

# EPA Science Advisory Board Integrated Nitrogen Committee

## Nitrogen Monitoring Programs

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# Today

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- The current status of N deposition monitoring programs
  - CASTNET, NADP/NTN, and NADP/AIRMoN
- Needs to maintain/improve the monitoring networks
- Some of the issues in interpretation of data
- Future directions of monitoring networks

# NADP/NTN Summary

## Network Summary

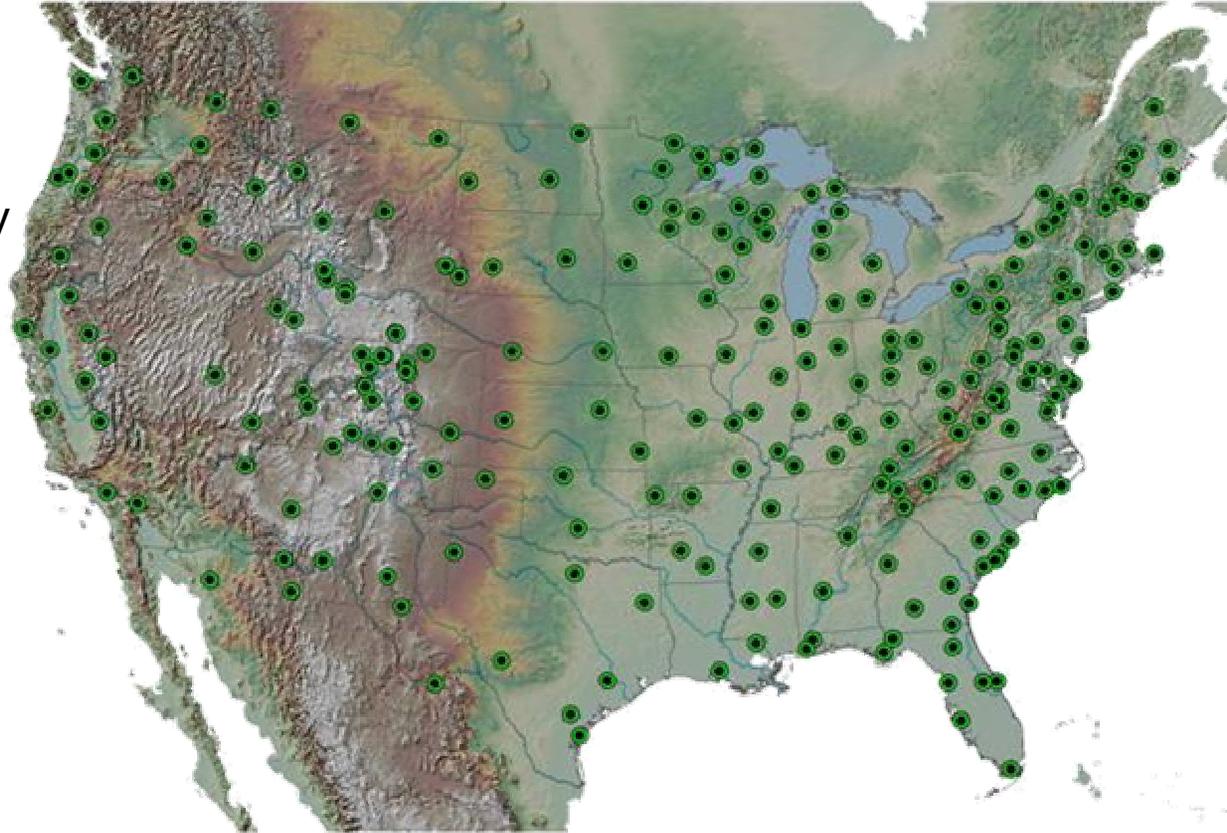
Number of Sites	250+ (2 collocated)
Sampler	Wet precipitation only
Chemical analysis	Laboratory AA, IC, flow injection
Anions	NO <sub>3</sub> , SO <sub>4</sub>
Cations	H, NH <sub>4</sub> , Ca, Mg, Na, K
Meteorology	Precipitation
Sampling frequency	1 week
Sampling schedule	Tuesday to Tuesday
Data availability	<a href="http://nadp.sws.uiuc.edu">http://nadp.sws.uiuc.edu</a>



**Major ion concentrations in precipitation are measured weekly by a wet-only deposition collector and used to calculate wet deposition**

# Current NADP/NTN

- Broad geographic and ecosystem coverage
- Sites are located away from local sources
- Regionally representative locations
- Consistent and comparable measurements
- Comprehensive QA program



# Current NADP/AIRMoN

- Provides source/receptor model verification
- Similar to NADP/NTN, except samples are taken daily after events
- 15% increased  $\text{NH}_4^+$  concentration compared to weekly NADP/NTN
- Limited geographic coverage
- Funded entirely by NOAA/ARL



# Needs at NADP/NTN

- Greatest source of uncertainty in wet deposition estimates is due to precipitation measurements
- Increasing data loss due to aging and outdated equipment
  - Equipment designed over 30 years ago
  - Half of network has equipment greater than 20 years old
  - \$6M to replace all collectors and raingages
- Manual sample and data collection
  - Labor intensive
  - 7 months from sample collection to reporting
- Low participation in network of aquatic and terrestrial scientists



# CASTNET Summary

## Network Summary

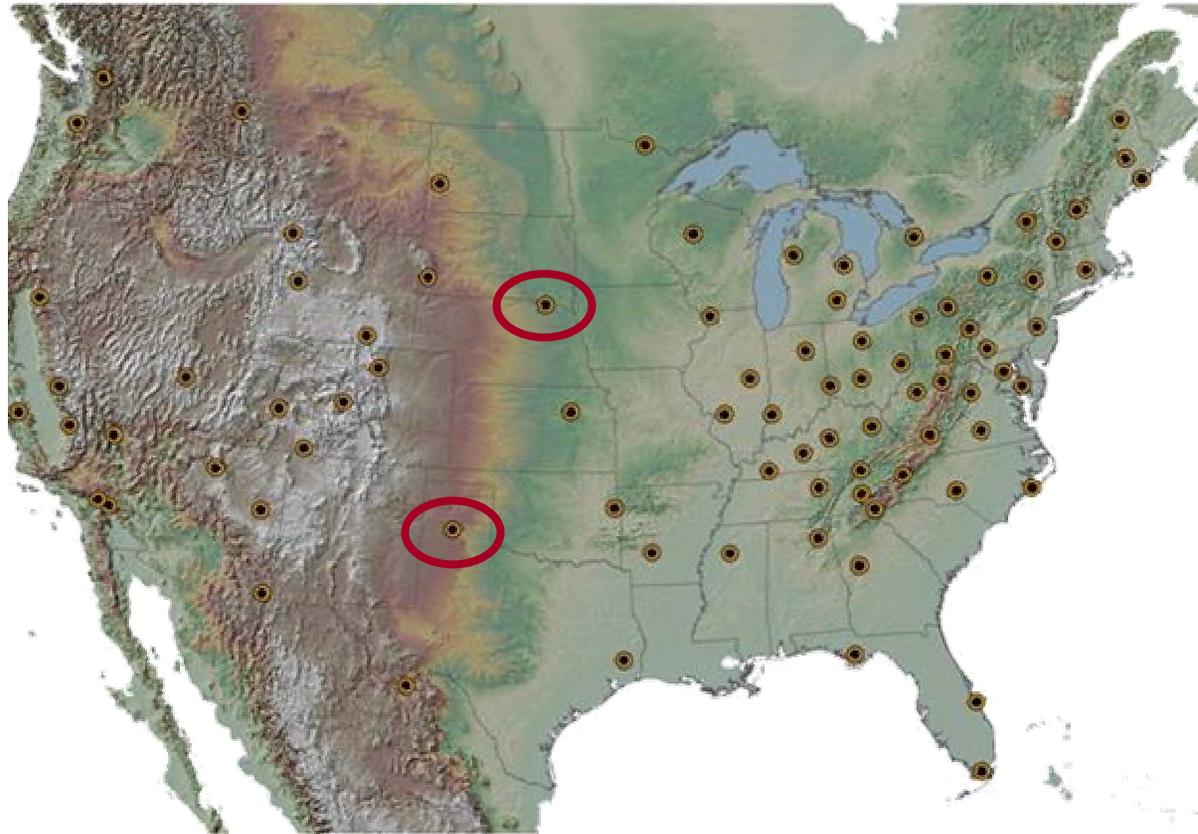
<b>Number of Sites</b>	88 (+ 2 collocated)
<b>Sampler</b>	Filter pack - Teflon®, Nylon®, and Whatman®
<b>Chemical analysis</b>	Laboratory extraction and ion chromatography
<b>Gaseous species</b>	HNO <sub>3</sub> , O <sub>3</sub> , SO <sub>2</sub>
<b>Particle species</b>	NO <sub>3</sub> , NH <sub>4</sub> , SO <sub>4</sub> , Base cations
<b>Meteorology</b>	Temperature, precipitation, relative humidity, solar radiation, wind speed, wind direction
<b>Land Use and Vegetation:</b> (site observations)	Leaf Area Index (LAI) Percent green leaf out Vegetation type
<b>Sampling height</b>	10 m
<b>Frequency</b>	168 hours (1 week)
<b>Sampling schedule</b>	Tuesday to Tuesday

CASTNET filter pack assembly



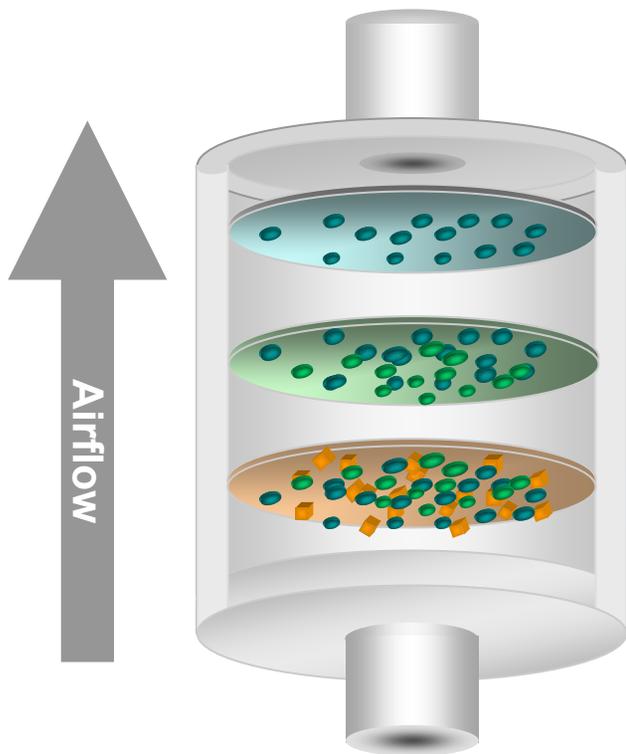
# Current CASTNET network

- Gas and particle concentrations in air are measured weekly on filters and used to estimate dry deposition
- Sites are <50km from companion NADP/NTN site
- Sample interval is the same as NADP/NTN
- CASTNET sites are located in rural areas
- New sites in central US
- An inferential model is used to estimate hourly dry deposition rates for ozone, SO<sub>2</sub>, HNO<sub>3</sub>, and particulate matter
- Data record from 1987
- <http://www.epa.gov/castnet>



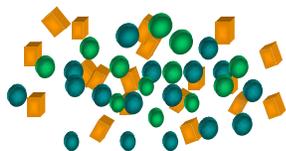
# CASTNET 3-Stage Filterpack

Gas and particle concentrations in air are measured by filter packs and then used to estimate daily dry deposition



<b>Whatman</b>	Gaseous • SO <sub>2</sub>
<b>Nylon</b>	Gaseous • HNO <sub>3</sub> • SO <sub>2</sub>
<b>Teflon</b>	Particulate • SO <sub>4</sub> <sup>2-</sup> • NO <sub>3</sub> <sup>-</sup> • NH <sub>4</sub> <sup>+</sup> • Ca, Na, Mg • Cl

Gases and Particles



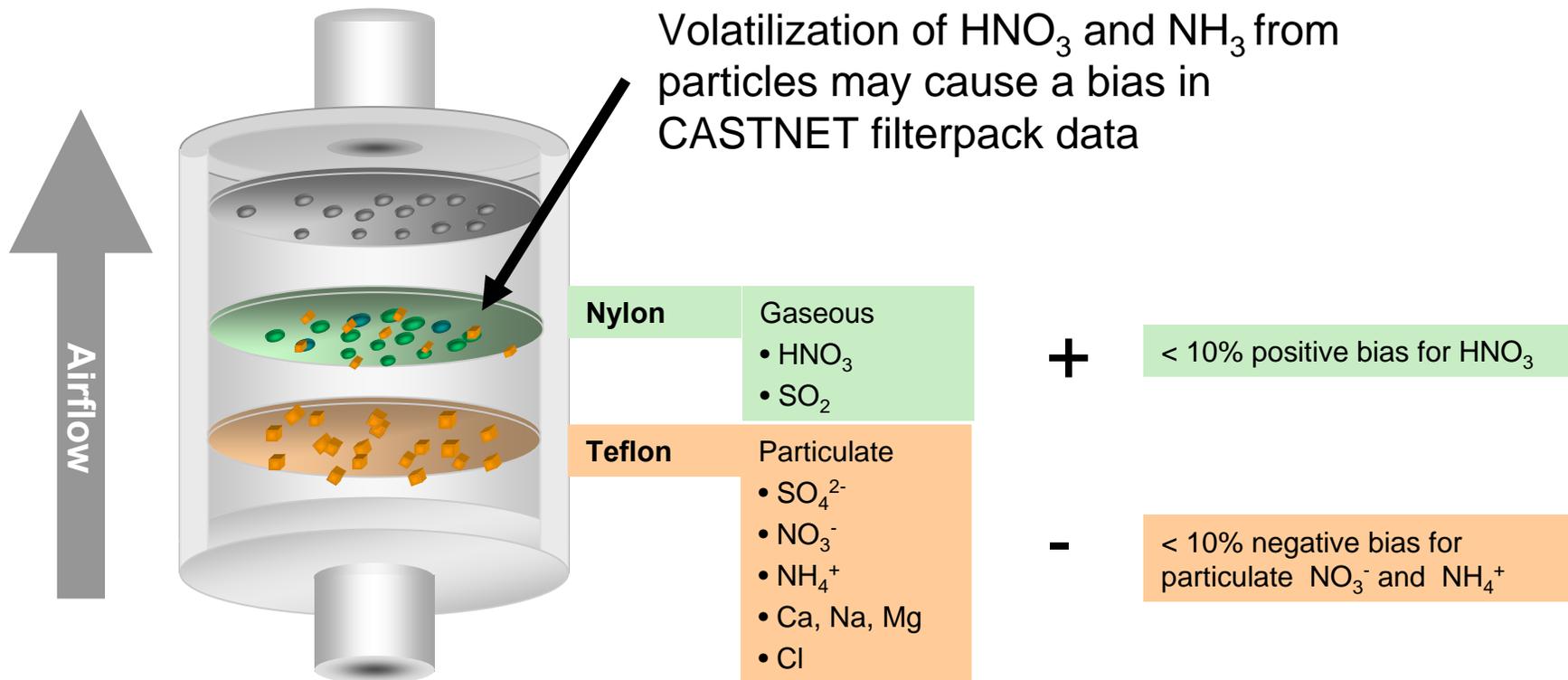
Filter packs are open-faced, with no size exclusion

- 20% of S and N deposition can be from coarse particles
- HNO<sub>3</sub> reacts with inlets

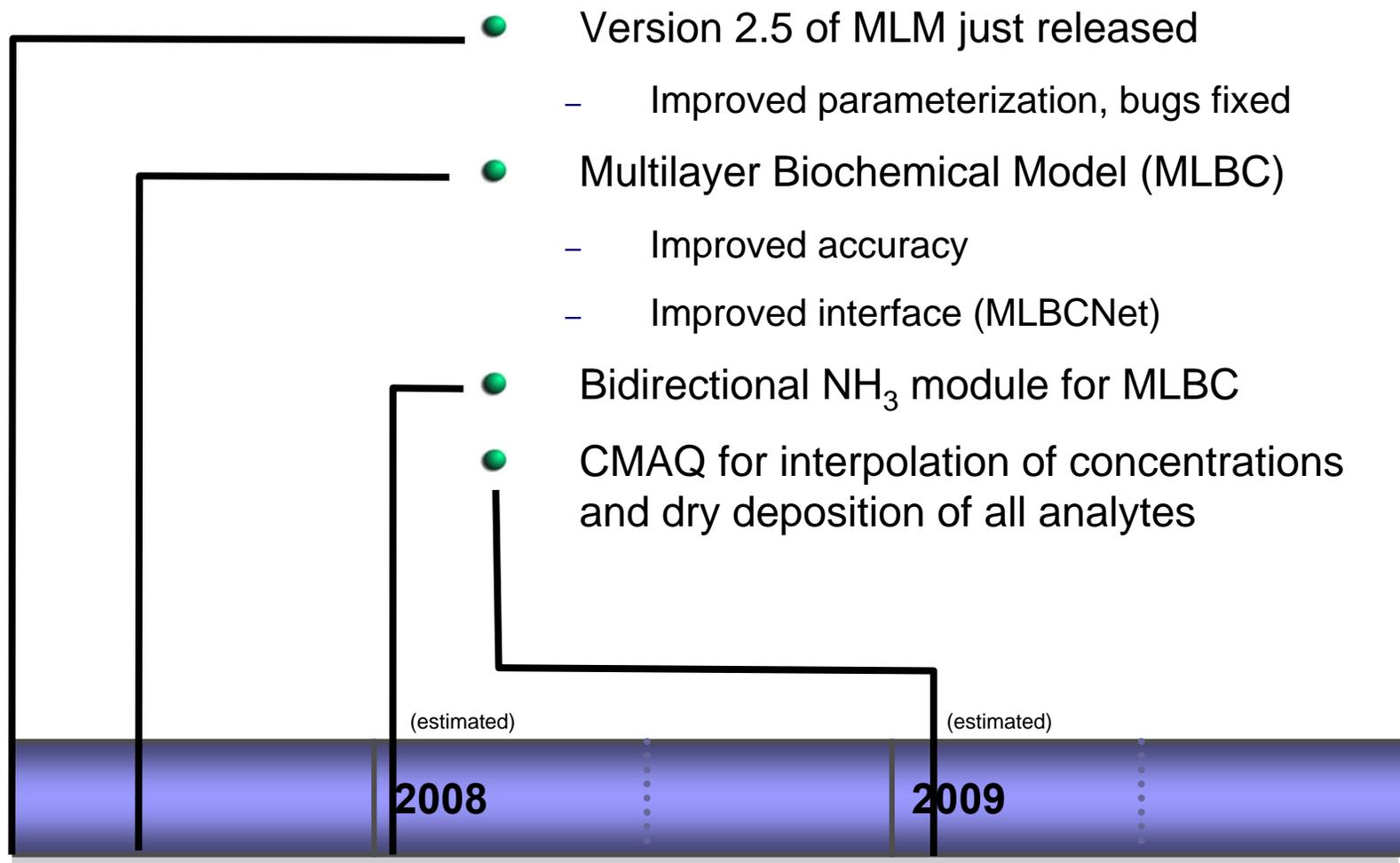
CASTNET filter pack assembly



# CASTNET 3-Stage Filterpack

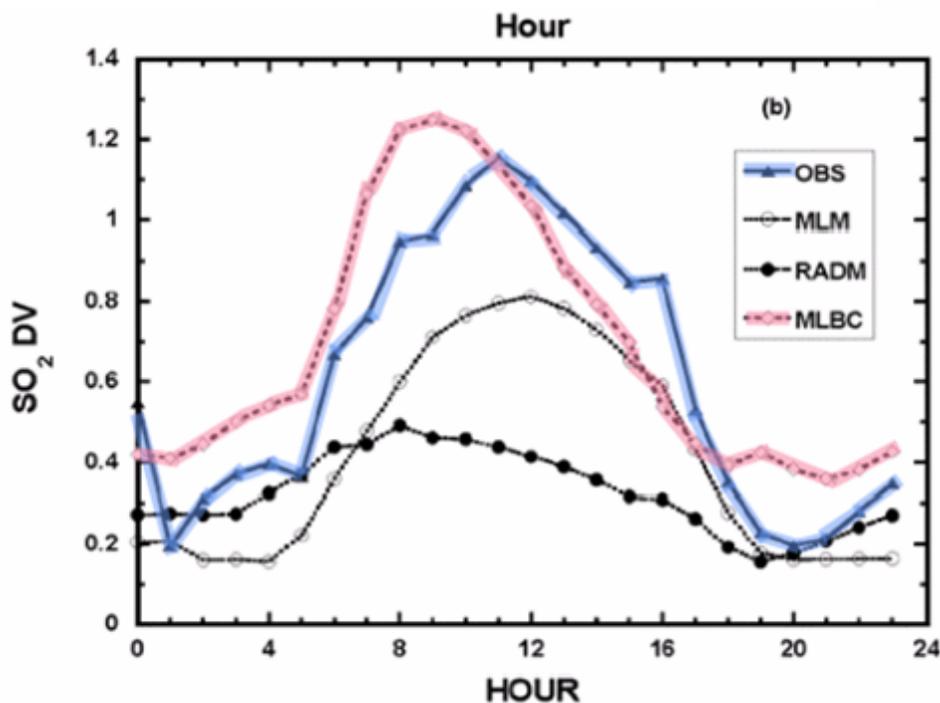


# Modeling dry deposition

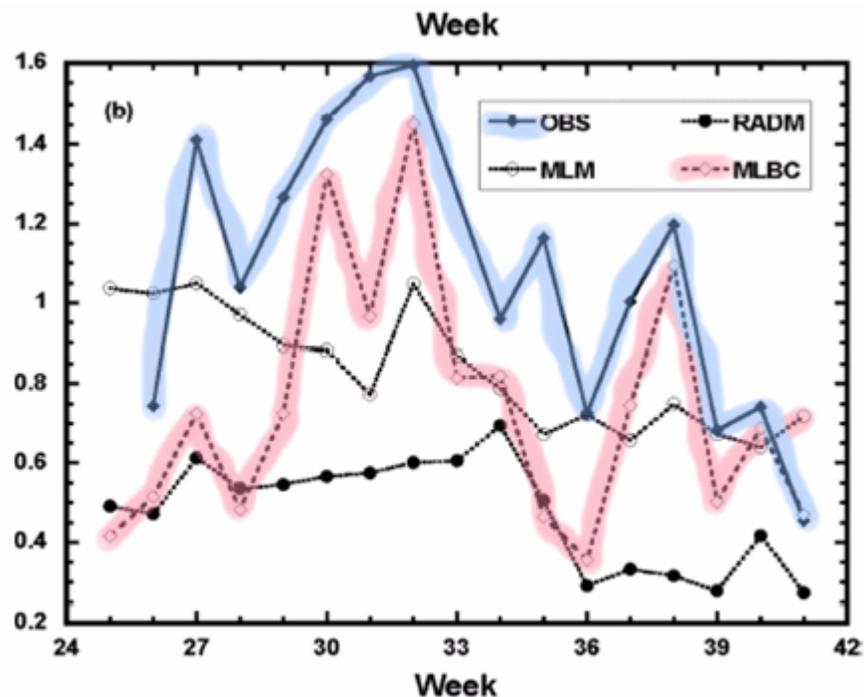


# Multilayer Biochemical Model (MLBC)

Improved performance over MLM in modeling observed deposition in time series and diurnal variations (*Wu et al, JGR 108:4014, 2003*)



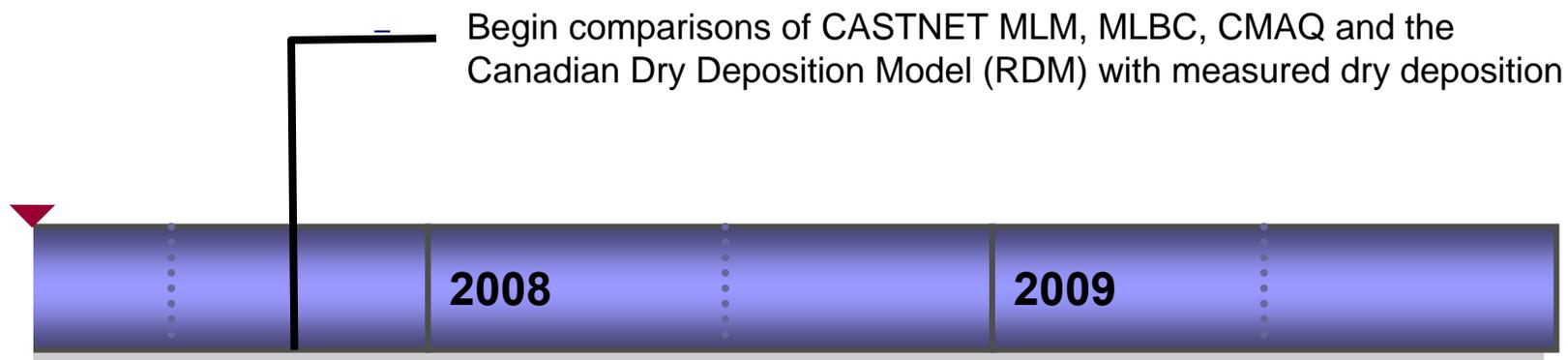
Kane Forest, NY



Nashville, TN

# Direct measurement of dry deposition is missing

- Dry deposition is the largest source of uncertainty for N deposition
  - CASTNET estimates have never been compared with direct measurements
  - Using old models to validate new models is no way to do science
- NOAA/ARL/ASMD is the only group in US proposing to make direct dry deposition measurements for model development
  - Unfunded and underutilized
  - Beneficial relationship threatened with reduced funding at ORD
- Currently working with Environment Canada at a single location
  - Gradient measurements on 50 m tower



# Near future for CASTNET

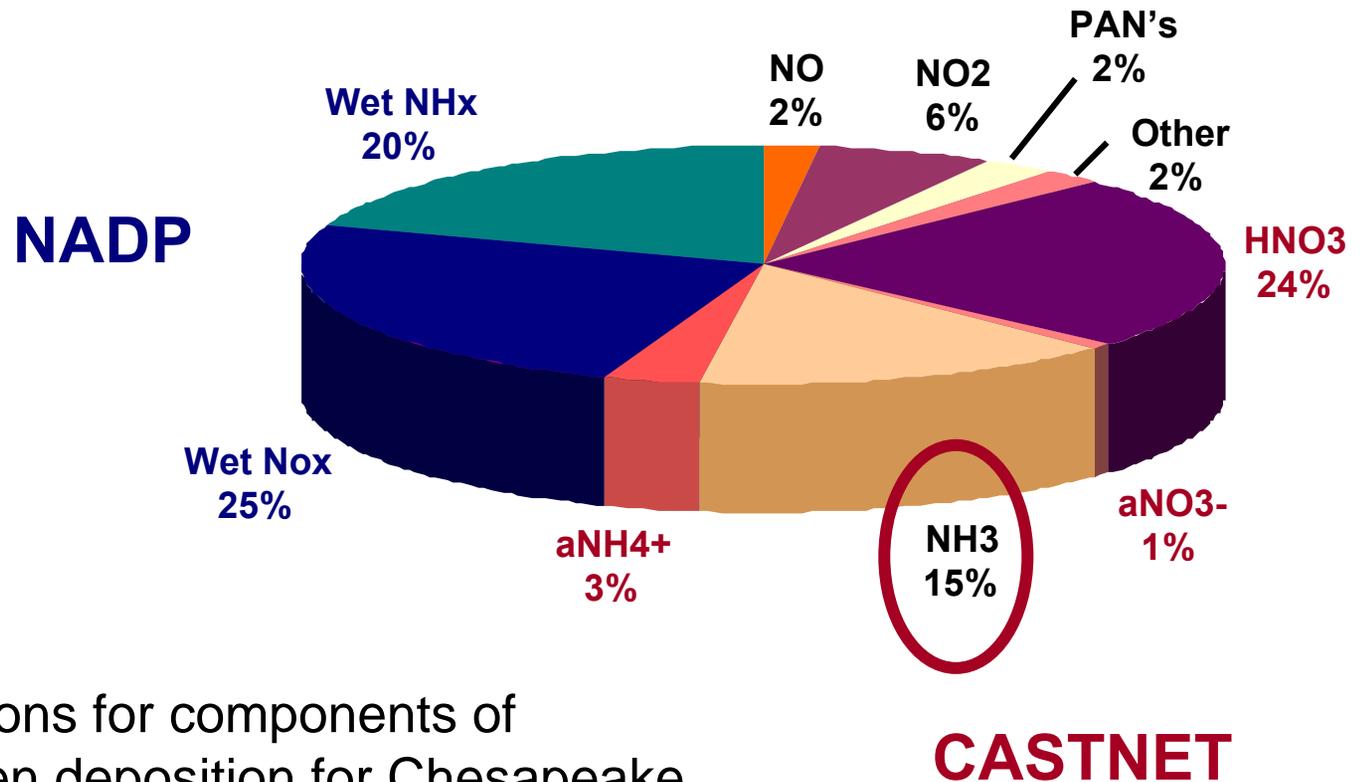
- 25% Reduction in FY08 EPA budget
- Continuing 10% annual reduction at NPS over next 4 years
- For 2008, 86 → 69 sites
  - 45 EPA sites ○
  - 24 NPS sites
- Implications for NADP
  - Elimination of 10 NADP/NTN sites
  - Substantial reduction in QA
  - Reduction in frequency of site audit program from once every three years to every 5 years



2008

2009

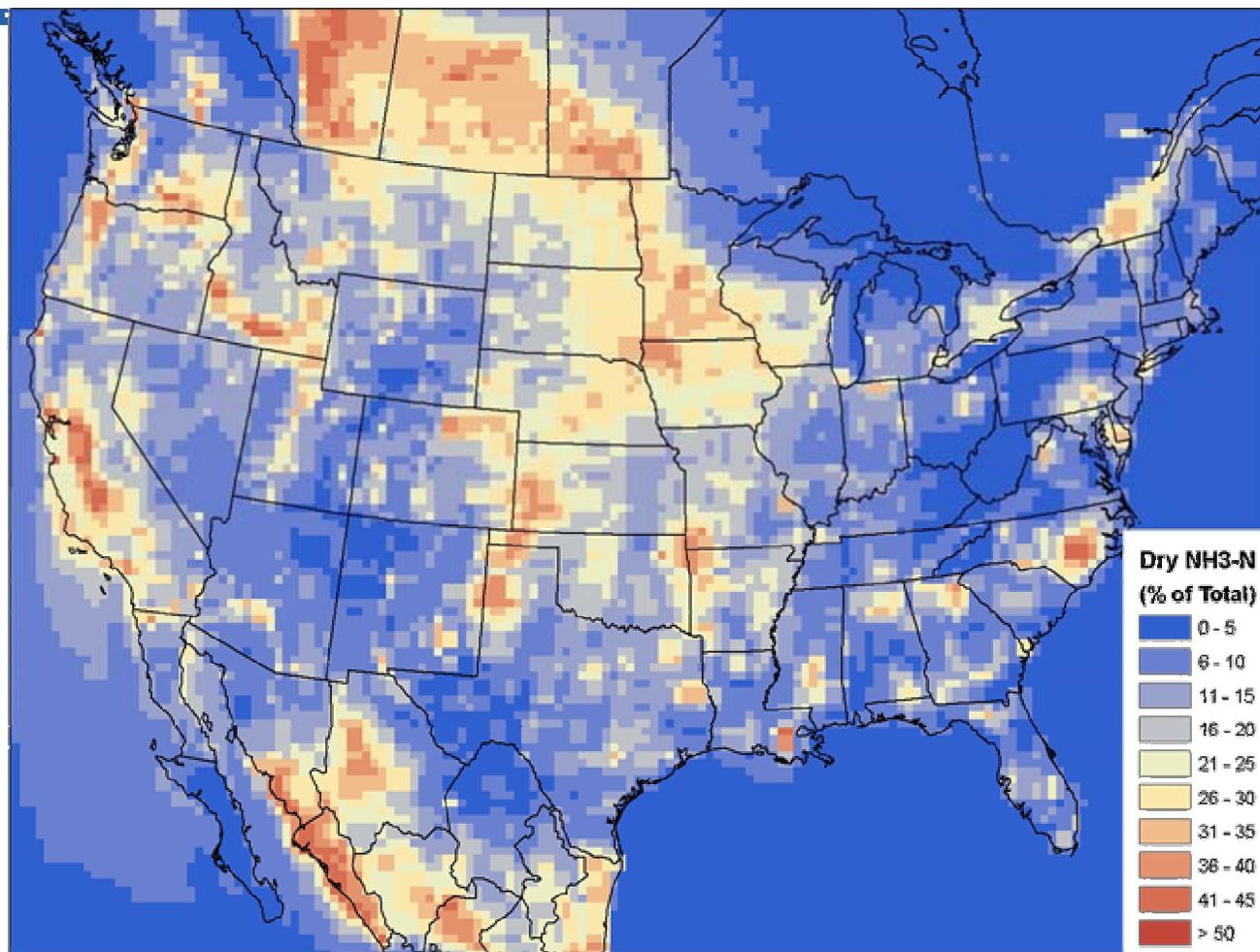
# What are we missing?



CMAQ predictions for components of reactive nitrogen deposition for Chesapeake Bay and watershed

# Percentage of total nitrogen deposition due to ammonia

- No network monitoring data available!
- Geographic patterns of deposition are variable and localized
- Local scale concentrations may vary 2-3 orders of magnitude in 10km
- Both active and passive monitoring strategies are being investigated



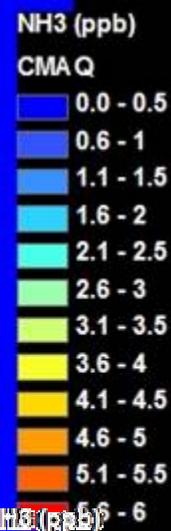
**CMAQ predicts over 30% of total N deposition is due to ammonia in some areas (2001)**

# What are our concerns about setting up an ammonia monitoring network?

- Are we measuring the right things?
  - We need total  $\text{NH}_x$  at each location:  
 $\text{wet NH}_4^+ + \text{particle NH}_4^+ + \text{gas NH}_3$
  - Do we know enough about  $\text{HNO}_3$  for ammonia measurements to be useful?
- Are other measurement technologies going to quickly supplant a network, rendering the capital investment obsolete?
- Do we know enough to model deposition of  $\text{NH}_3$ ?
  - It's more complicated than  $\text{SO}_2$  or  $\text{HNO}_3$  because of bidirectional flux
- Are we measuring in the right places?

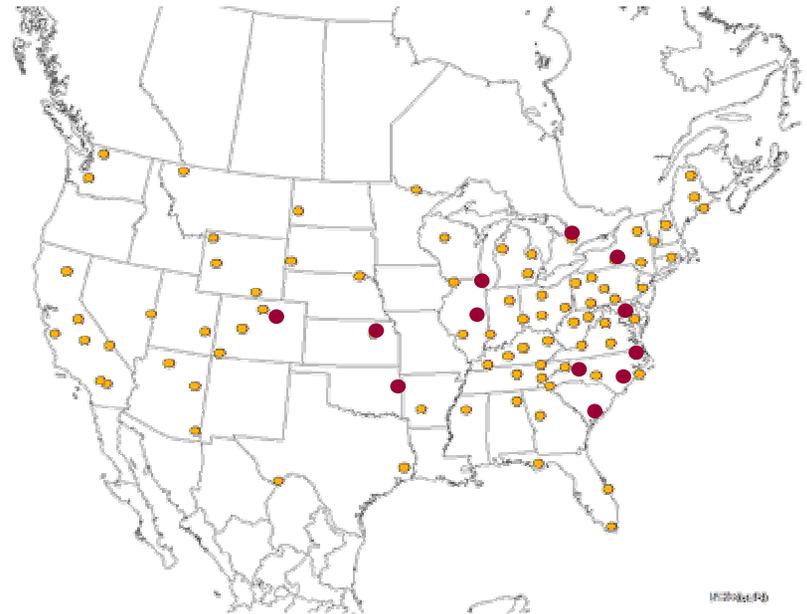
# Predicted NH<sub>3</sub> concentrations at collocated CASTNET/NADP sites

CMAQ 2001



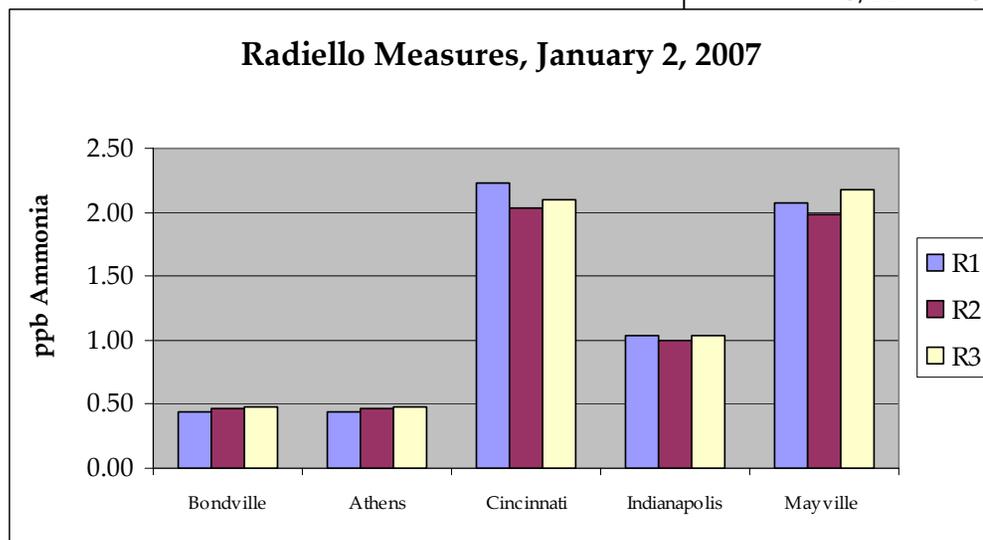
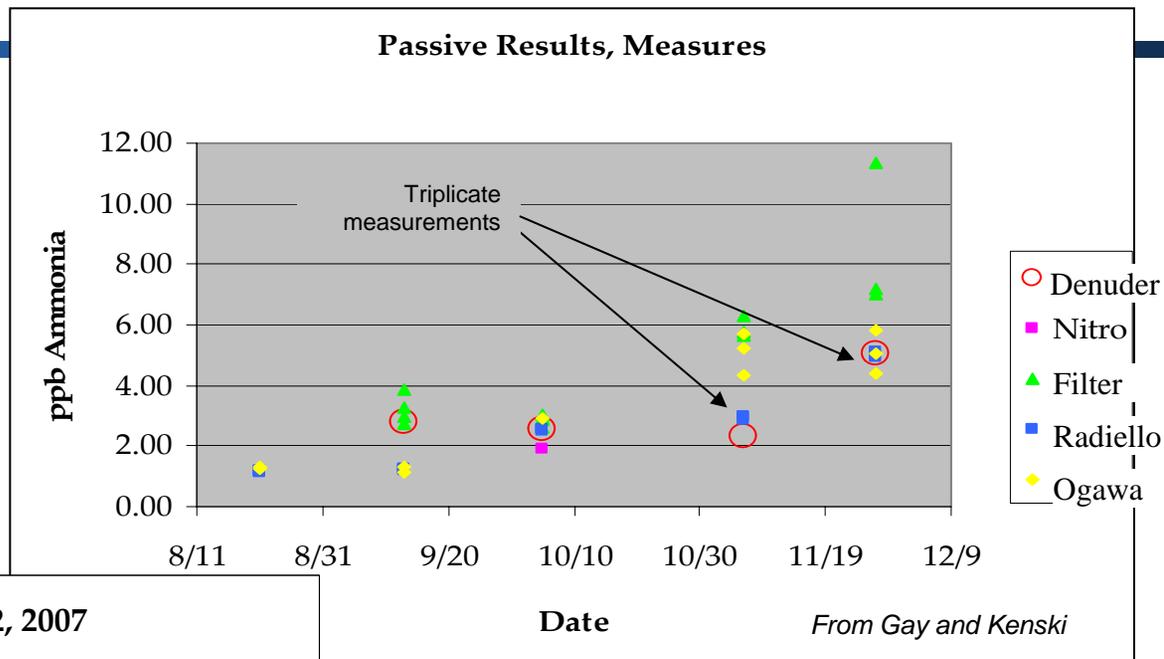
# Proposed NADP Passive Ammonia Network

- Purpose: To determine actual costs of network, sampling variability and other considerations
- Bi-Weekly measurements
- Core network of 10 EPA-sponsored sites
  - Triplicate + field blank
  - Collocated with denuder or continuous ammonia monitoring
  - Ongoing evaluation of data will be used to determine if frequency of field blanks and replicates may be reduced
  - \$7700 per site
- QAPP & SOPs
- Total program cost \$225K over two years
- Additional sites may be added at \$5k/site



# Radiellos had very promising results

- Best accuracy compared to denuder measurements
- Best reproducibility
- Lowest detection limits



# Change in sampling protocols

- CAMD investigating modified Super-SASS samplers at CASTNET
  - Replace filterpacks with denuder/filterpacks for  $\text{HNO}_3$  and  $\text{NH}_3$
  - Less bias for  $\text{NO}_x$  and  $\text{NH}_x$
  - Add daily protocol for better temporal resolution at some sites
  - Further reduction in the number of sites due to higher cost of sampling
- OAQPS testing SASS sampler with ammonia cartridge for Speciation Trends Network (STN) sites

