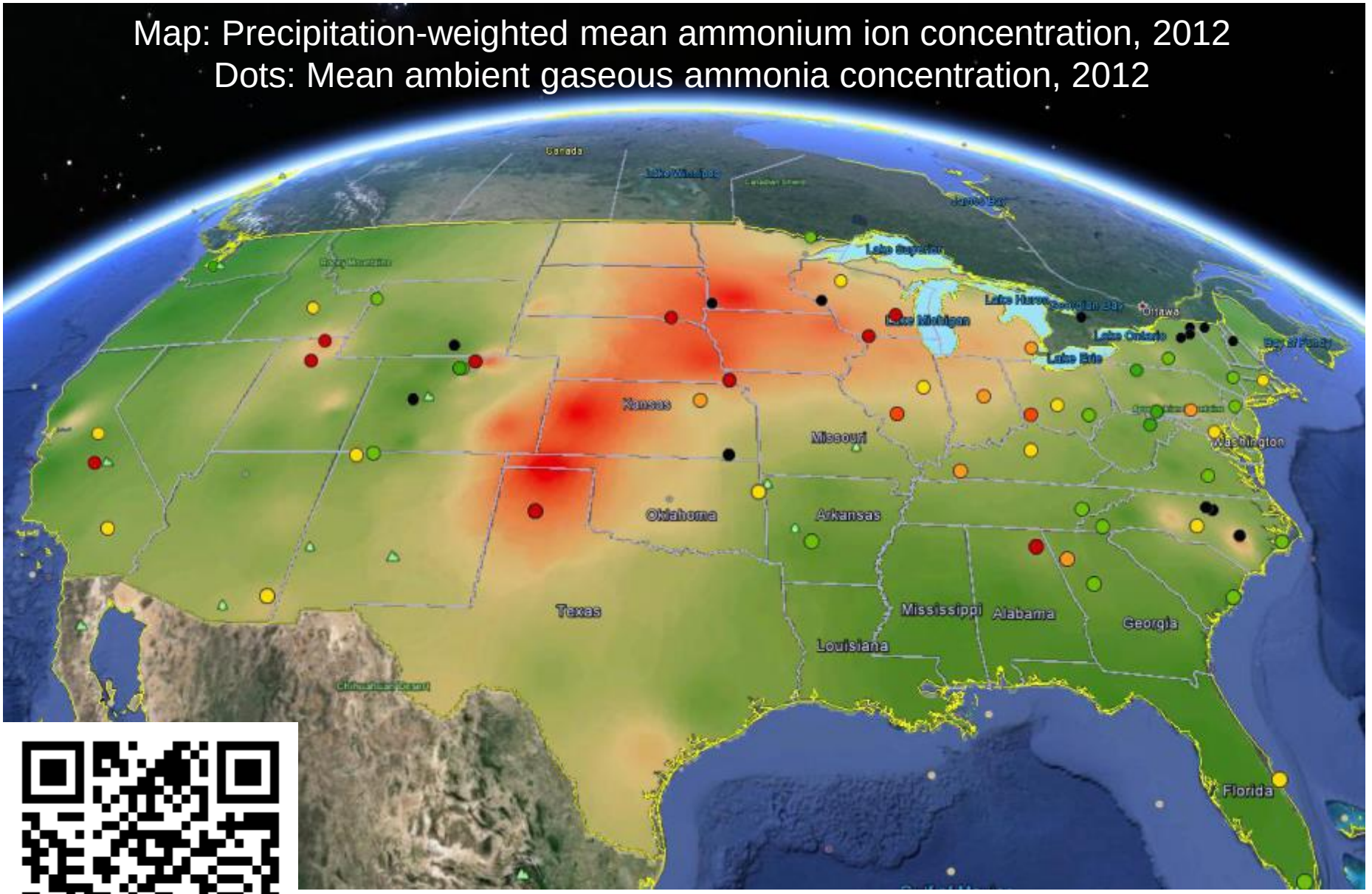



**radiello** is patented by
FONDAZIONE SALVATORE MAUGERI-IRCCS
Centro di Ricerche Ambientali - via Svizzera, 16 - 35127 PADOVA

# AMoN Methodology

- Sampler Type
  - Radiello-type passive diffusive sampler (PDS)
- Field Deployment
  - 2 week deployments in NADP-provided field shelter, 2 m height
- Laboratory Analysis
  - Flow injection analysis (FIA) colorimetry for ammonium ion

Map: Precipitation-weighted mean ammonium ion concentration, 2012
Dots: Mean ambient gaseous ammonia concentration, 2012




http://go.illinois.edu/NADPAmonMap

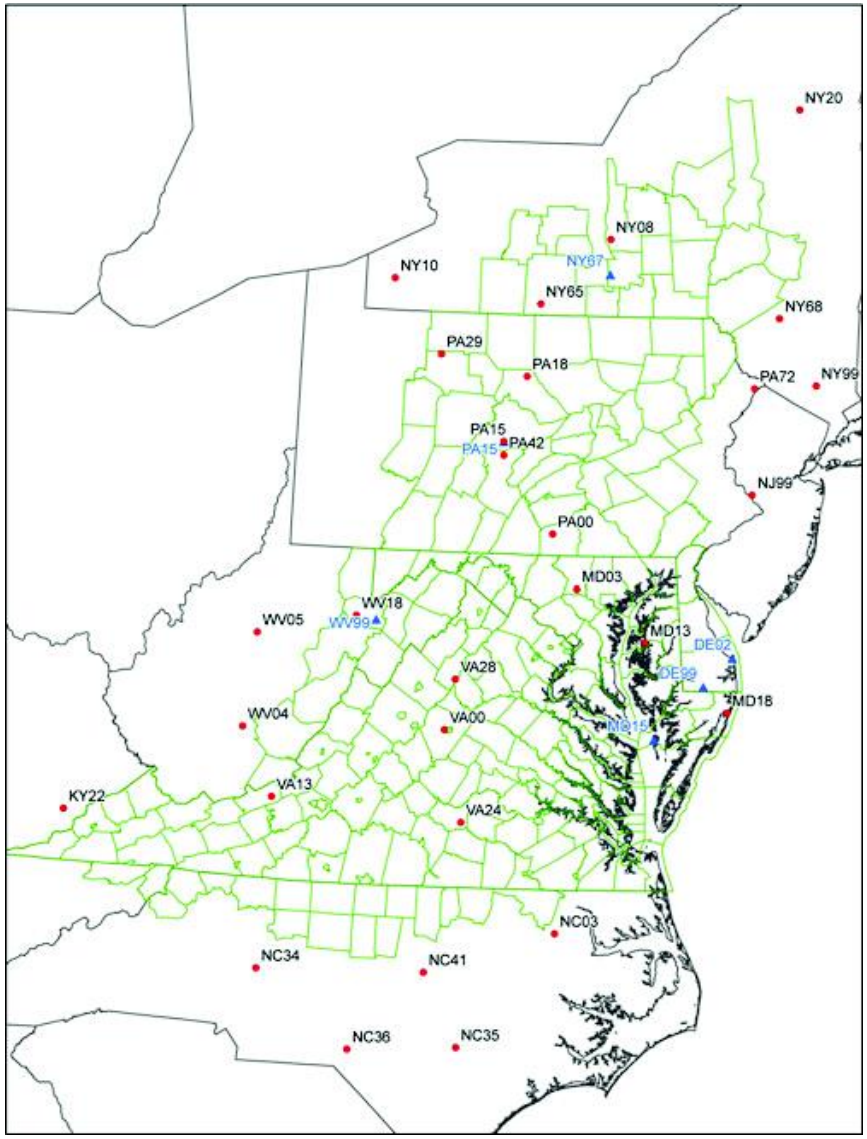
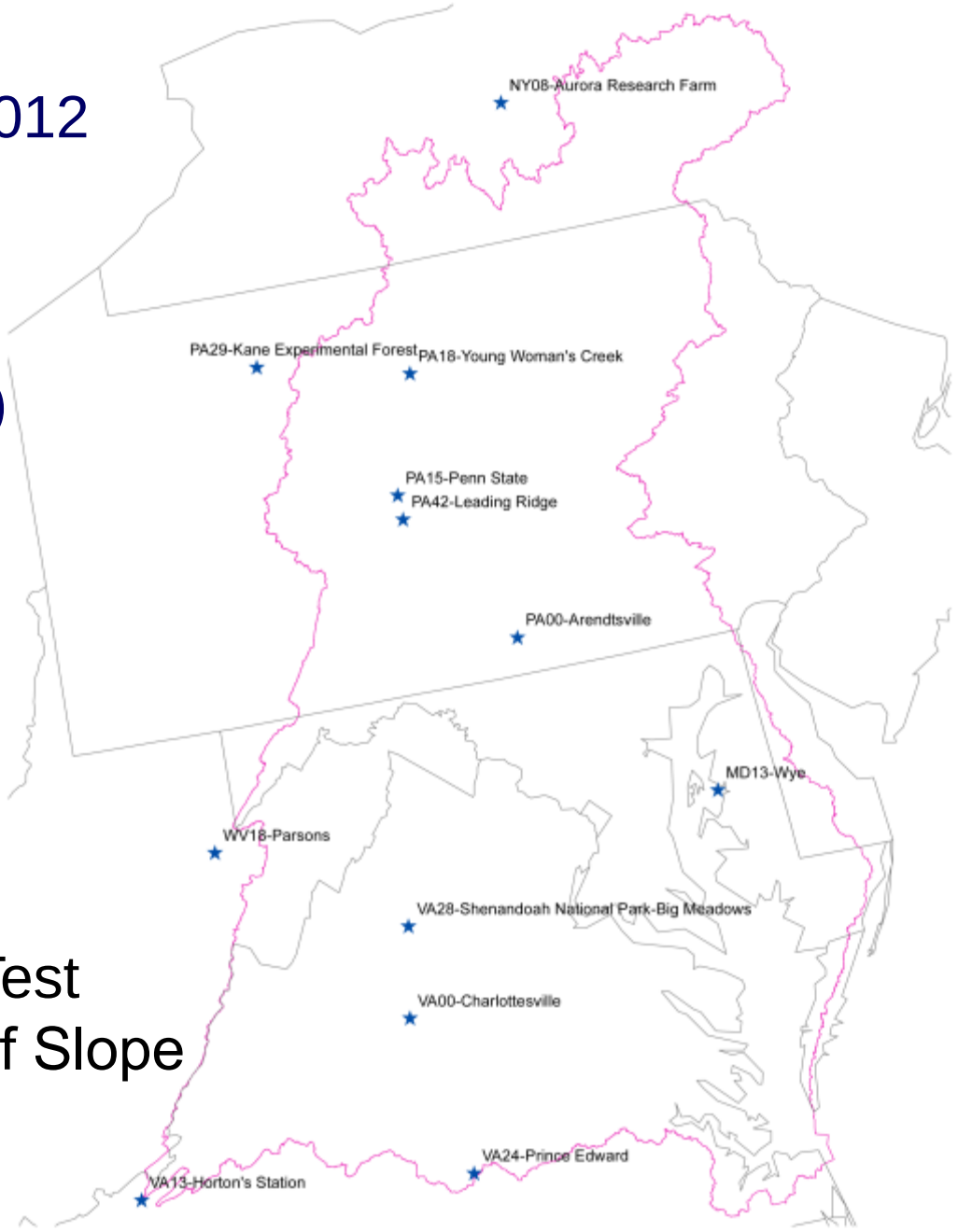


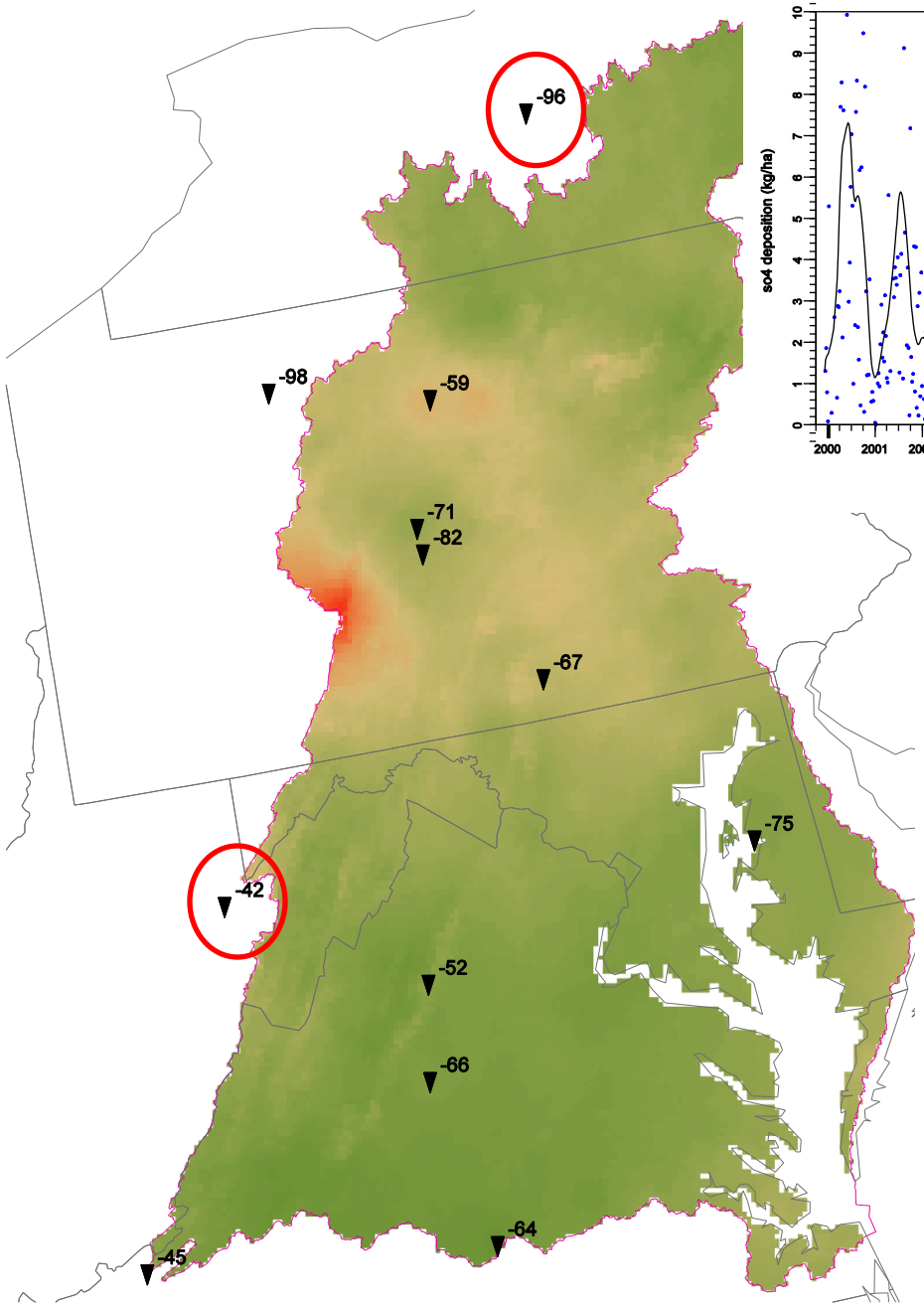

FIGURE 2. Locations of the 29 National Atmospheric Deposition Program/National Trends Network (circle) and 6 AIRMoN (triangle) Precipitation Chemistry Monitoring Sites Used for Development of the Wetfall Regression Model. Figure 2 also shows the land segments of the watershed model, which are the smallest spatial units of atmospheric deposition estimates used in the Chesapeake Total Maximum Daily Load (Shenk and Linker, this issue).

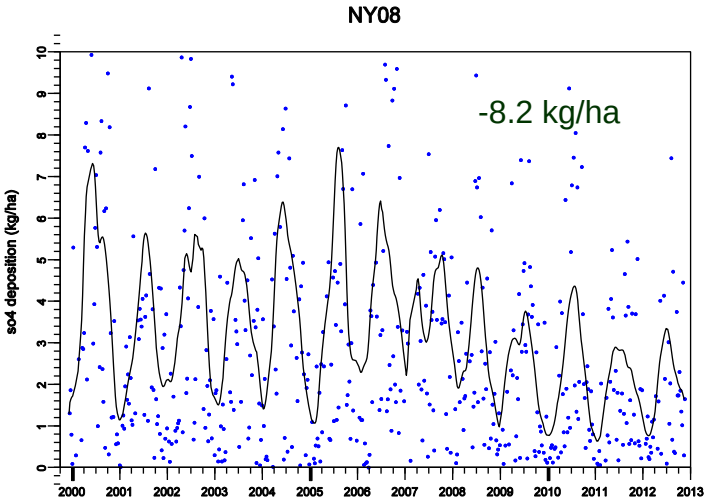
# Wet Deposition Trends in Chesapeake Bay, 2000-2012

- $SO_4$
- $NO_3$
- $NH_4$
- Inorganic-N ($NO_3$+$NH_4$)



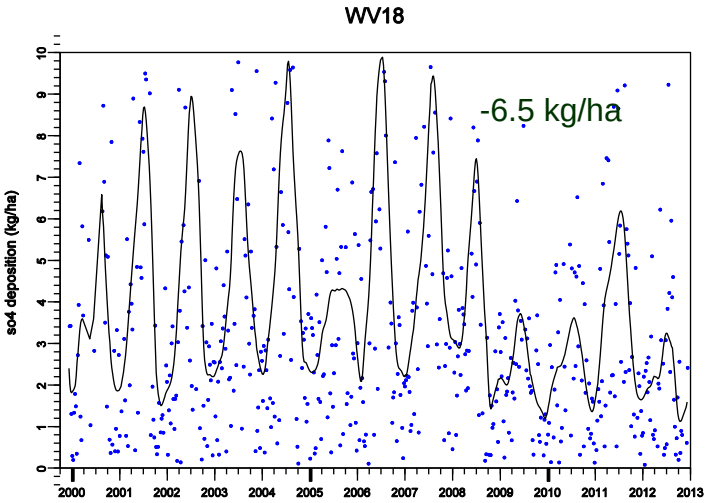

Seasonal Kendall Trend Test
Sen's Median Estimator of Slope



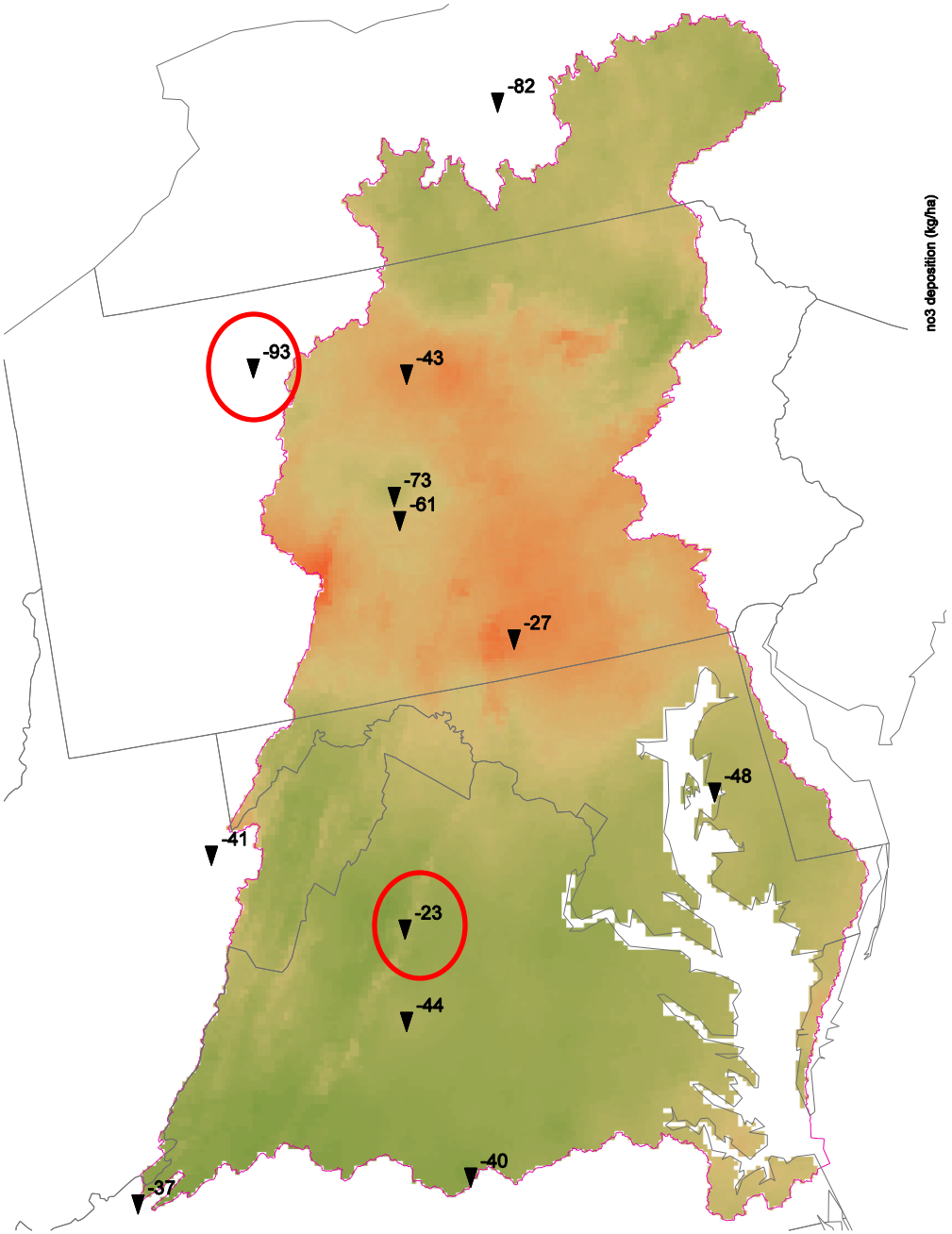

sition, 2012
- 2012

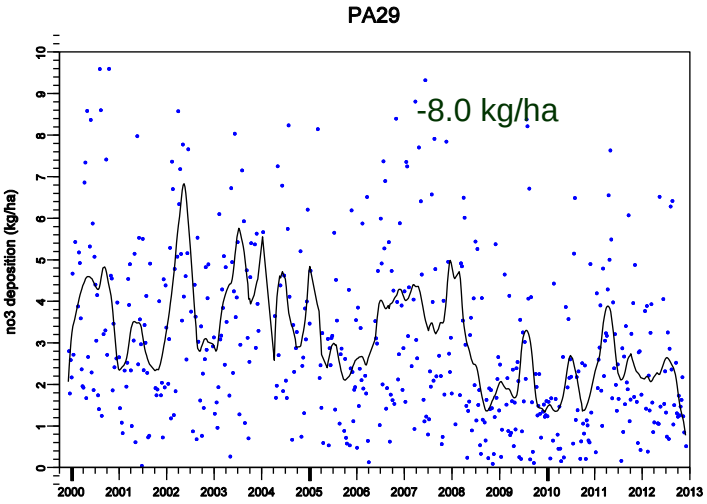
~22% of watershed has deposition > 10 kg/ha-yr



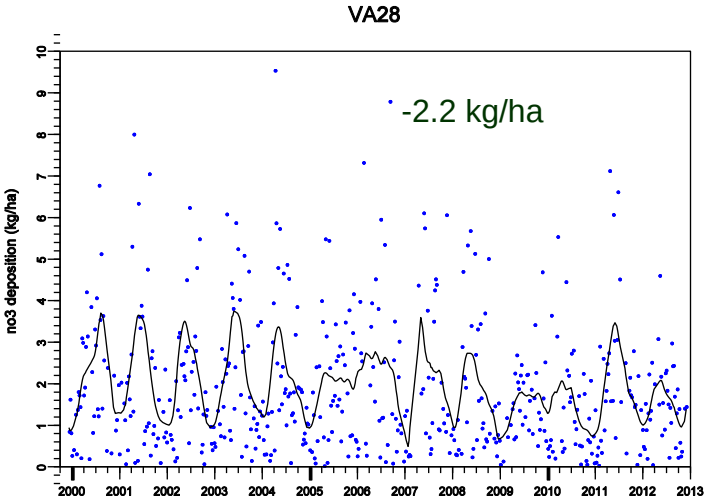

0

▼ Trend, %

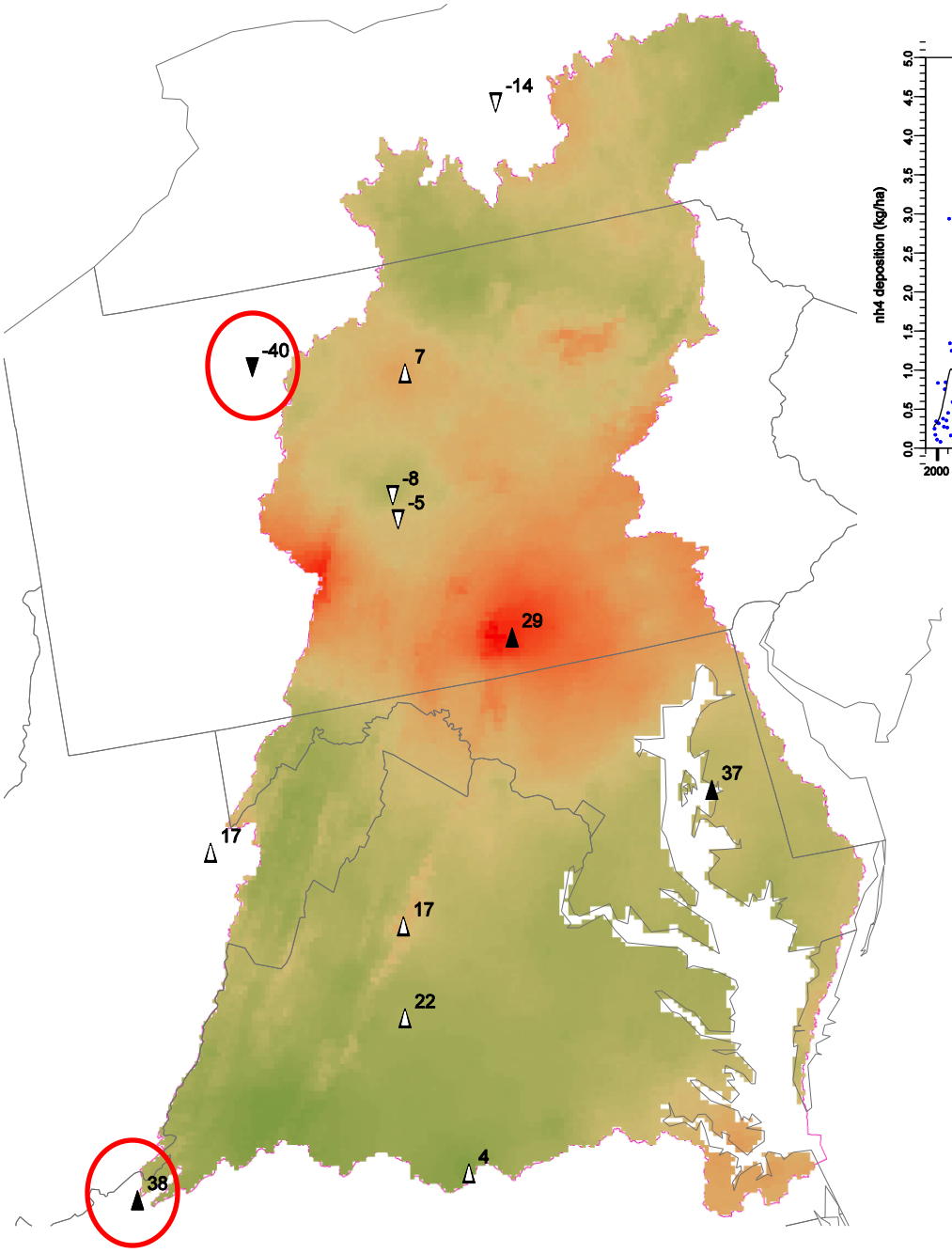


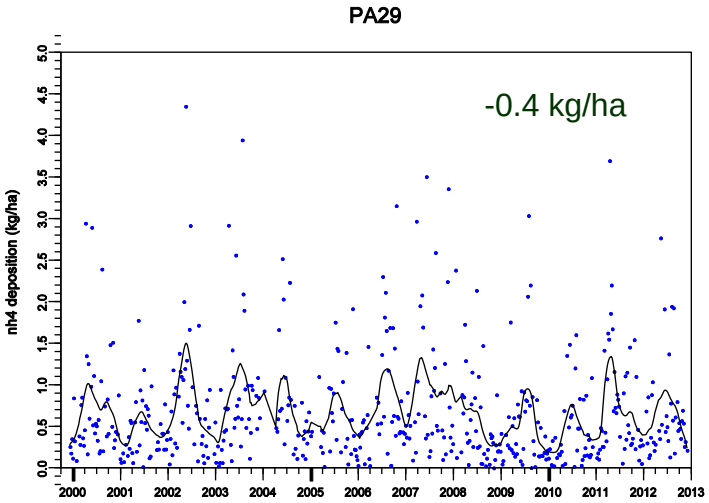




~29% of watershed has deposition > 10 kg/ha-yr



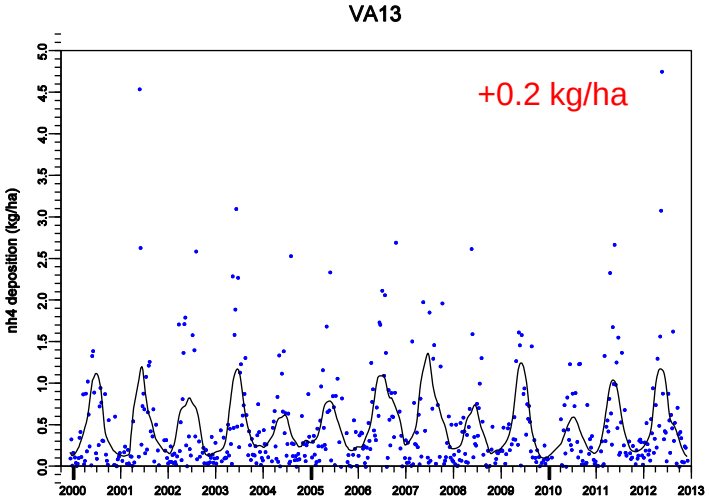

▼ Trend, %



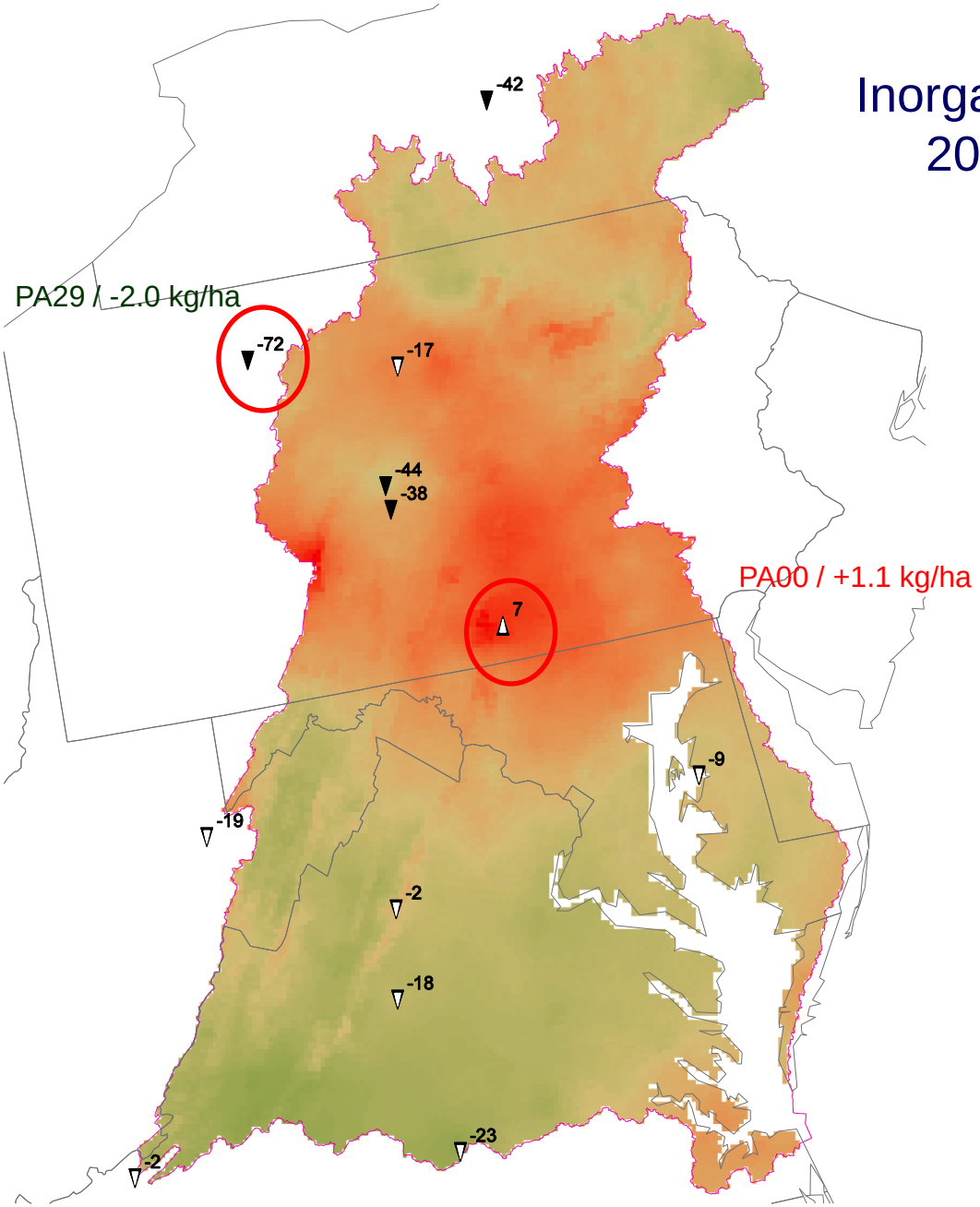

n,

~1% of watershed has deposition > 5 kg/ha-yr




▼ Trend, %

# Inorganic Nitrogen Wet Deposition, 2012 and Trend, 2000 -2012




~25% of watershed has deposition > 5 kg/ha-yr

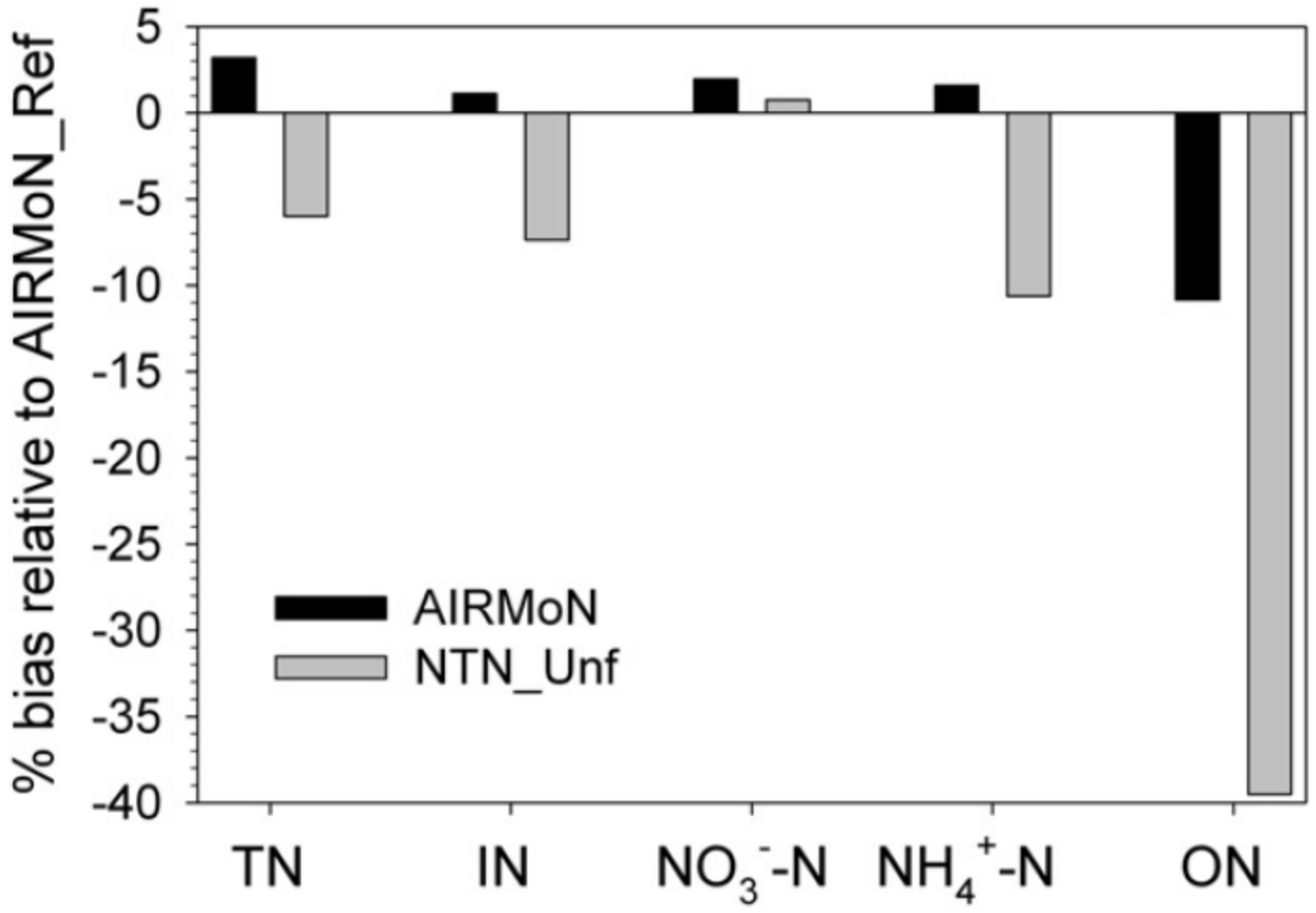
N (kg/ha)

≥ 8.0
6.0
4.0
2.0
0

▼ Trend, %

# Stability of Nitrogen in NADP Wet Deposition Samples

Median relative bias between precipitation collection methods




Walker et al., *Atmospheric Environment* **2012**, dx.doi.org/10.1016/j.atmosenv.2012.06.058

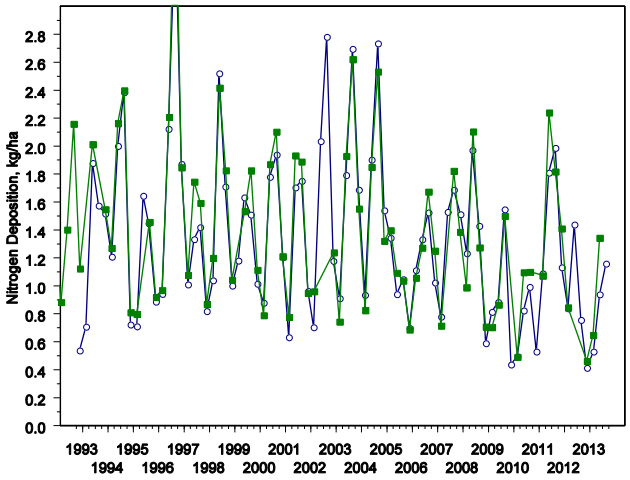
# Stability of Nutrients (Inorg-N, $PO_4$)

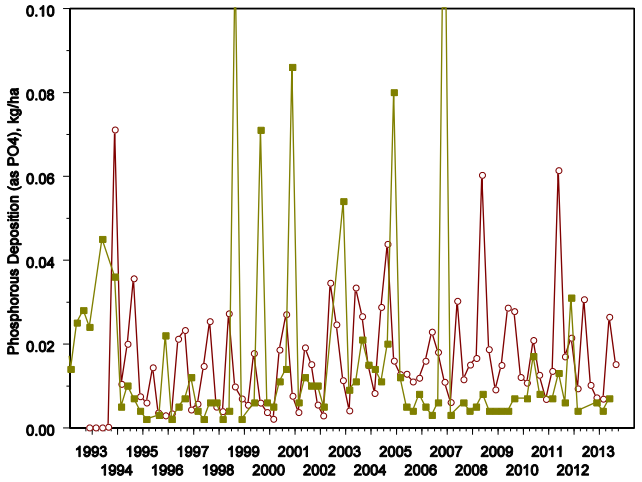
## Atmospheric Integrated Research Monitoring Network (AIRMoN)

### Inorganic Nitrogen

### Orthophosphate

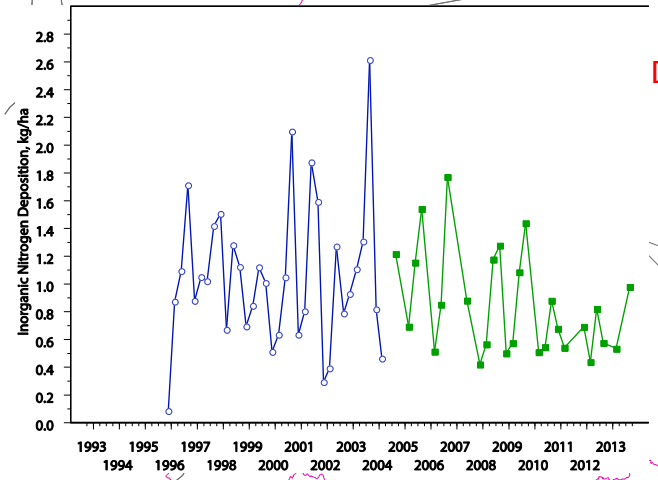
PA15



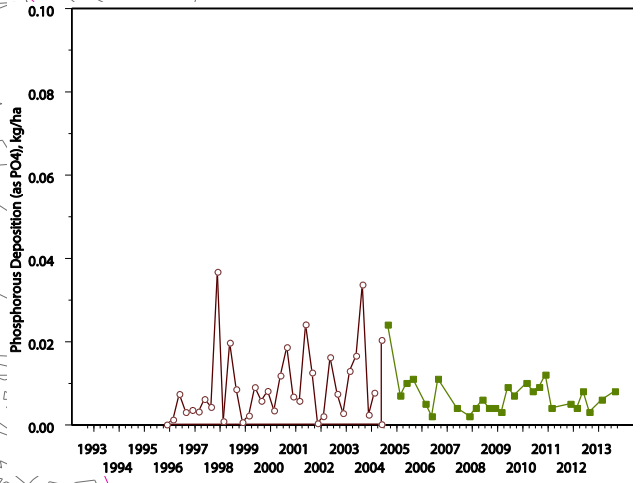




○ - AIRMoN (daily)
■ - NTN (weekly)

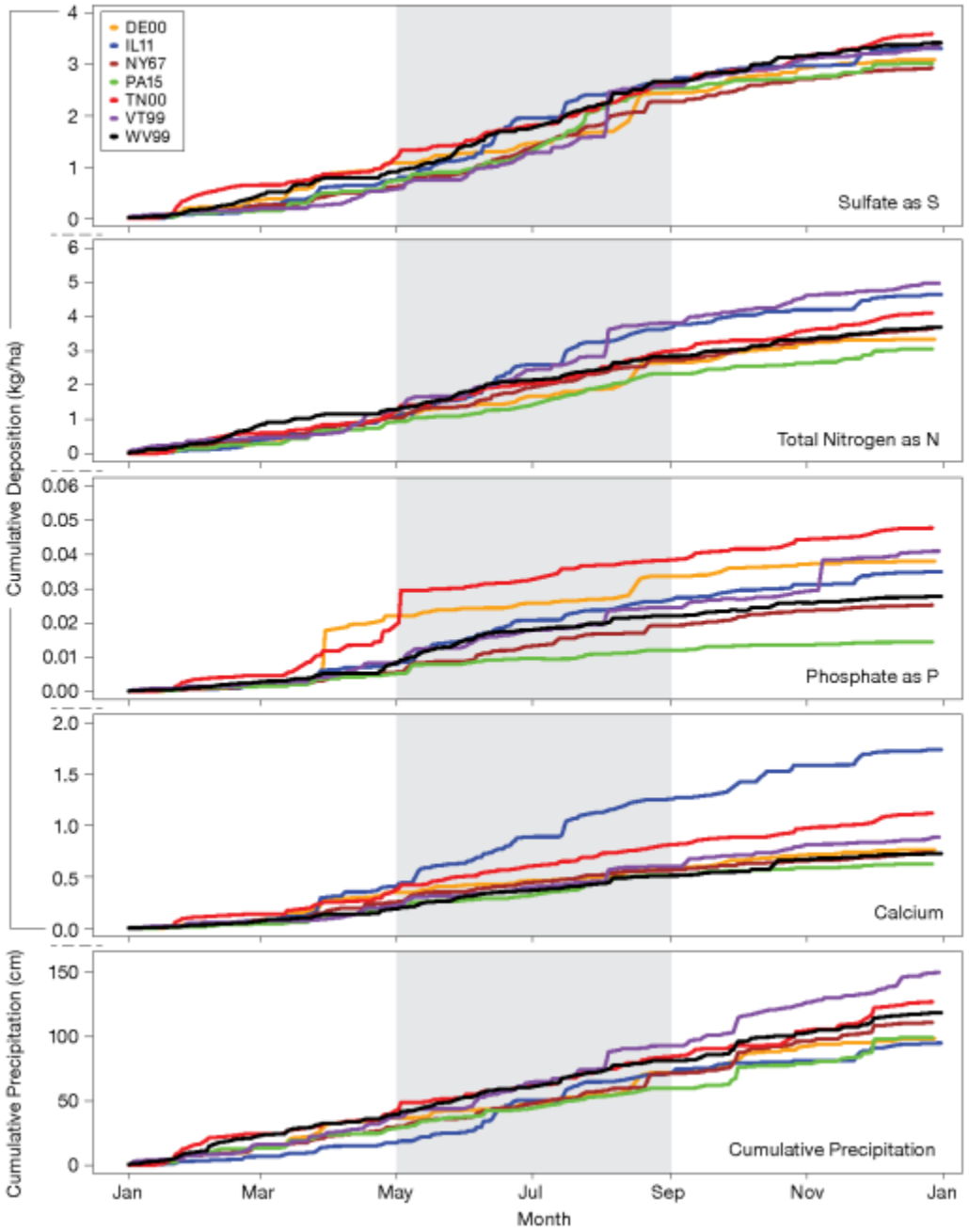
MD99



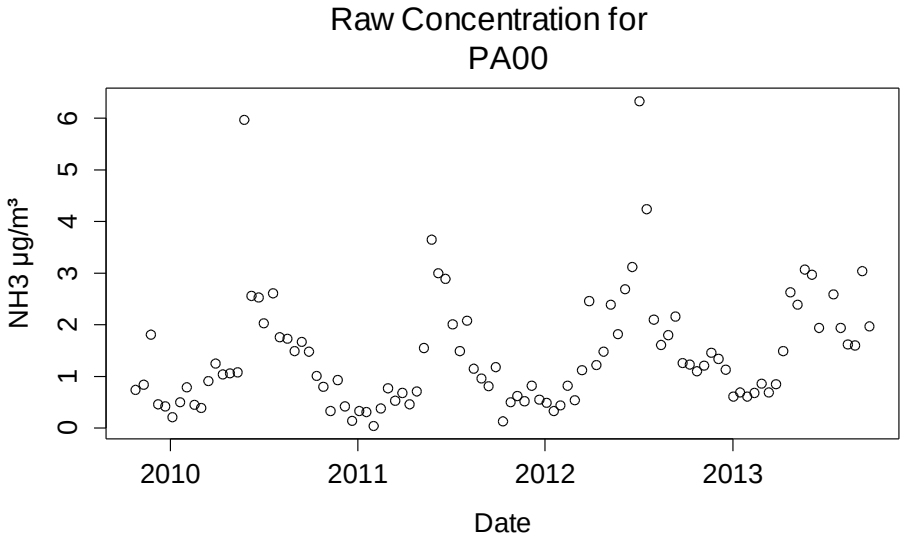

D99



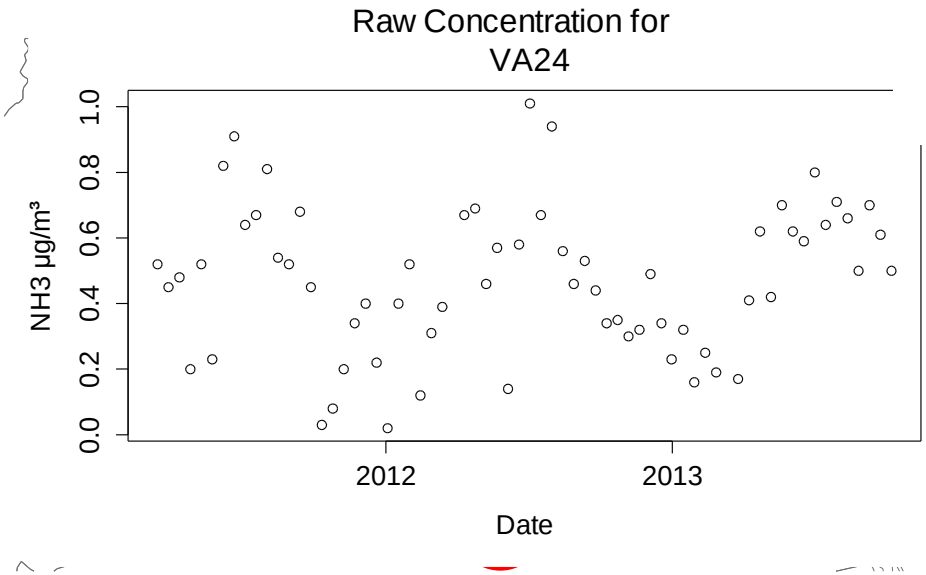
# Deposition Accumulation During Year (AIRMoN)

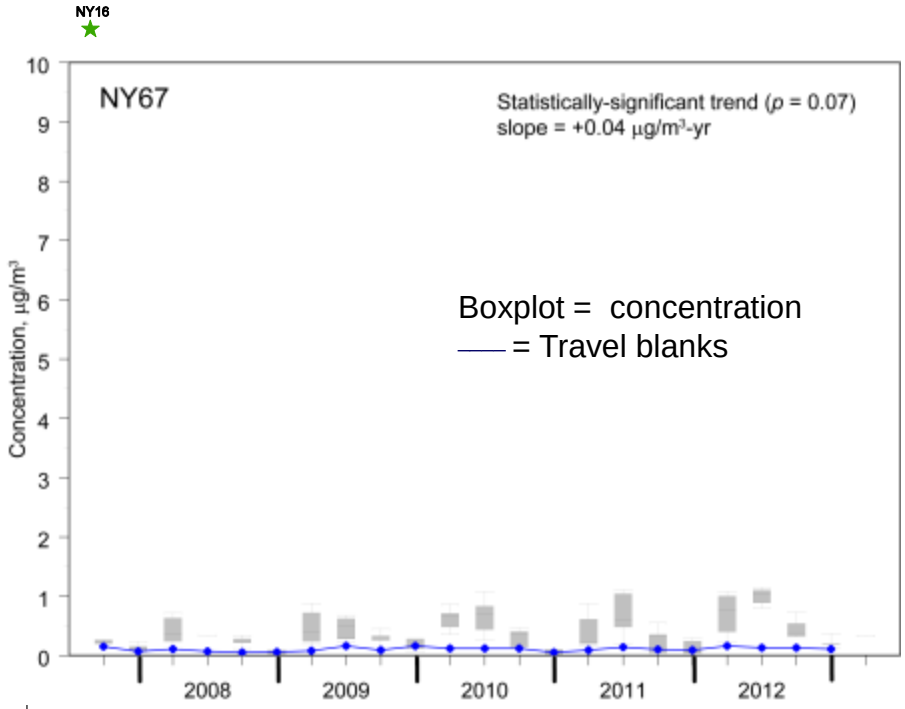


# Ammonia Monitoring Network (AMoN)







# Concluding Remarks about Wet Deposition in Chesapeake Bay Region

- "Acid rain" is still a concern on an episodic basis in the Chesapeake Bay region
- Deposition is not a fixed, annual value!
  - Continued decreasing trends in $SO_4$/$NO_3$ through 2012
  - Regional increases in $NH_4$ and Inorg-N
  - Deposition is episodic
- NADP measurements have bias due to sampling methods (nitrogen, phosphorous losses)

For more information, see **http://nadp.isws.illinois.edu** or email **clehmann@illinois.edu**