The National Atmospheric Deposition Program Ammonia Monitoring Network (NADP/AMoN)

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National Atmospheric
Deposition Program

Outline of Presentation

- Introduction to the National Atmospheric Deposition Program (NADP)
- Passive Air Sampling
- Ammonia Monitoring Network (AMoN) Methodology
- AMoN Data Quality Objectives
- Evaluation of AMoN Data Quality Indicators

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.

National Atmospheric Deposition Program

National Atmospheric Deposition Program (NADP) Stations

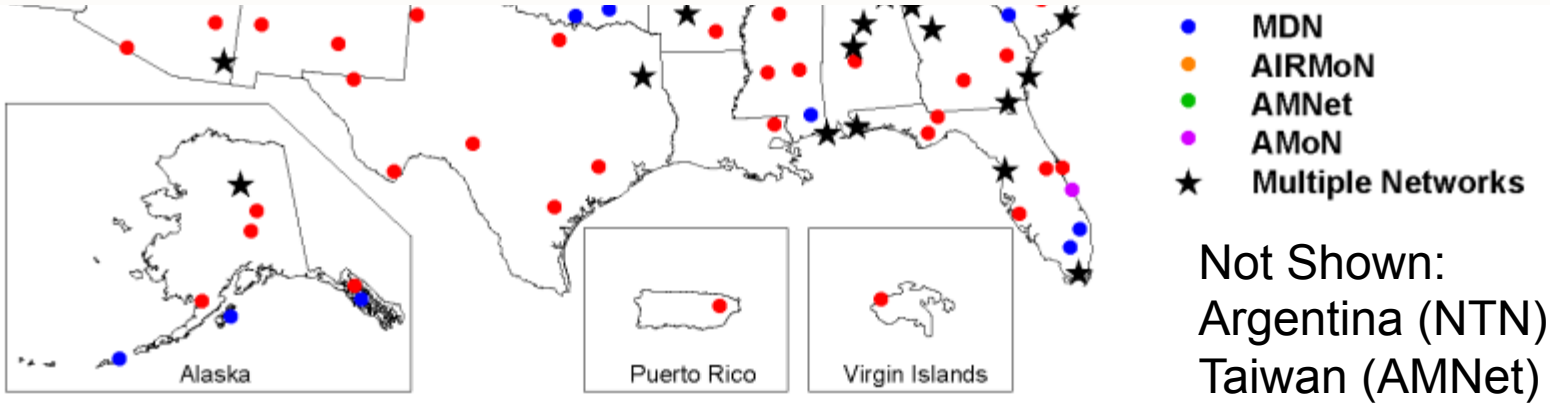
NTN – National Trends Network (acidic precipitation), since 1978; 265 sites

MDN – Mercury Deposition Network (mercury in precipitation), since 1995; 120 sites

AIRMoN – Atmospheric Integrated Research Monitoring Network (acidic precipitation events), since 1992; 6 sites

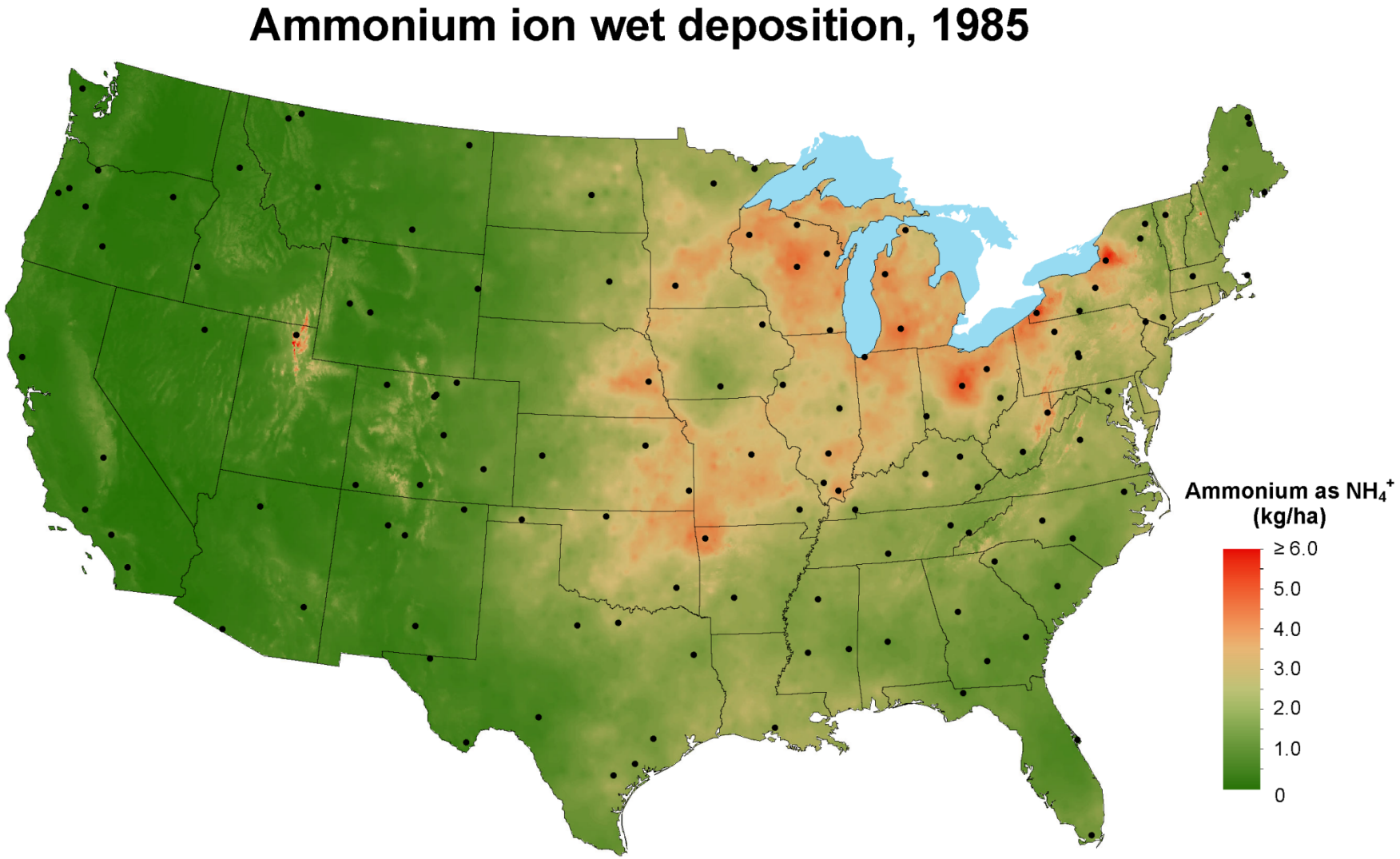
AMNet – Ambient Mercury Network (gaseous mercury), since 2009; 24 sites

AMoN – Ammonia Monitoring Network (gaseous ammonia), since 2007; 93 sites



Not Shown:
Argentina (NTN)
Taiwan (AMNet)

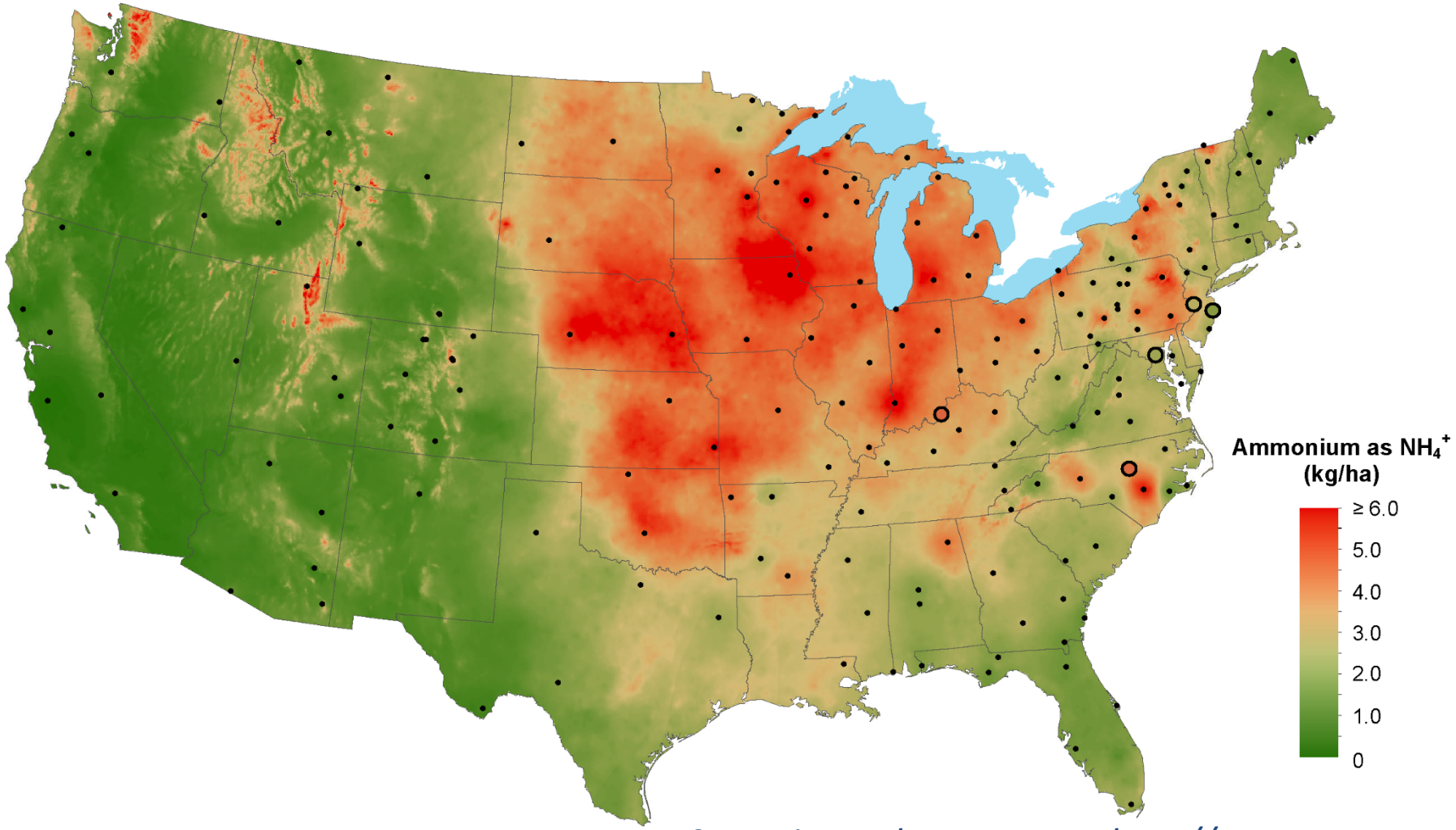
Motivation



National Atmospheric Deposition Program/National Trends Network
http://nadp.isws.illinois.edu

Motivation

Ammonium ion wet deposition, 2013

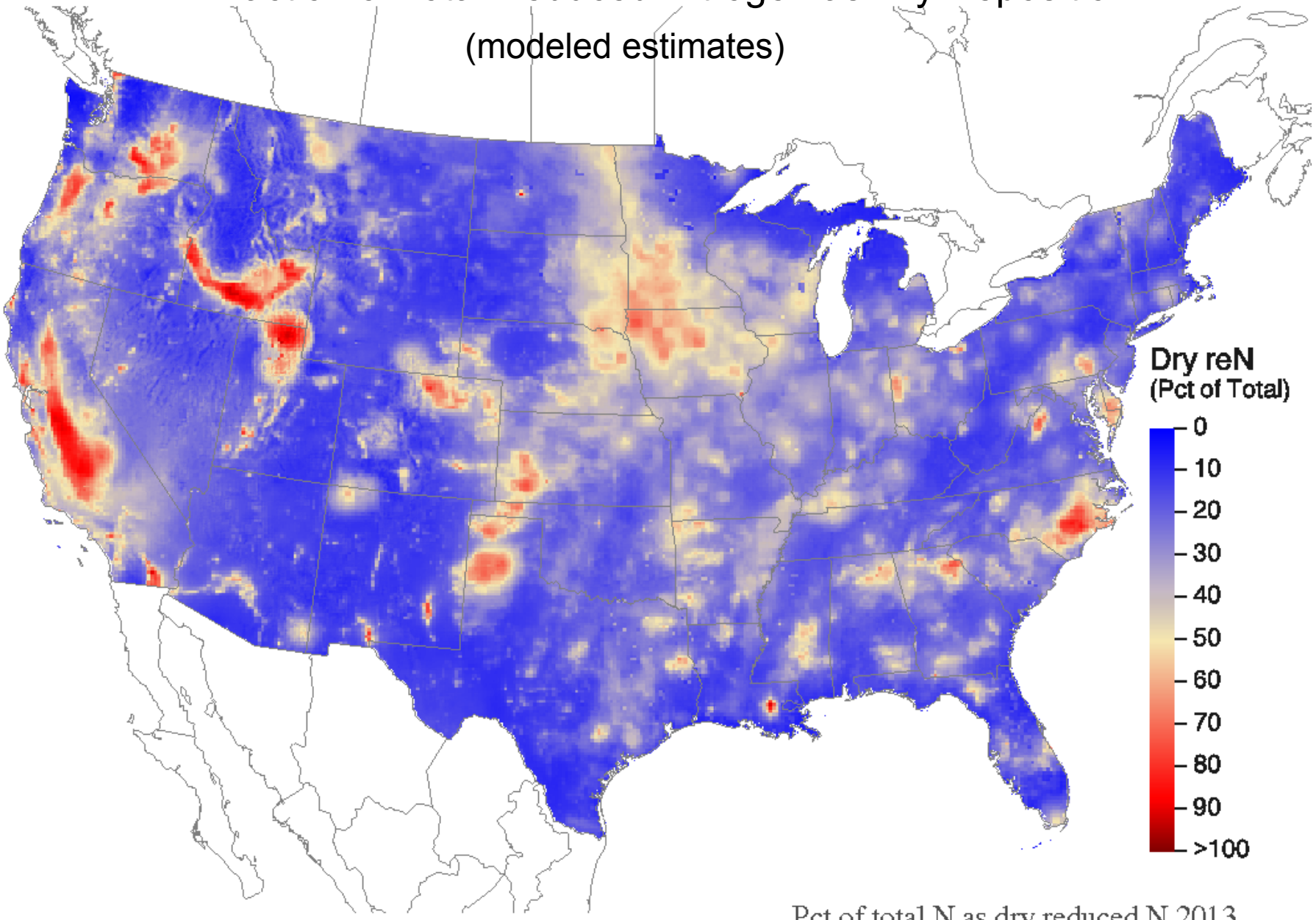


See animated sequence at http://nadp.isws.illinois.edu/data/animaps.aspx

National Atmospheric Deposition Program/National Trends Network
http://nadp.isws.illinois.edu

Fraction of Total Reduced Nitrogen as Dry Deposition

(modeled estimates)



Pct of total N as dry reduced N 2013

Source: CASTNET/CMAQ/NTN/AMON/SEARCH

USEPA 10/15/14

Current AMoN Site Locations

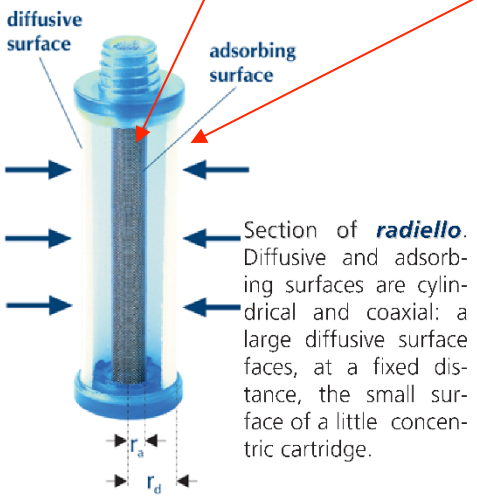
- 94 active sites
- 6 inactive sites

Not shown:
Bettles, Alaska (AK06)

Radiello Passive-Diffusive Samplers (PDS)

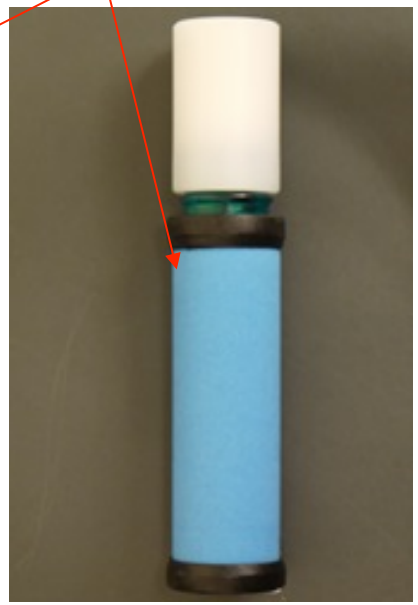
Phosphoric acid absorbing surface

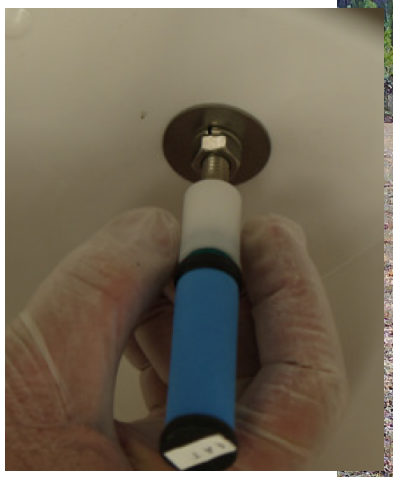
Gas-permeable membrane

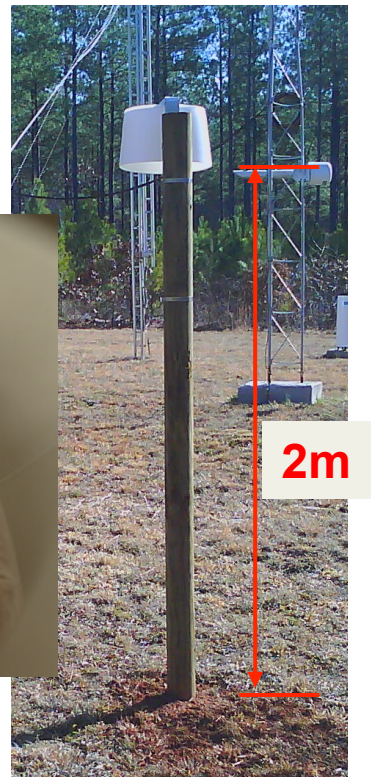


Section of ***radiello***. Diffusive and adsorbing surfaces are cylindrical and coaxial: a large diffusive surface faces, at a fixed distance, the small surface of a little concentric cartridge.

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







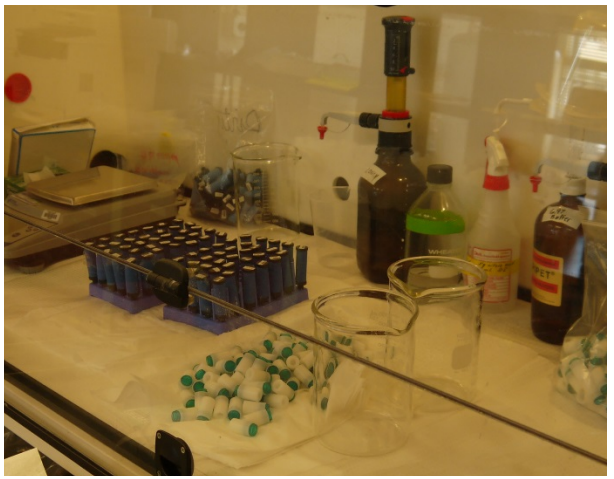
SIGMA-ALDRICH

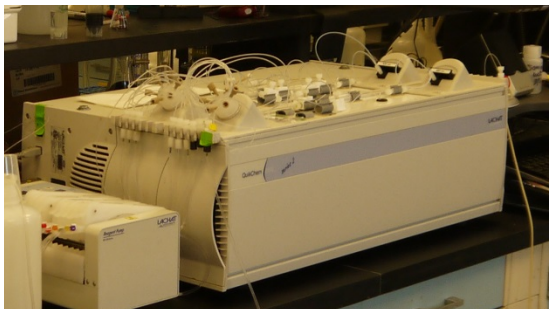
SUPELCO
Solutions within.

- No electricity
- No moving parts
- Suitable for spatially-dense network (economical)

AMoN Laboratory Methodology

- Sample Preparation
  - Samples prepared and extracted in dedicated clean-air bench
- Analysis
  - Flow injection analysis (FIA) colorimetry for ammonium ion

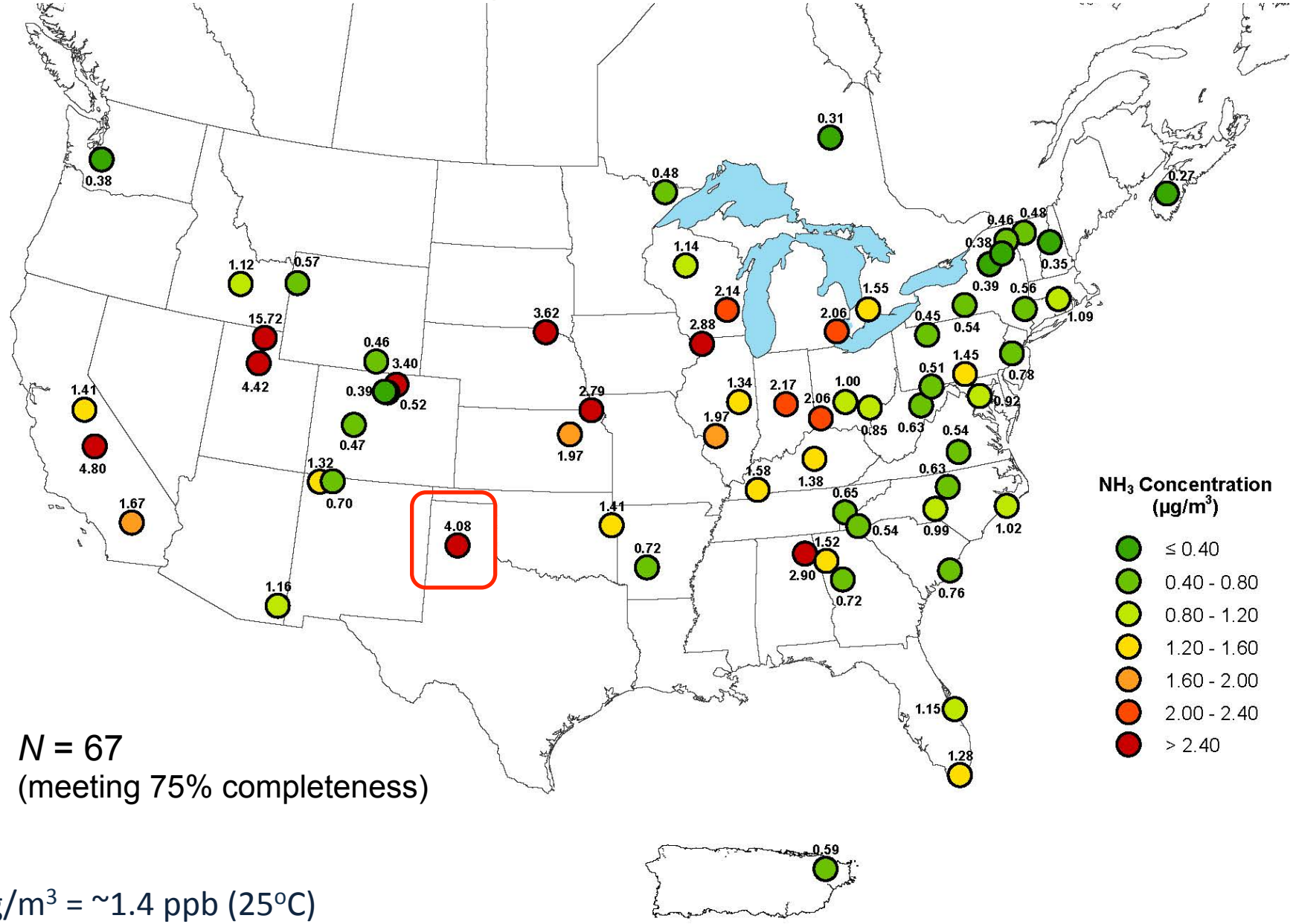




AMoN Quality Assurance

- **Laboratory Blanks** – Source water, reagent, and extraction blanks with each set analyzed
- **Travel Blanks** – Shipped randomly to 25% of sites with every two week deployment
- **Triplicates** – Deployed randomly at 5% of sites and always at Bondville (rural Champaign, IL); select sites pay supplement to have triplicates for all deployments
- **Reference Comparison** – Denuders and continuous monitor at Bondville, IL
- **External Audit** – Visits to sites when feasible; annual update of site information and photos.

AMoN Average Concentrations, 2014

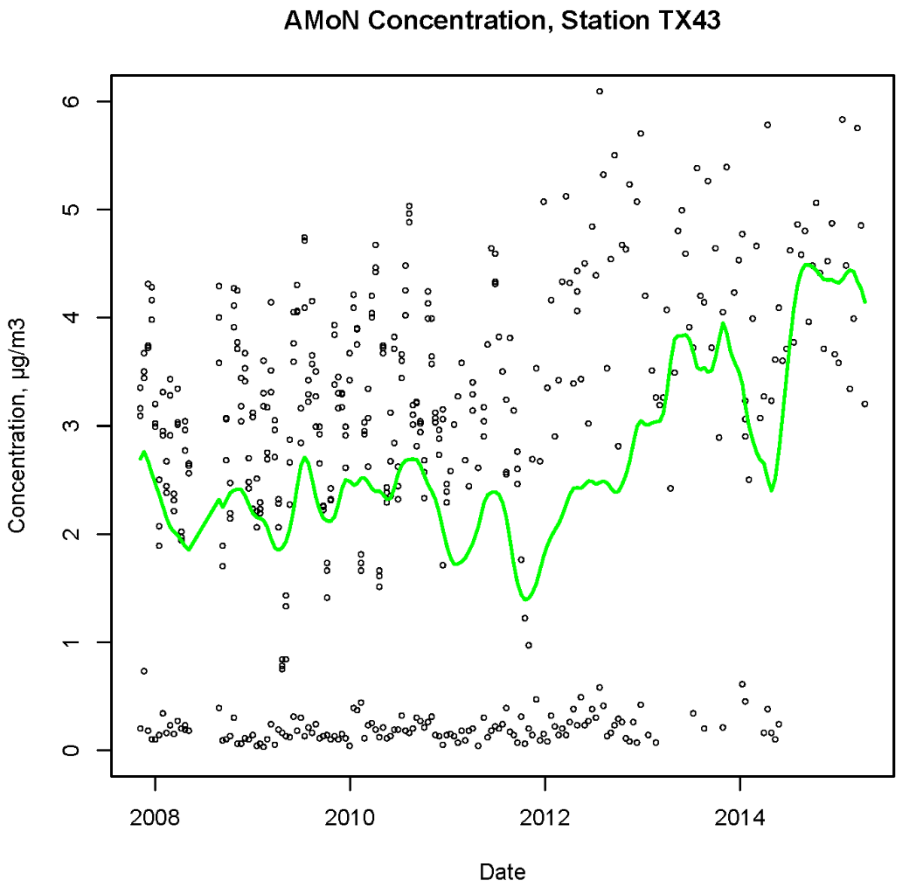


N = 67
(meeting 75% completeness)

1 µg/m^3 = ~1.4 ppb (25^{o}C)
Median (2007 – 2015) = 0.8 µg/m^3 = 1.1 ppb$_v$

Ammonia Concentration Time Series

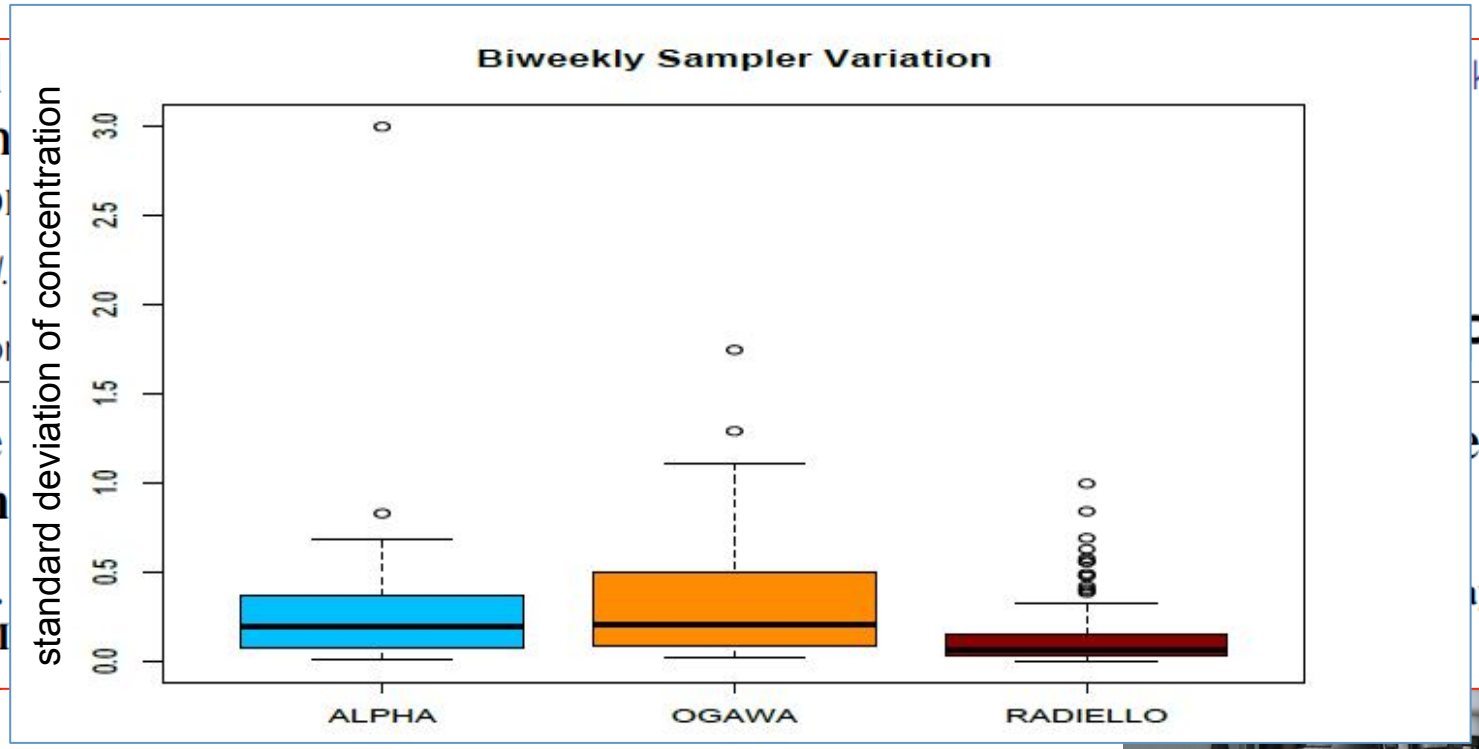
Cañónceta, Randall County, Texas

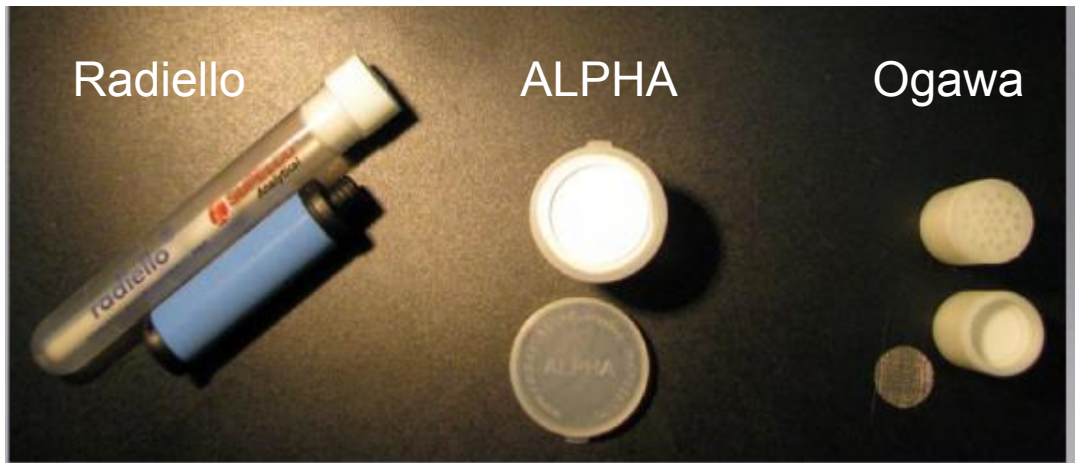


AMoN Data Quality Objectives (DQOs) Proposed

Data Quality Indicator	Data Quality Objective	Method of Evaluation	Frequency of Evaluation
Comparability	Slope = ± 20%	Reference Method (denuder)	Reference station (Bondville, IL)
Precision	COV = ± 20%	Randomized Triplicates	Every deployment (5% of samples)
Bias	Concentration ≤ 0.2 mg/ L (as extract)	Randomized Travel Blanks	Every deployment (25% of samples)
Sensitivity	≥ 90% of concentrations ≥ median travel blank	Randomized Travel Blanks	Annually

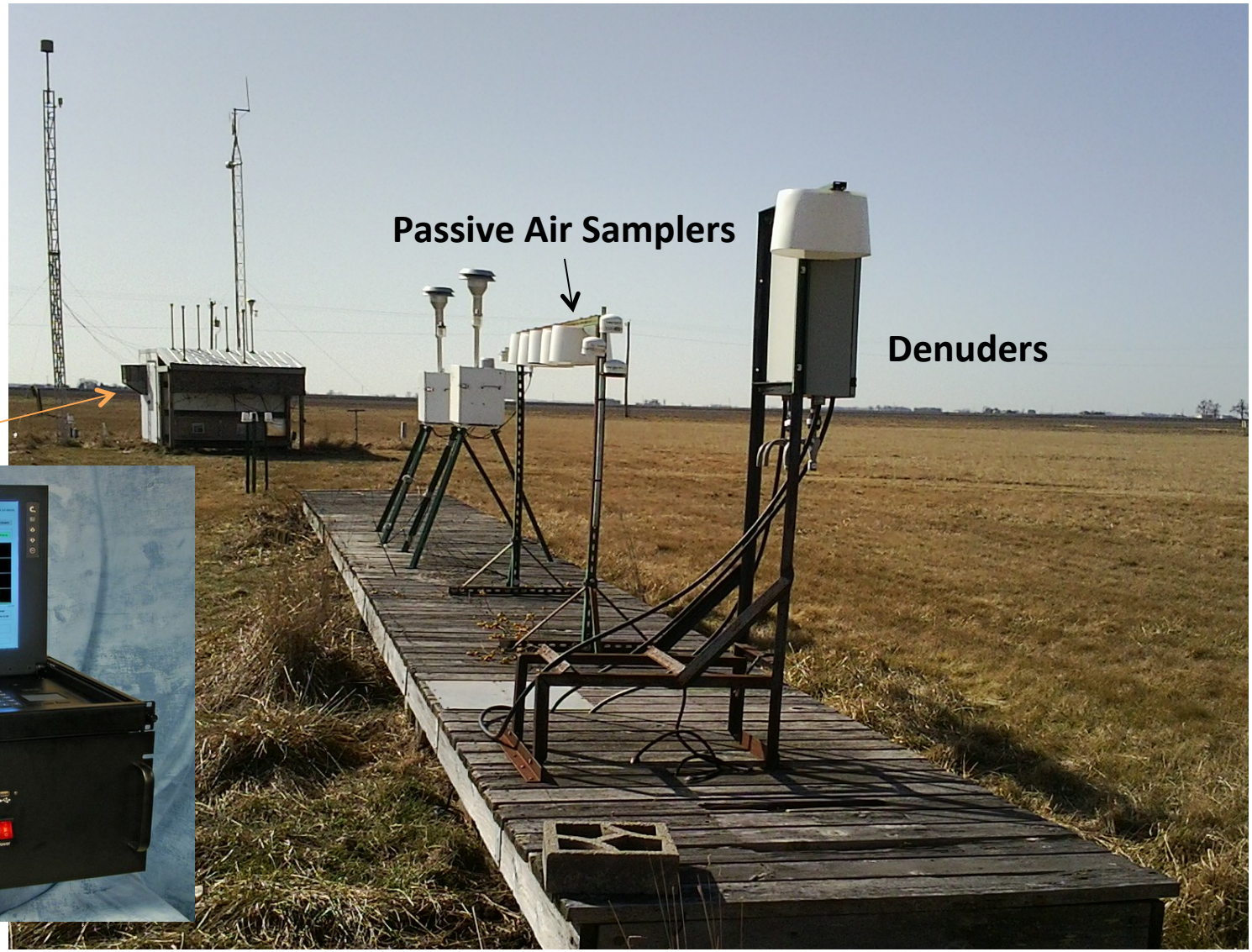
Radiello Measurement Comparison





Comparison to Other Methods

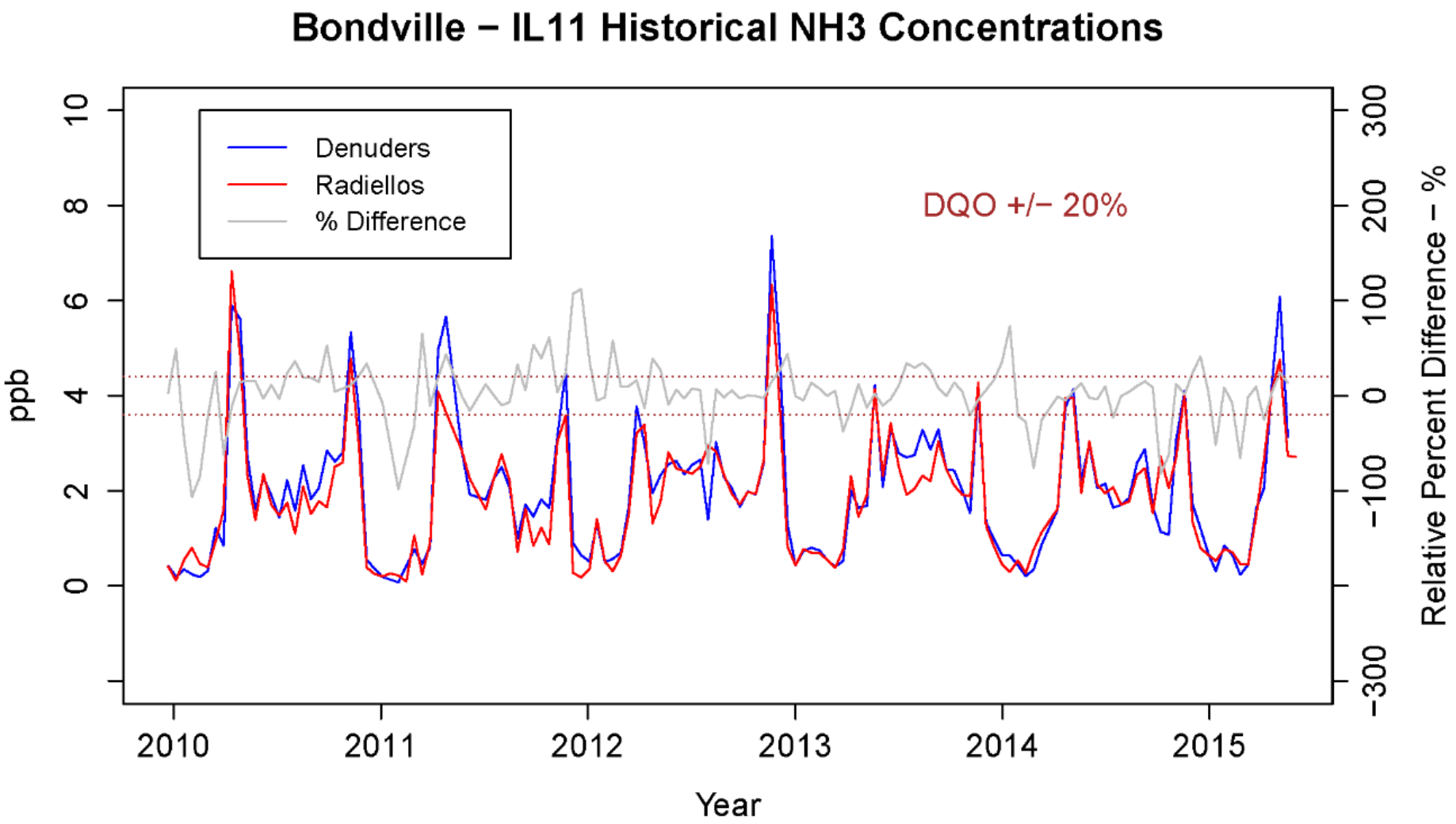
Bondville (Champaign County, IL)



Pranalytica Continuous Monitor

Accuracy and Comparability

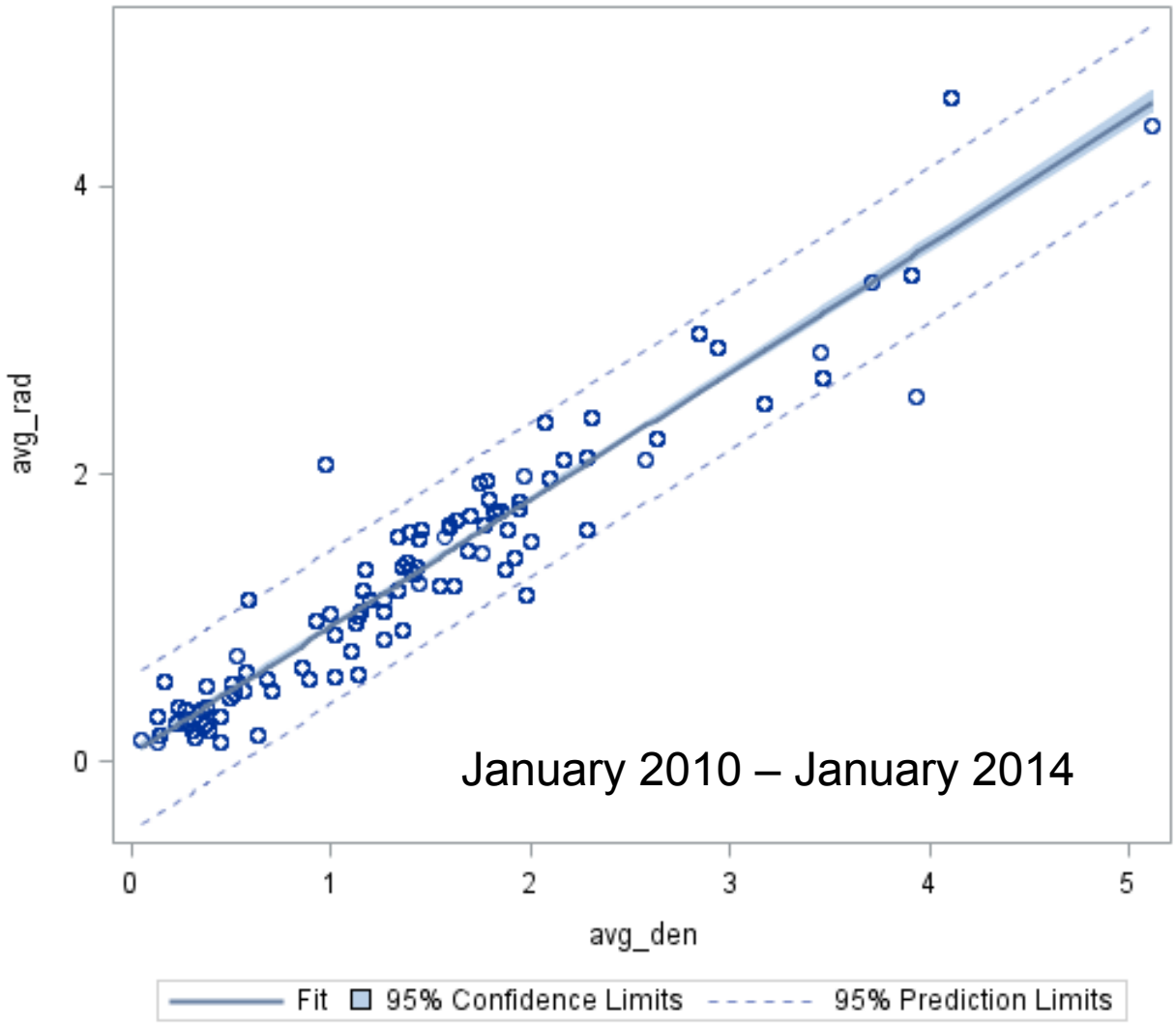
Triplicate denuders and passives deployed at Bondville, IL



Comparability

Radiello = 0.93 * denuder – 0.012
R^2 = 0.9

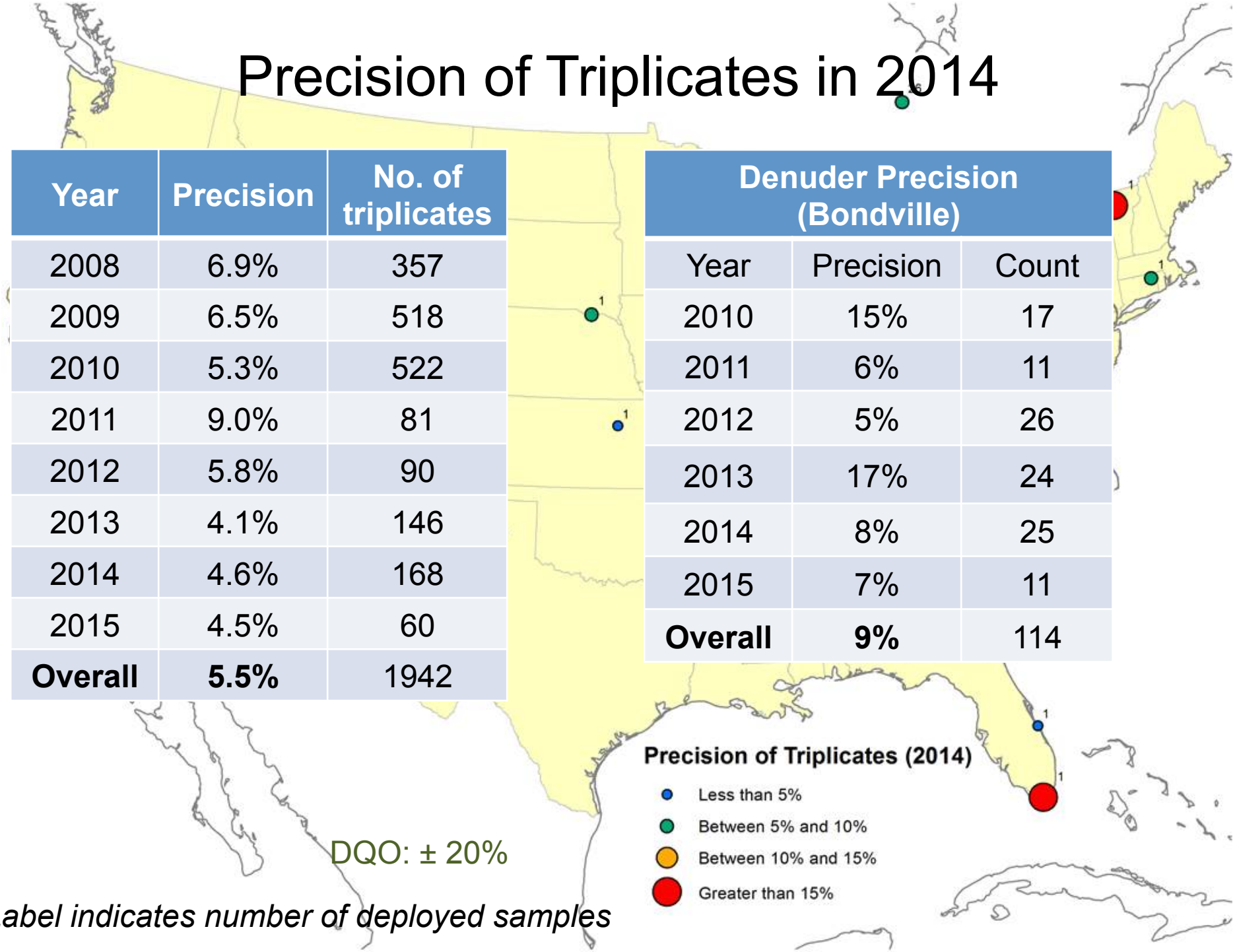
DQO: ± 20%



Precision of Triplicates in 2014

Year	Precision	No. of triplicates
2008	6.9%	357
2009	6.5%	518
2010	5.3%	522
2011	9.0%	81
2012	5.8%	90
2013	4.1%	146
2014	4.6%	168
2015	4.5%	60
Overall	**5.5%**	1942

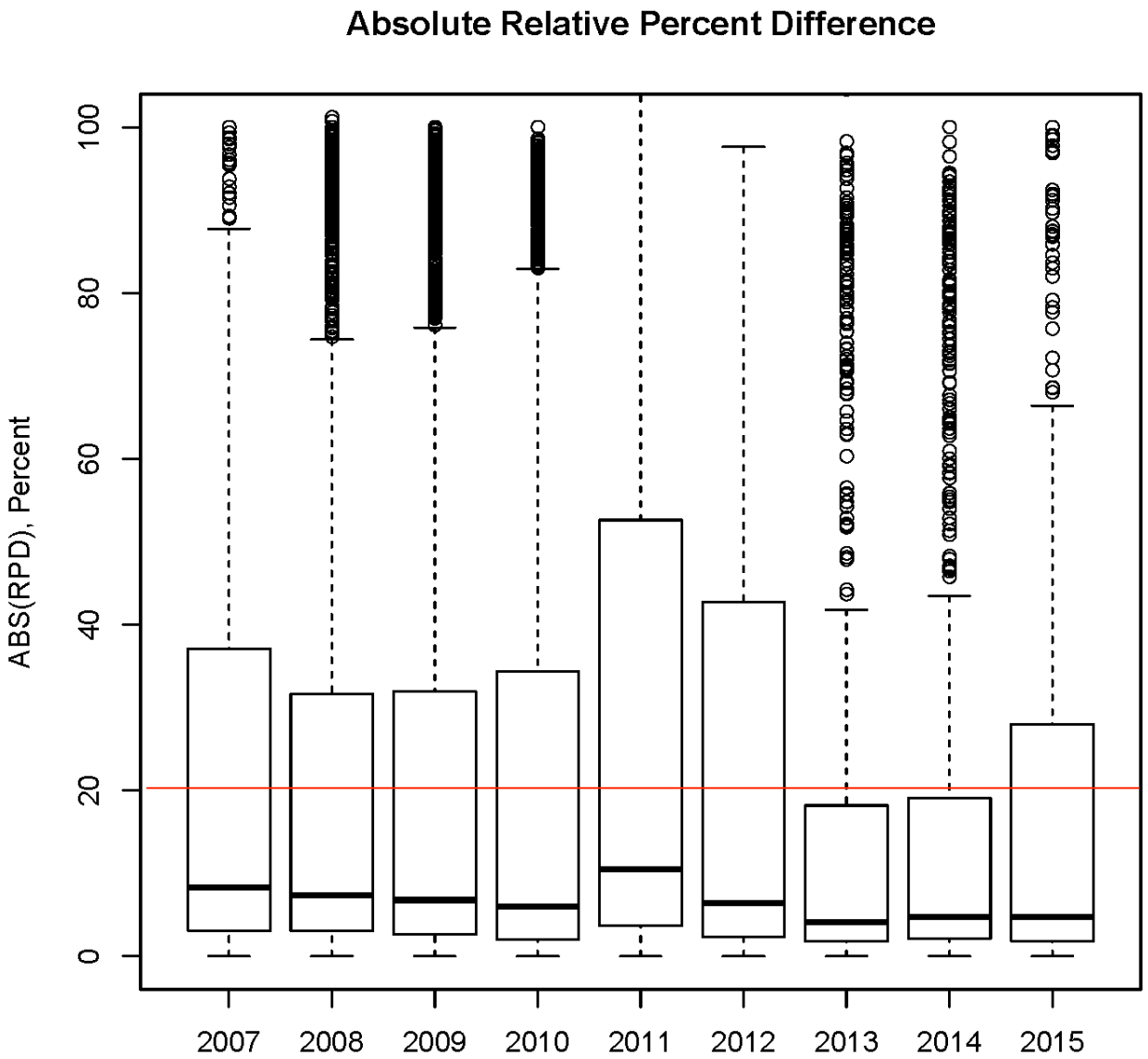
Denuder Precision (Bondville)		
Year	Precision	Count
2010	15%	17
2011	6%	11
2012	5%	26
2013	17%	24
2014	8%	25
2015	7%	11
Overall	**9%**	114



DQO: ± 20%

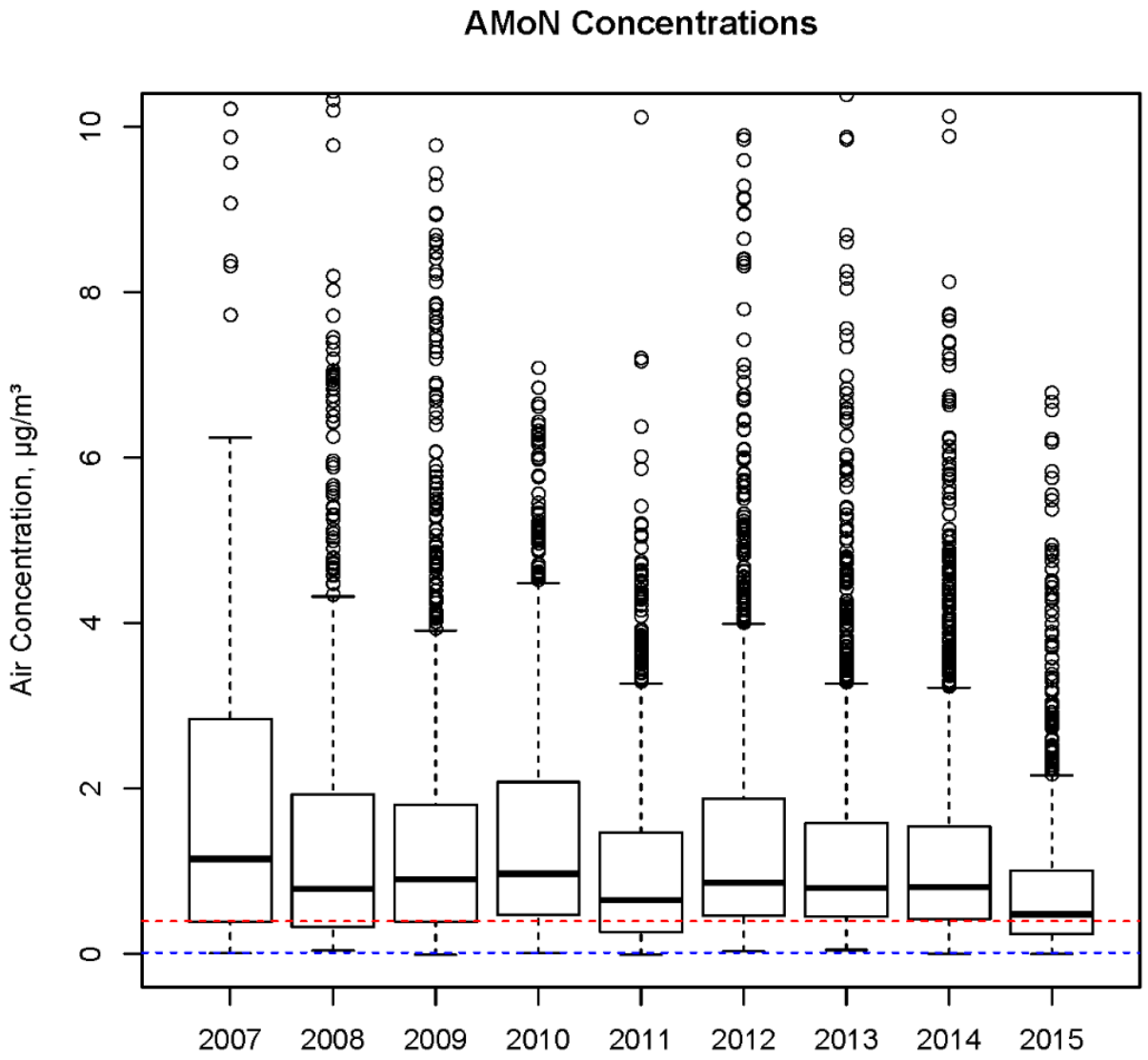
Label indicates number of deployed samples

Precision



DQO: ± 20%

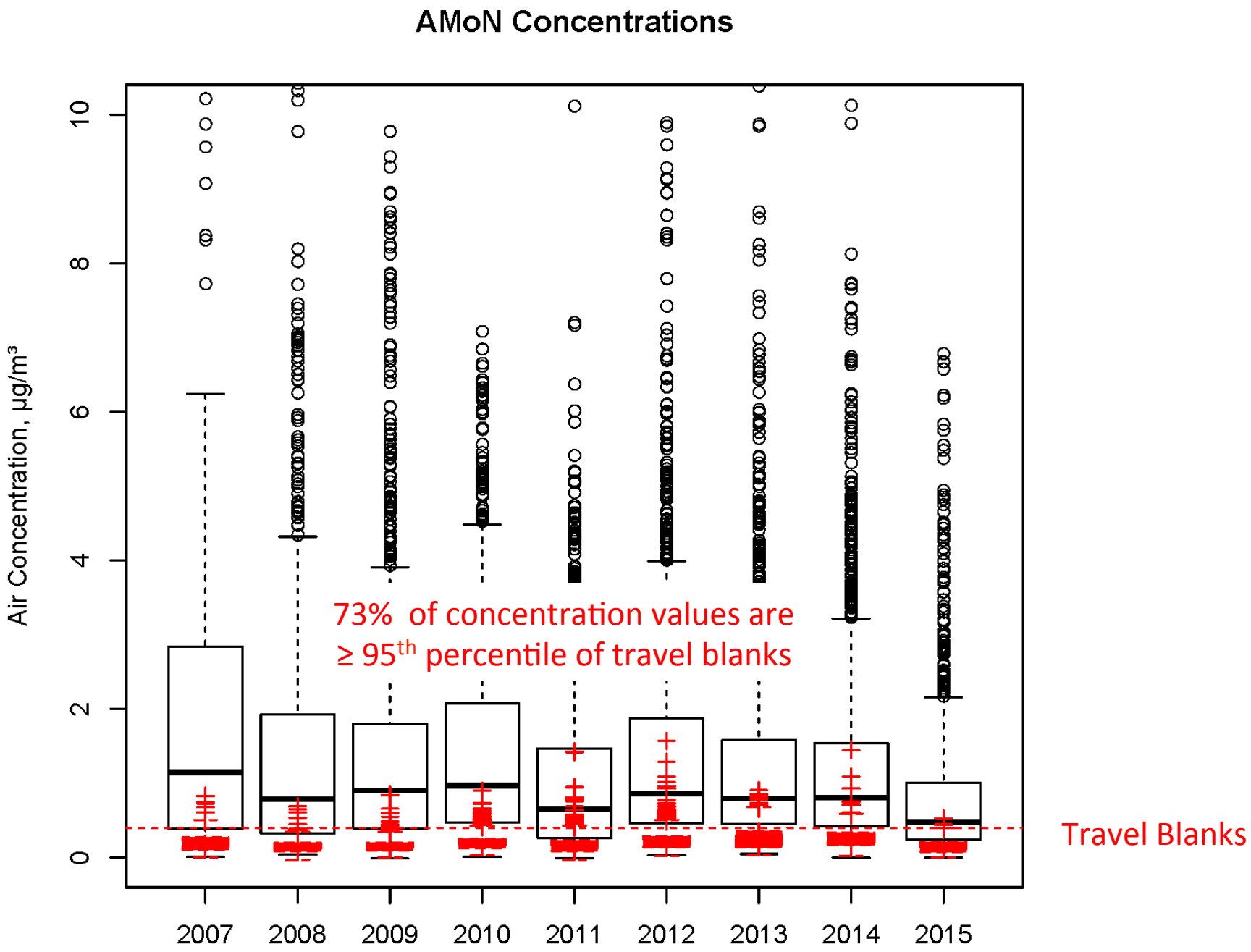
Bias



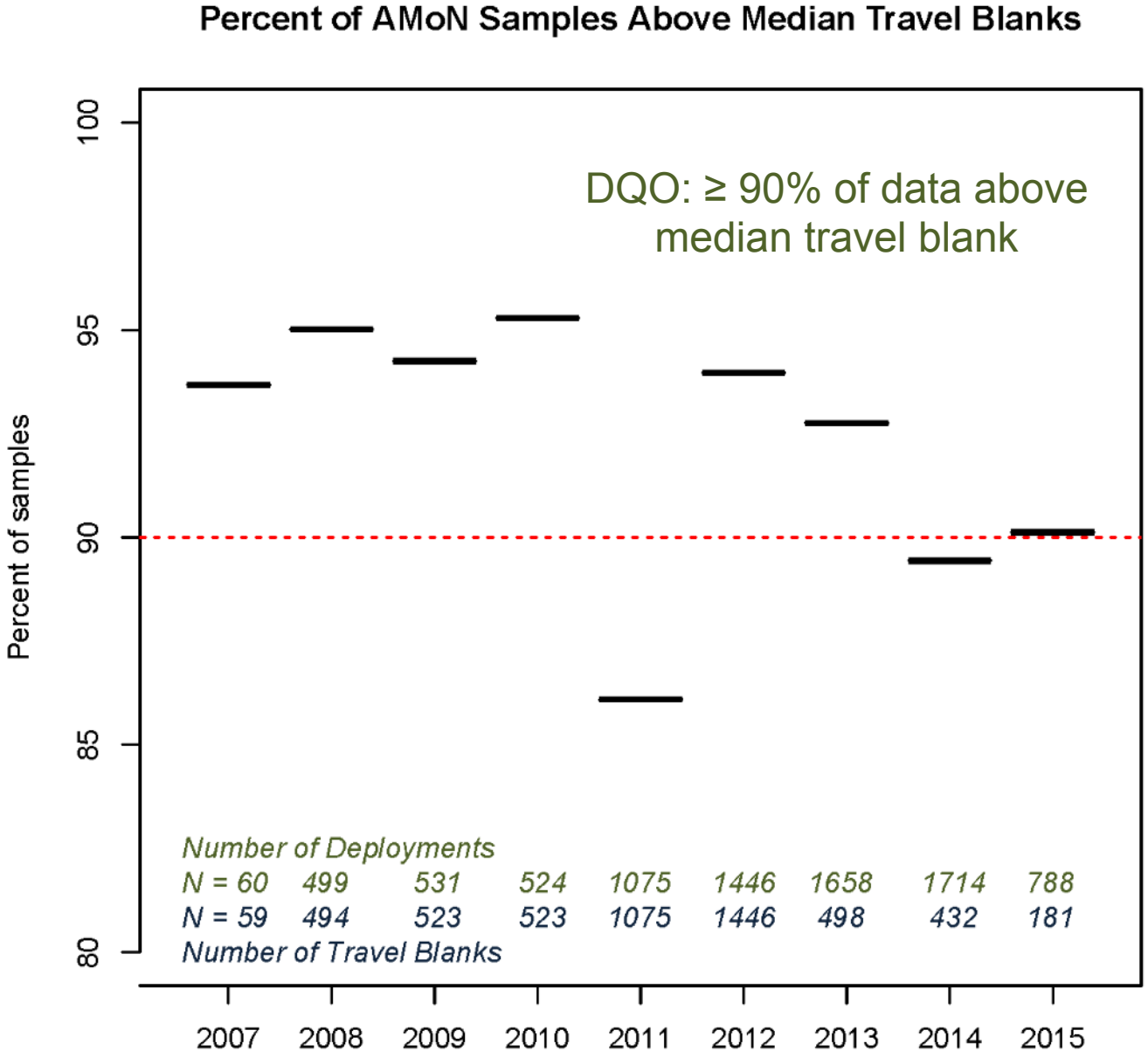
DQO: ≥ 90% of data above median travel blank

Travel blank flag: 0.4 µg/m^3

Lab MDL: 0.02 µg/m^3

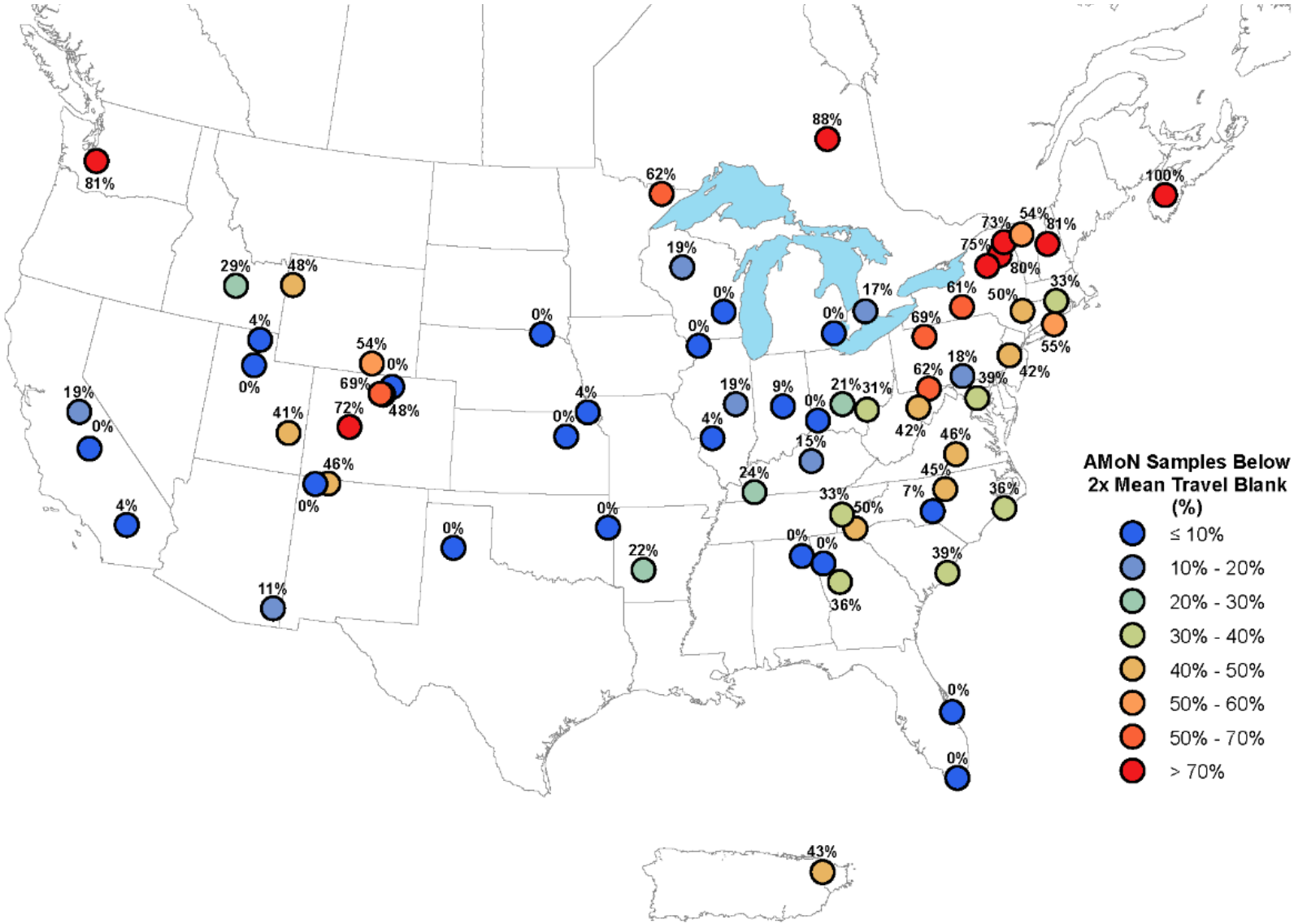

AMoN Concentrations
Air Concentration, µg/m³
0
2
4
6
8
10
2007
2008
2009
2010
2011
2012
2013
2014
2015
73% of concentration values are
≥ 95th percentile of travel blanks
Travel Blanks

Sensitivity

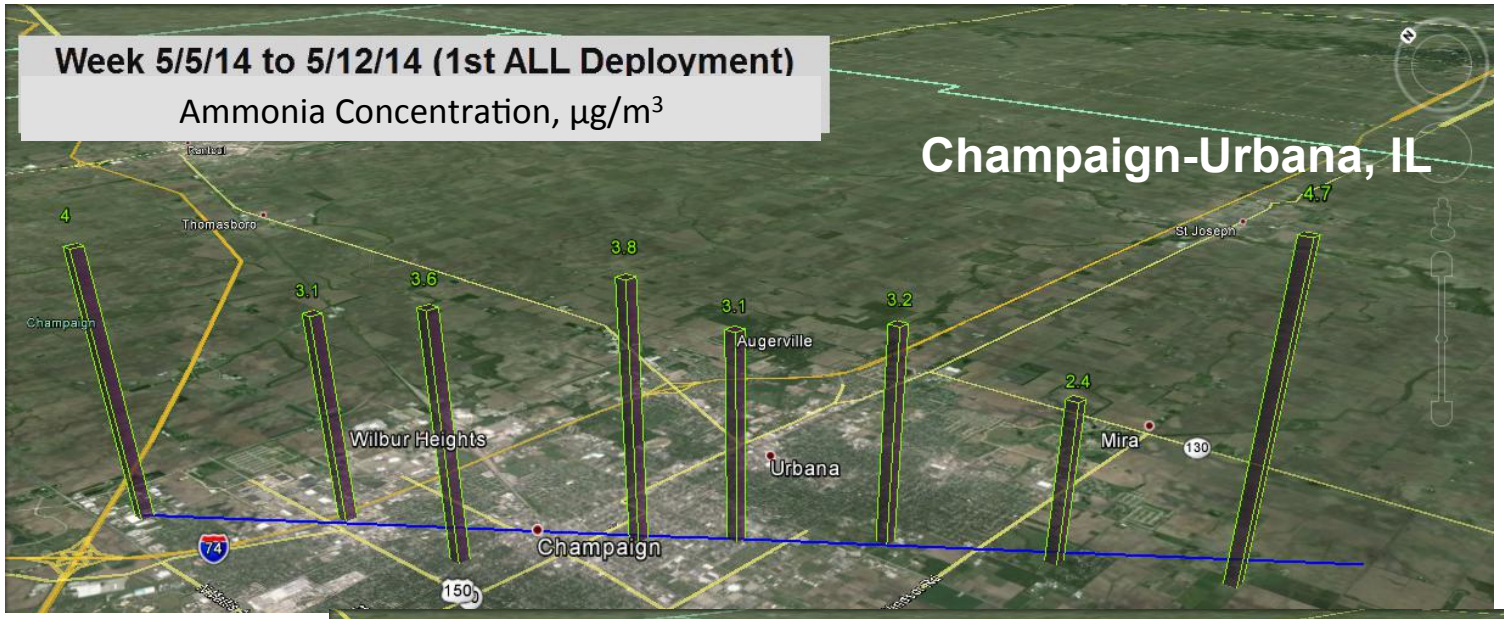


Sensitivity

Percent of samples < 2 x Mean Travel Blank, 2014

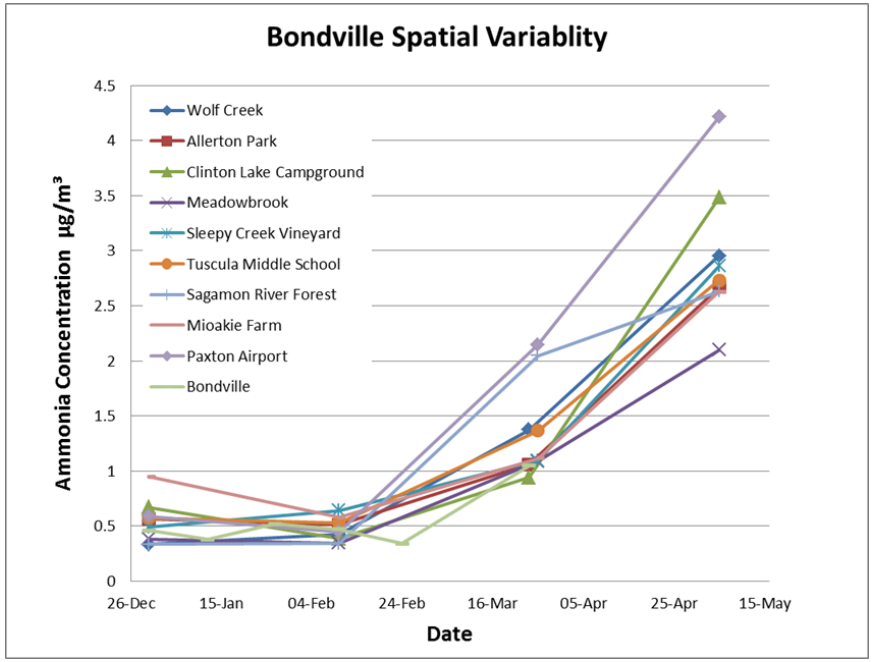


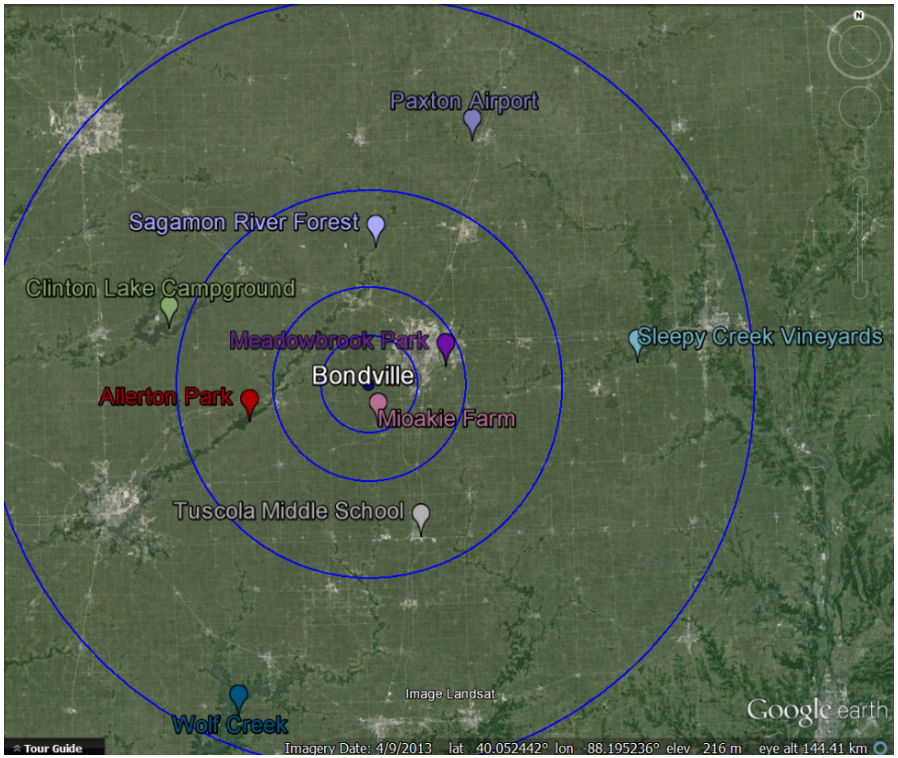
Spatial Representativeness



Spatial Variability Studies
Bondville, IL

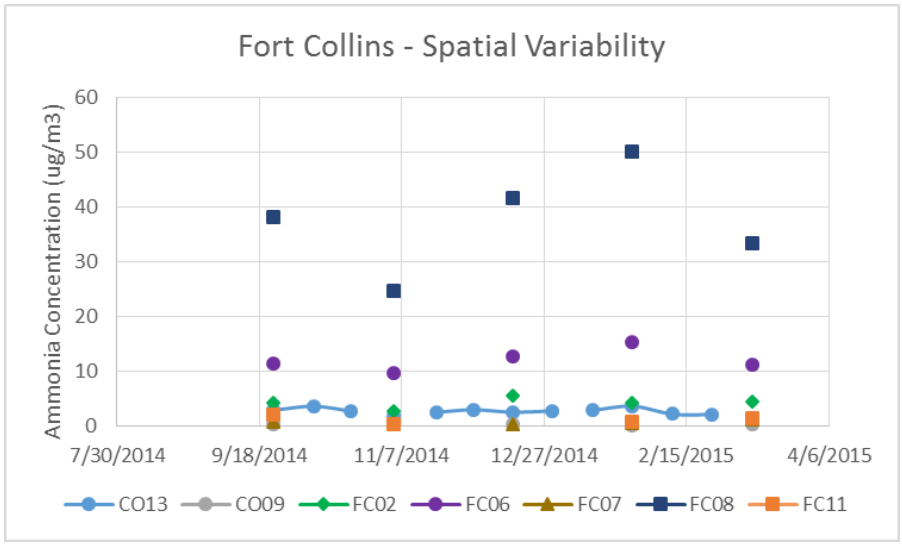
- Evaluate data usability as inputs for modeled estimates of deposition
- Samples deployed for 2 weeks, once every 6 weeks

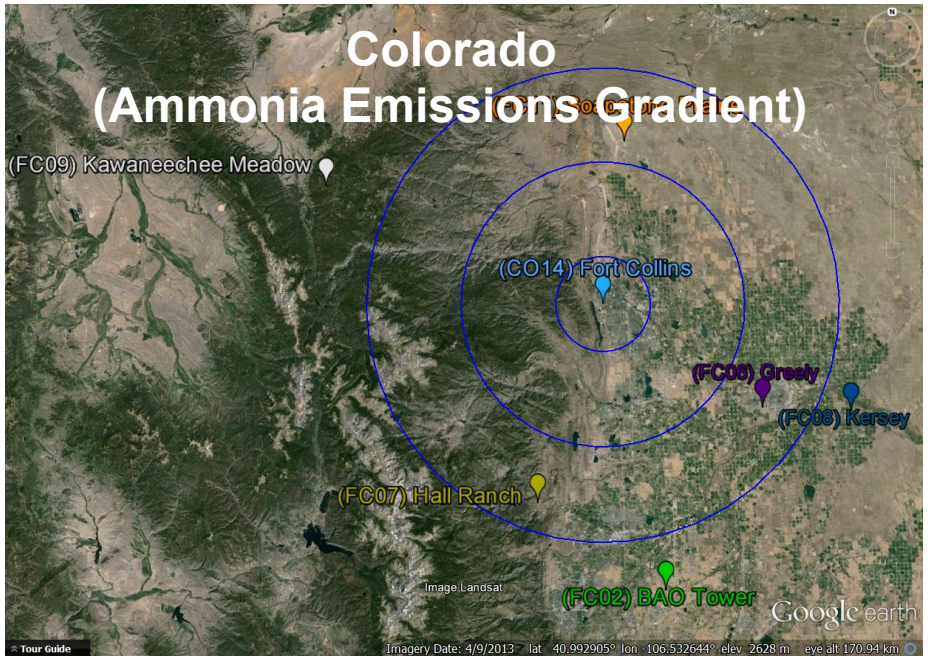




Spatial Variability Study
Ft. Collins, CO

- Evaluate data usability as inputs for modeled estimates of deposition
- Samples deployed for 2 weeks, once every 6 weeks





Coweeta, NC
Flux Study

- Southern Appalachia Nitrogen Deposition Study (SANDS)
- Quantify seasonal and annual total deposition fluxes of nitrogen
  - CASTNET filterpack
  - Passive Monitors (NH_3, SO_2, HNO_3)
  - Continuous Analyzer (MARGA 2-S and fast response NOy analyzer)

Publications Using AMoN Data

- Examining the transport of NH_3 emissions across landscapes using nitrogen isotope ratios (Felix *et. al.*, 2014)
- CALPUFF and CAFOs: Air pollution modeling and environmental justice analysis in the NC hog industry (Ogneva-Himmelberger *et. al.*, 2015)
- Ammonia losses and nitrogen partitioning at a southern High Plains open lot dairy (Todd *et. al.*, 2015)
- A statistical comparison of active and passive ammonia measurements collected at Clean Air Status and Trends Network (CASTNET) sites (Puchalski *et. al.,* 2015)
- The increasing importance of deposition of reduced nitrogen in the United States (Li *et. al.*, in progress)

Please join us at our next NADP meeting….

ACID RAIN 2015
ROCHESTER, NY, USA

http://acidrain2015.org

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