



Detecting Past and Future Trends in Nitrogen Deposition: A Modeling Study to Guide the Placement of Future Monitoring Sites

Robert W. Pinder, Alice B. Gilliland, Robin L. Dennis
Atmospheric Modeling Division, NOAA Air Resources Laboratory,
in partnership with USEPA National Exposure Research Laboratory

National Atmospheric Deposition Program Annual Meeting
September 11, 2007



RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions



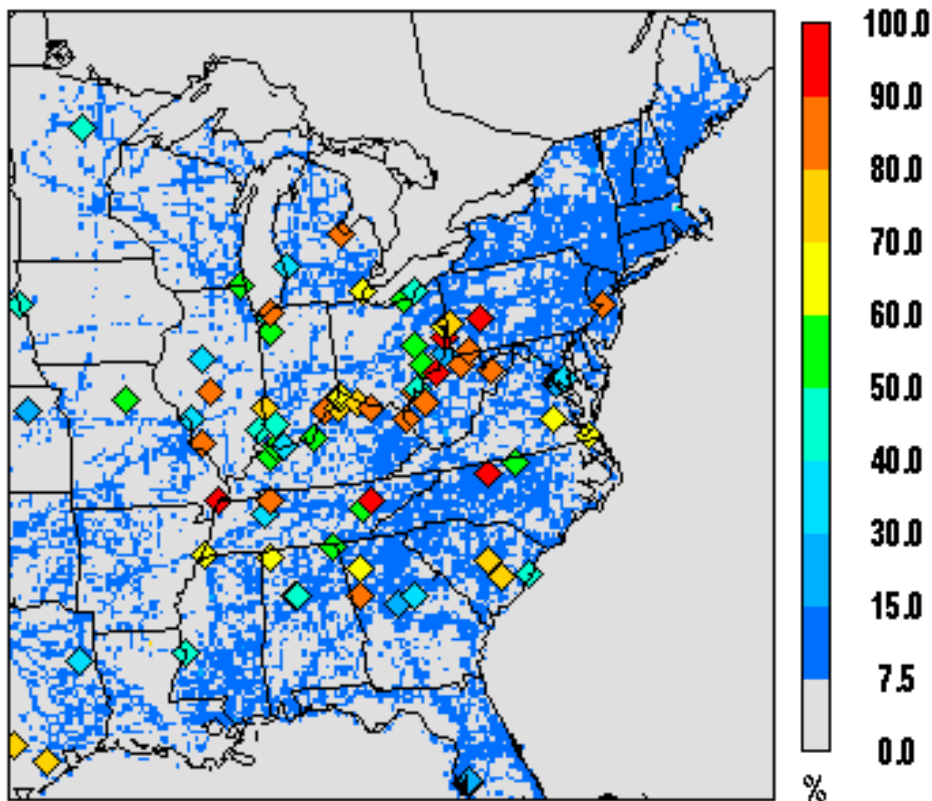
Are current national monitoring networks capable of detecting future trends in nitrogen deposition?

1. Use the air quality model CMAQ to predict future trends in nitrogen deposition
2. Evaluate the air quality model CMAQ using known emission changes from the past: NOx State Implementation Plan Call (2002-2005)
3. For indicator trends that are well simulated by CMAQ, evaluate coverage of national networks for future deposition changes: Clean Air Interstate Rule (2010, 2020)



Natural Experiment: NO_x State Implementation Plan Call

NO_x Emission reduction, 2002-2004



Source: Gilliland et al. 2007, in review at *Atmospheric Environment*

NO_x emission change relative to 2002:

Sector	2004	2005
Power Plants	-36%	-22%
Vehicles	-12%	-18%
Total	-13%	-15%

- Use CMAQ to simulate summer of 2002, 2004, 2005
- Compare to observed change in network observations



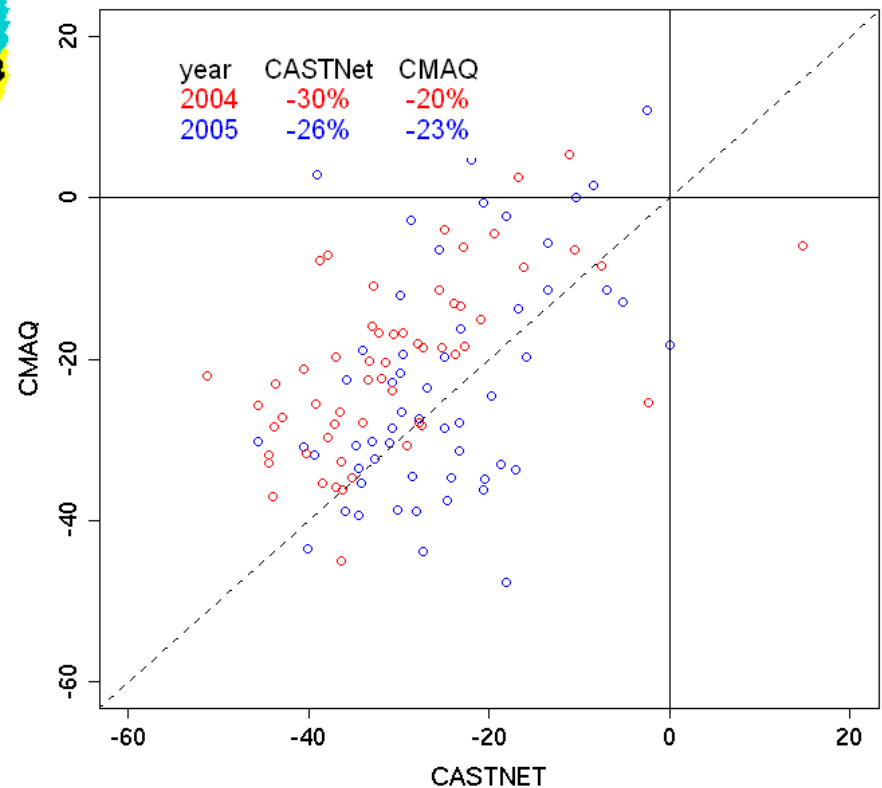
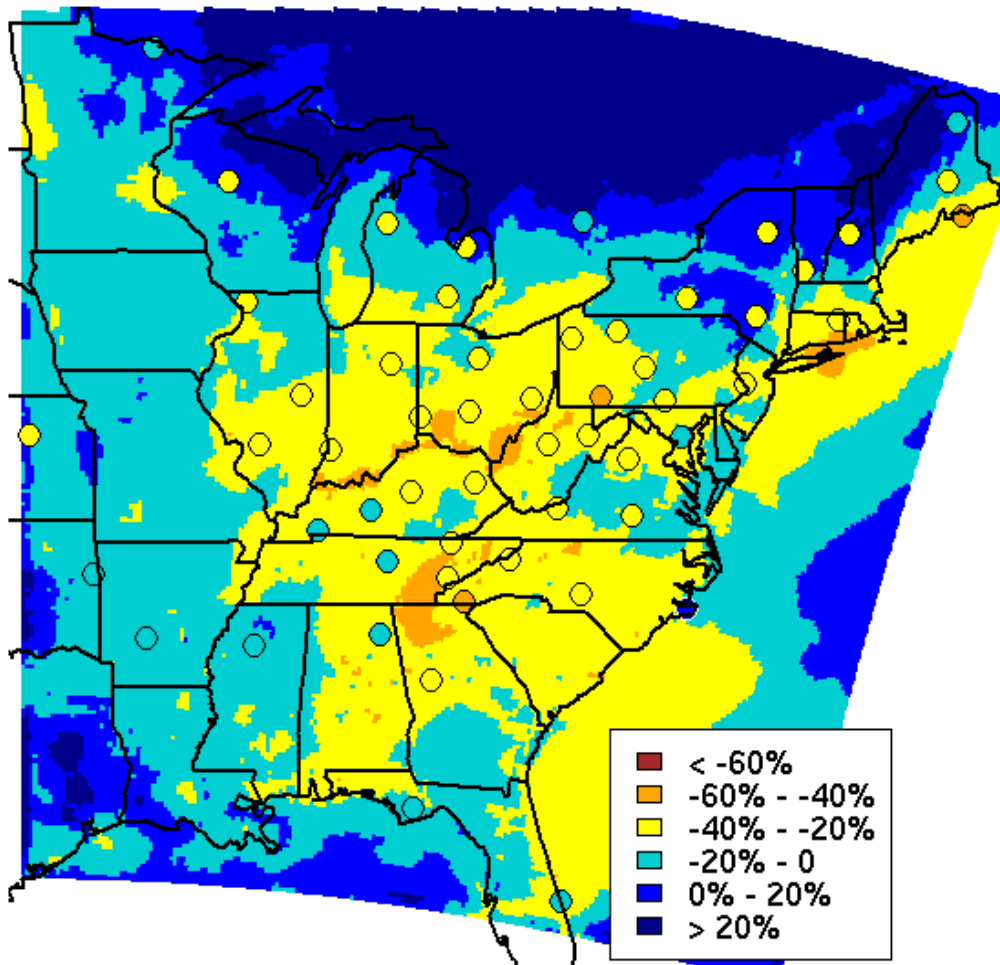
RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions



CASTNet and the NO_x SIP Call

Percent change summer average total nitrate concentration,
relative to year 2002



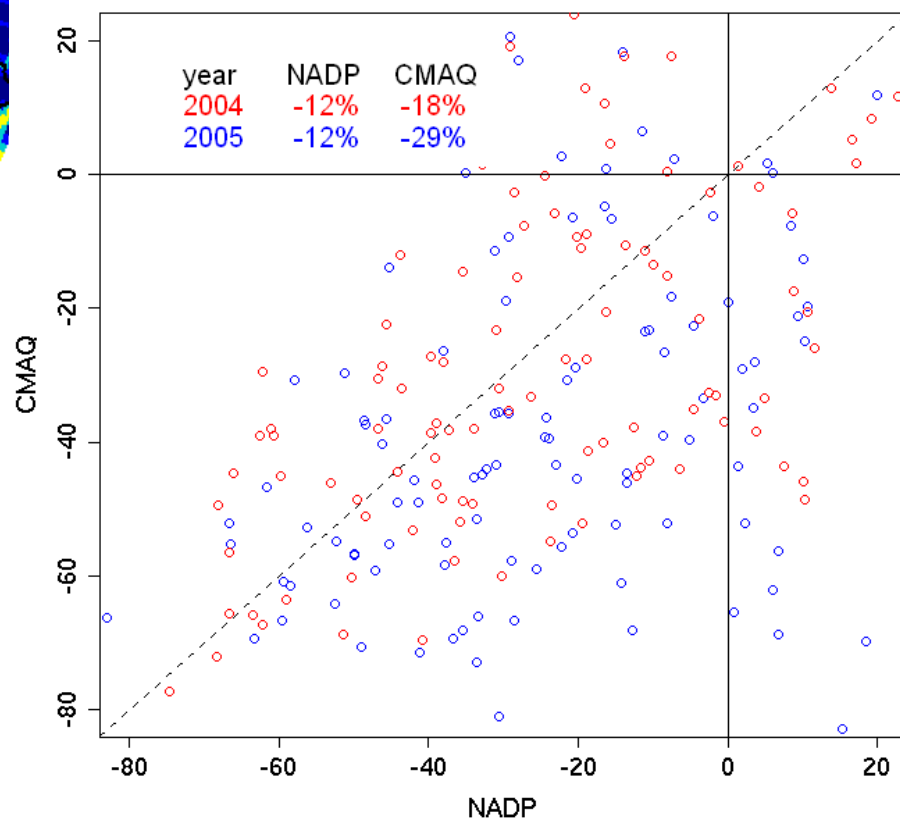
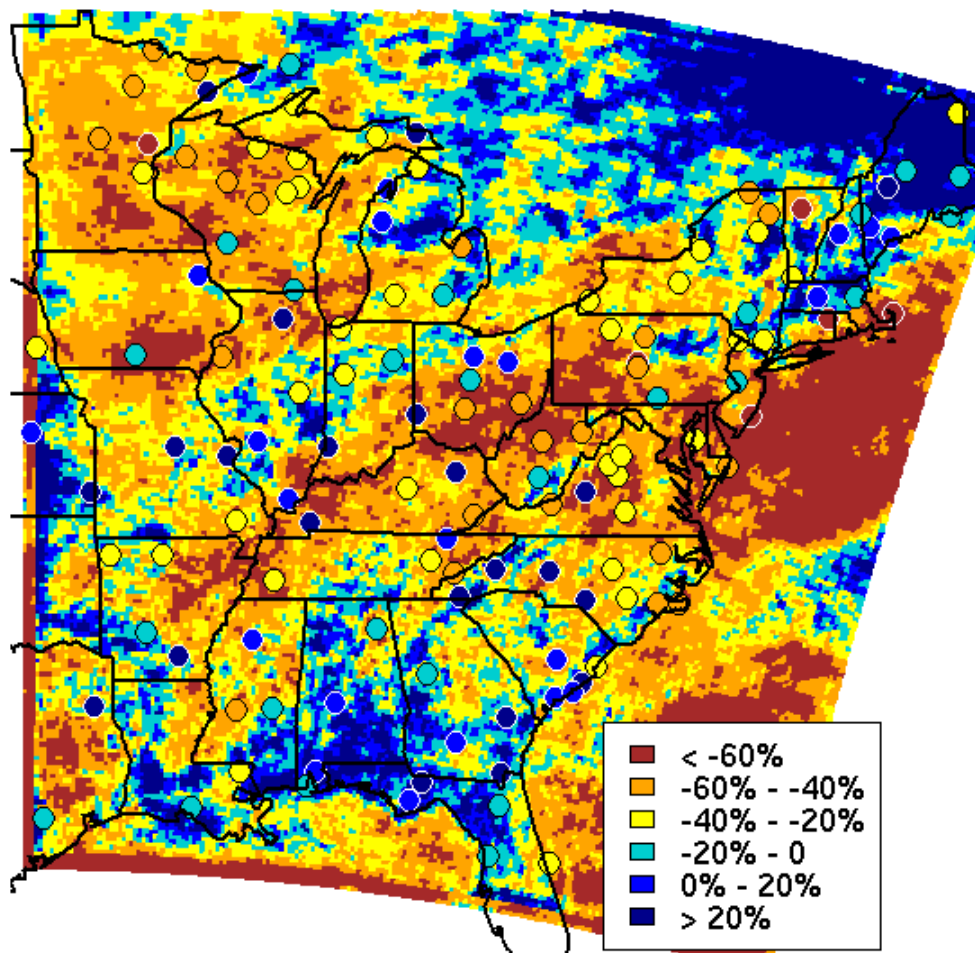
RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions



NADP and NO_x SIP Call

Percent change summer average nitrate wet deposition, relative to year 2002



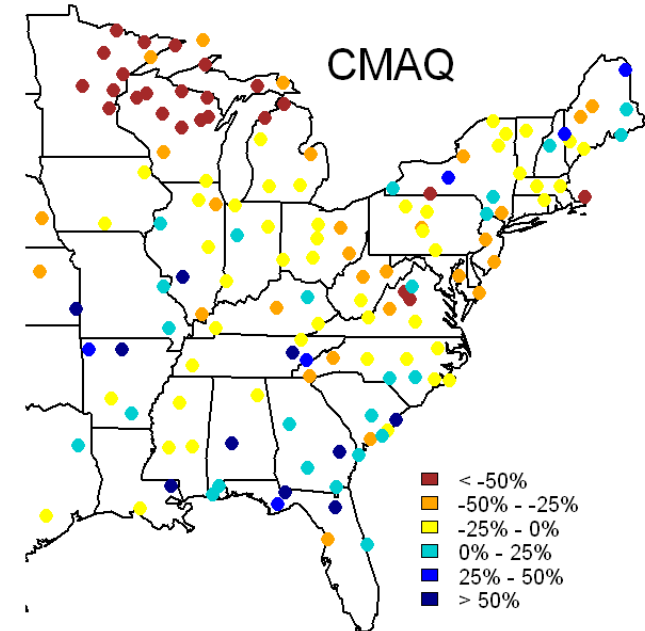
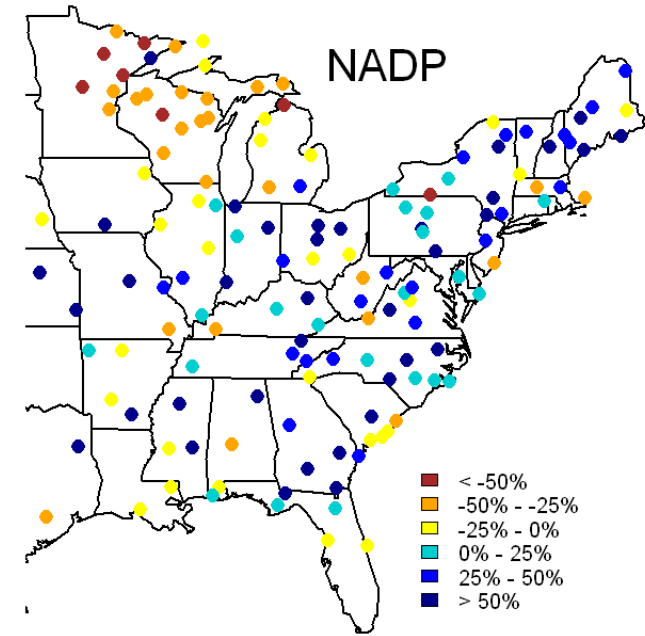
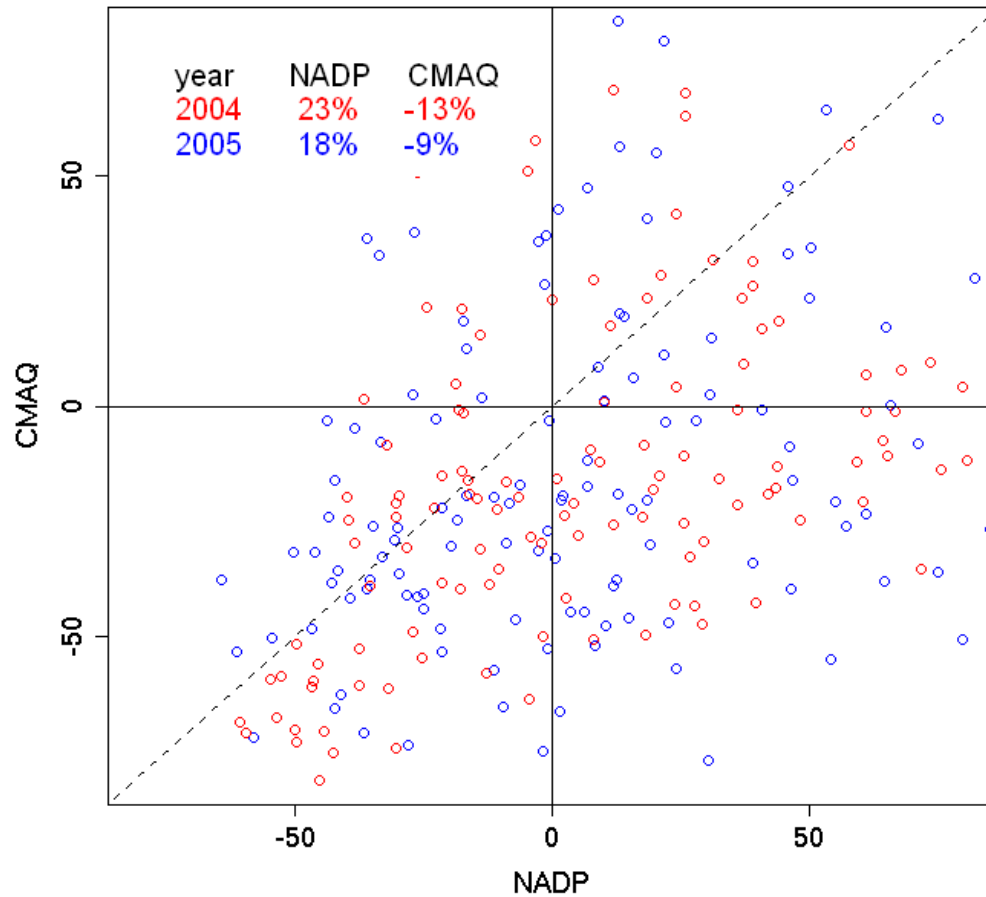
RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions



Relative Change in Precipitation

Percent change precipitation, relative to 2002



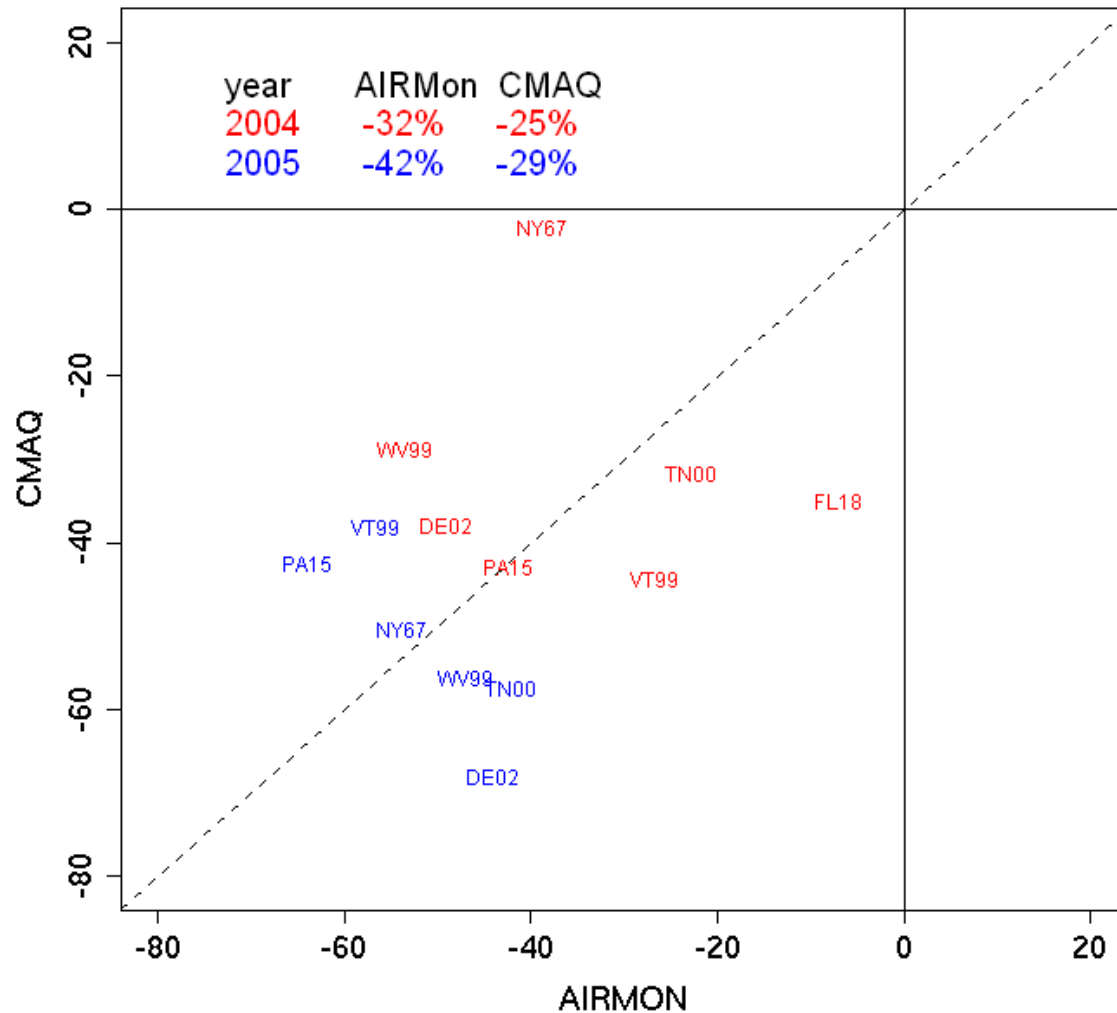
RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions



AIRMon:

High time resolution nitrate wet deposition measurements



Explanations:

- Differences in AIRMon protocol:
 - Daily samples
 - Chilled to minimize biological activity
- Model performance is better at NADP stations near AIRMon locations



RESEARCH & DEVELOPMENT

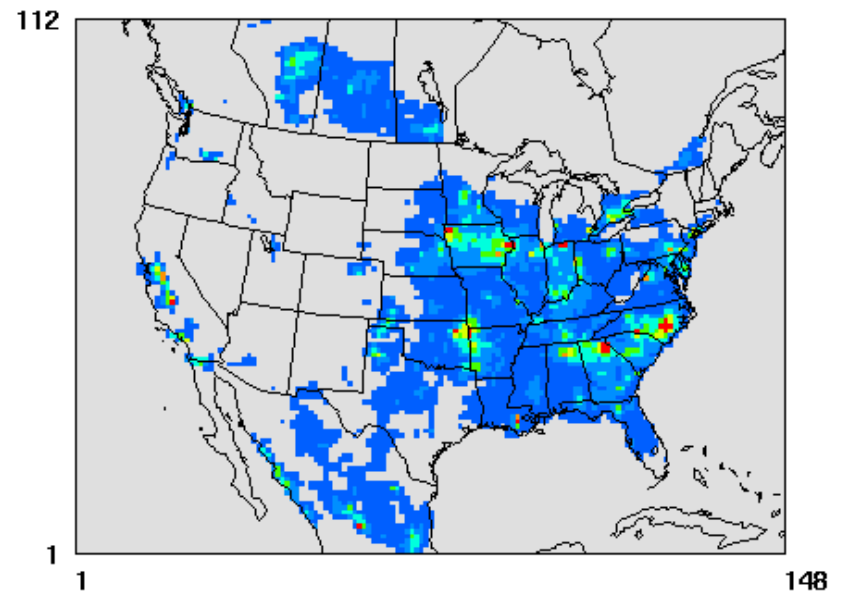
Building a scientific foundation for sound environmental decisions



Future Case: Clean Air Interstate Rule

- CAIR Rule 2001, 2010, 2020 Emissions
- Year 2001 meteorology
- 36km Continental US Domain

Model Domain and NH₃ Emissions

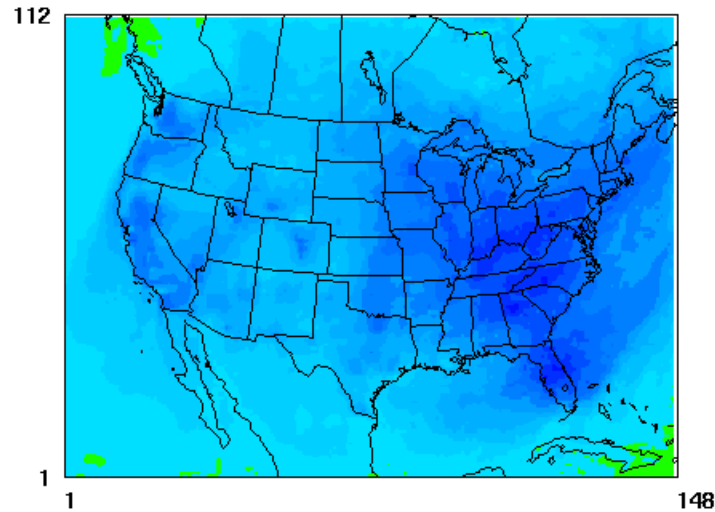


Species	2010	2020
SO ₂	-28%	-35%
NO _x	-30%	-40%
NH ₃	+4%	+13%

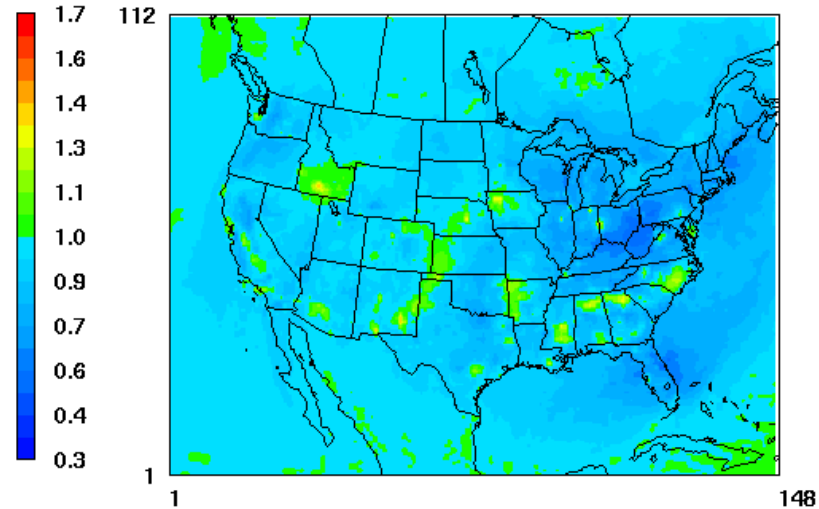


Ratio 2020:2001 Nitrogen Deposition (July)

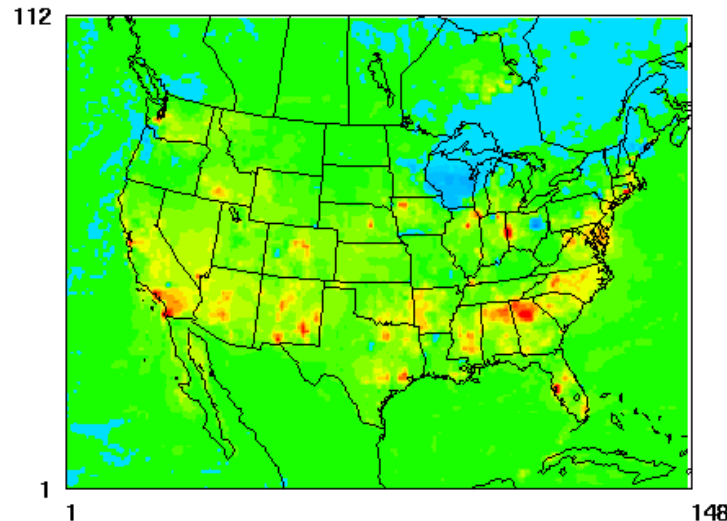
Oxidized N Deposition (Ox-N)



Total N Deposition



Reduced-form N Deposition (NH_x)



Decrease in oxidized N deposition

Increase in reduced N deposition

Total N deposition decreases, except near ammonia emission sources

Depends in part on uncertain future NH₃ emission scenario



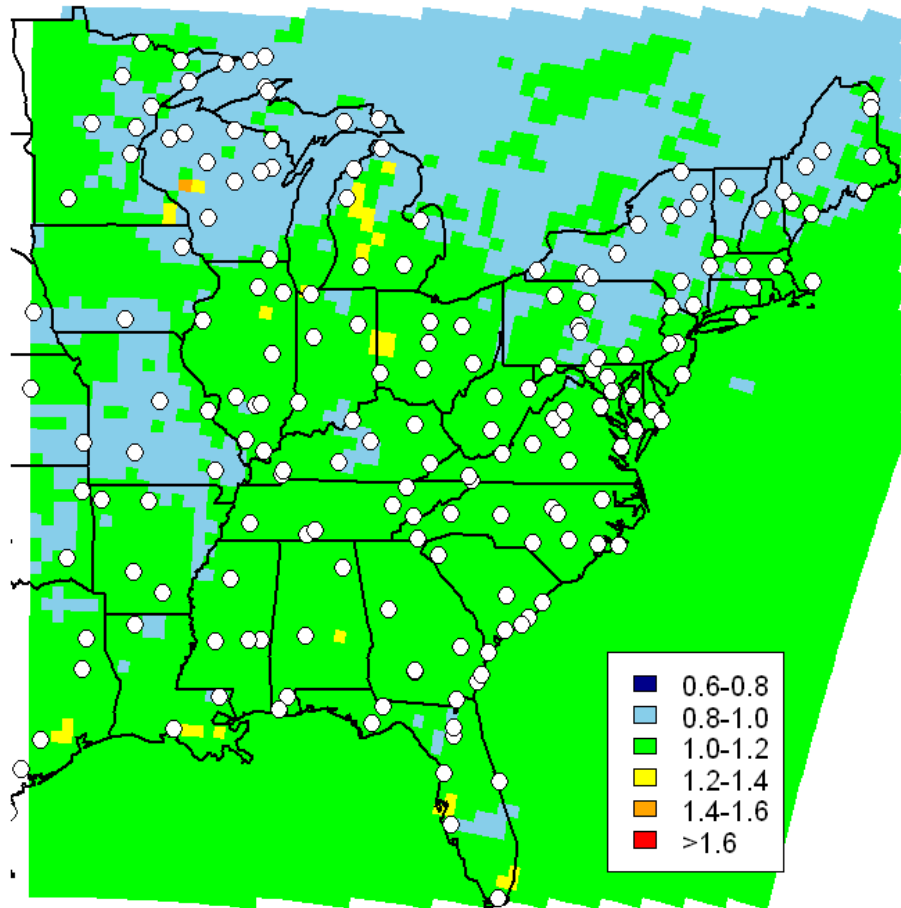
RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions

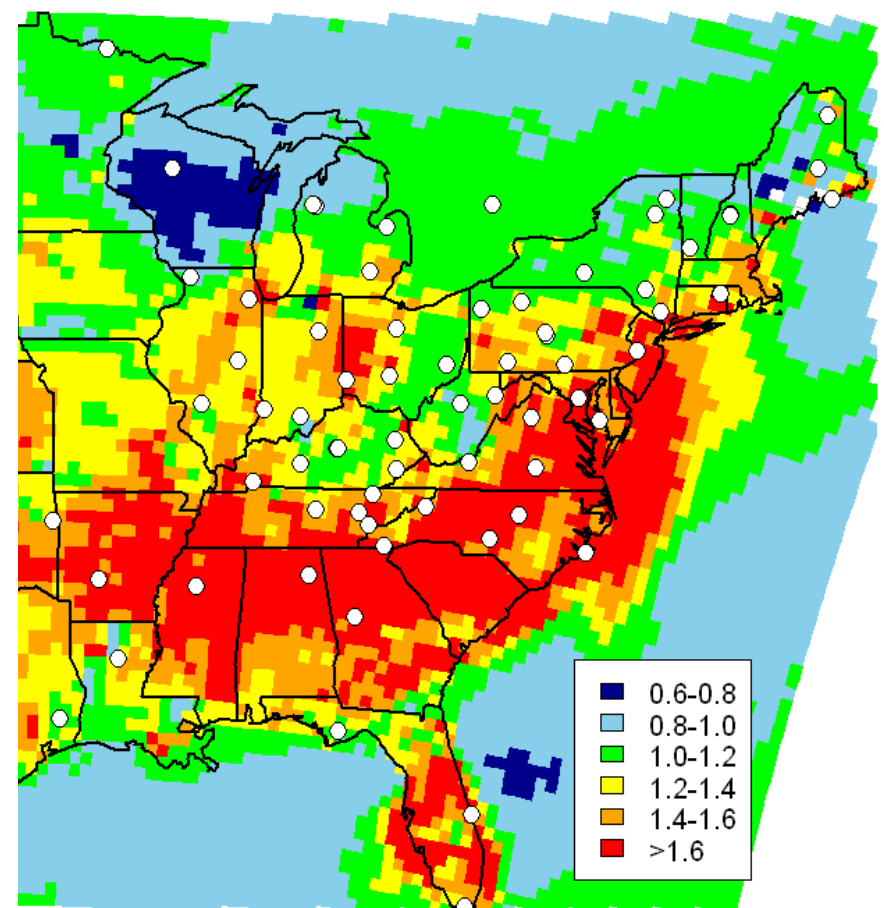


Future NH_x Deposition Change and Network Coverage

Ratio 2020:2001, NH_x Wet Deposition



Ratio 2020:2001, NH_x Dry Deposition



RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions



Are current national monitoring networks capable of detecting future trends in nitrogen deposition?

- Nitrate deposition:
 - Impact of power plant reductions captured in model and CASTNet concentrations
 - NADP has sufficient spatial coverage
 - In the future, urban plumes dominate
- Reduced form nitrogen deposition:
 - Need NH_x air concentrations
 - Future increases are due to NH_3 dry deposition near sources – both agricultural and urban



DISCLAIMER: The research presented here was performed under the Memorandum of Understanding between the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and under agreement number DW13921548. This work constitutes a contribution to the NOAA Air Quality Program. Although it has been reviewed by EPA and NOAA and approved for publication, it does not necessarily reflect their policies or views.



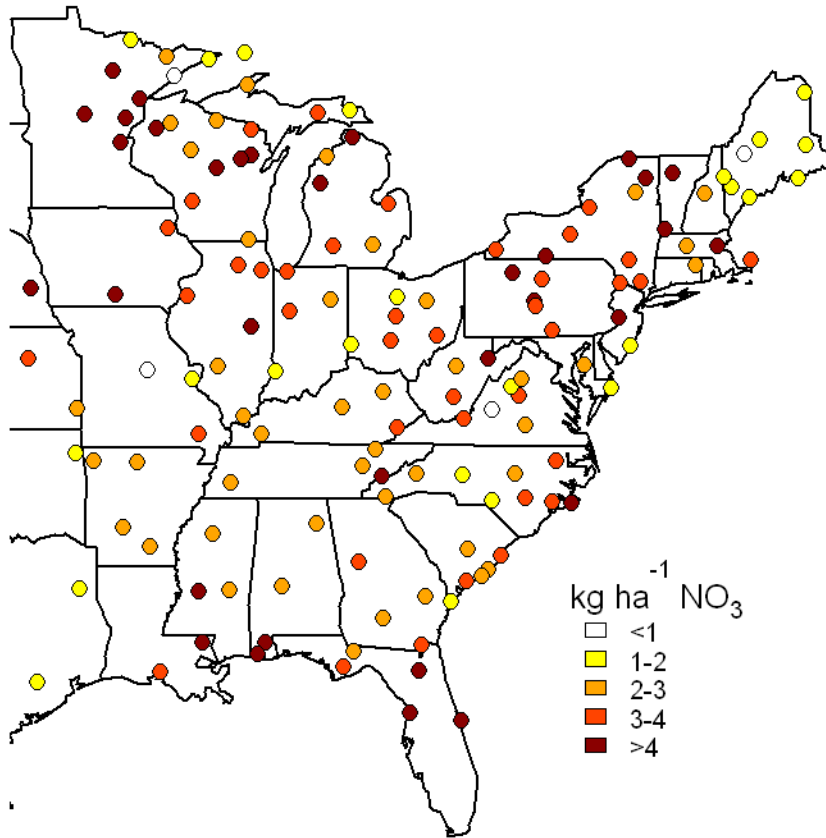
RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions

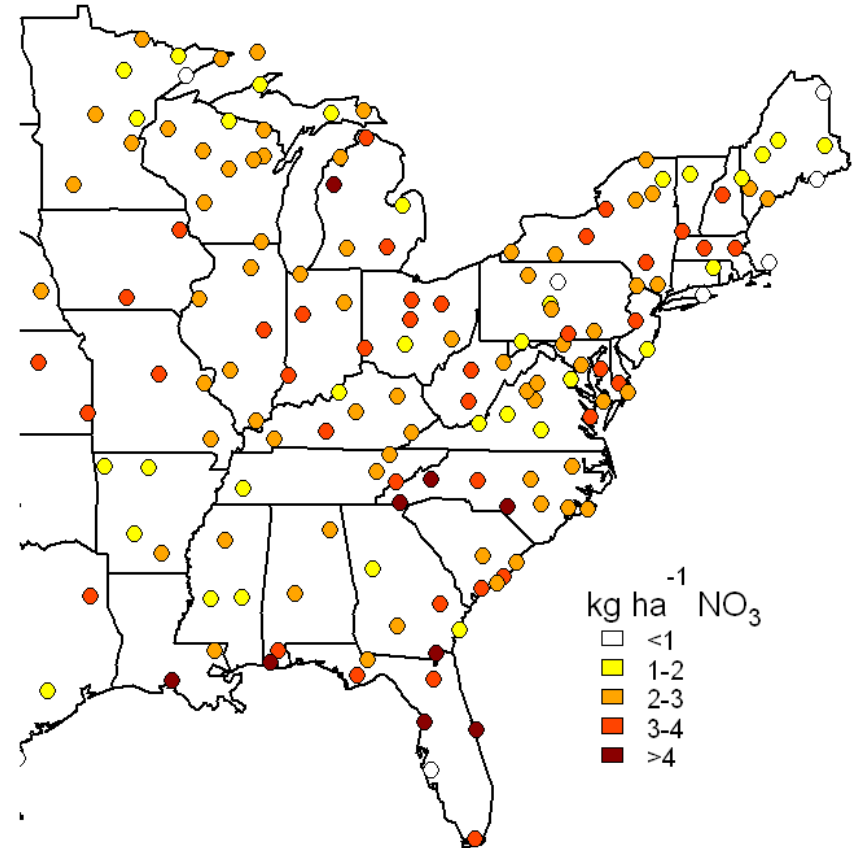


NADP and NOx SIP Call

Observed Summer 2002 total nitrate deposition



Observed Summer 2005 total nitrate deposition



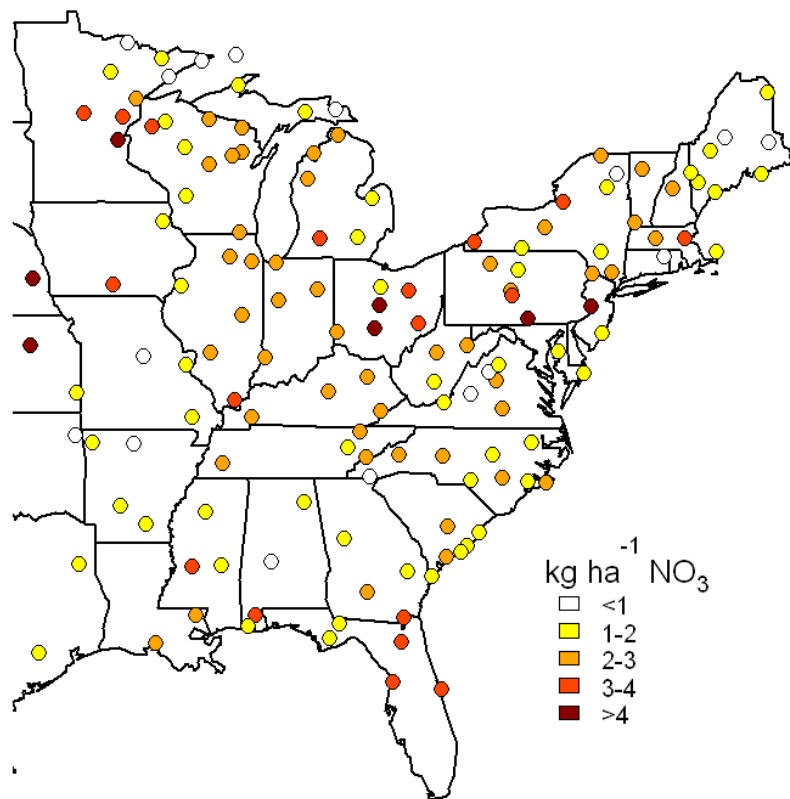
RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions

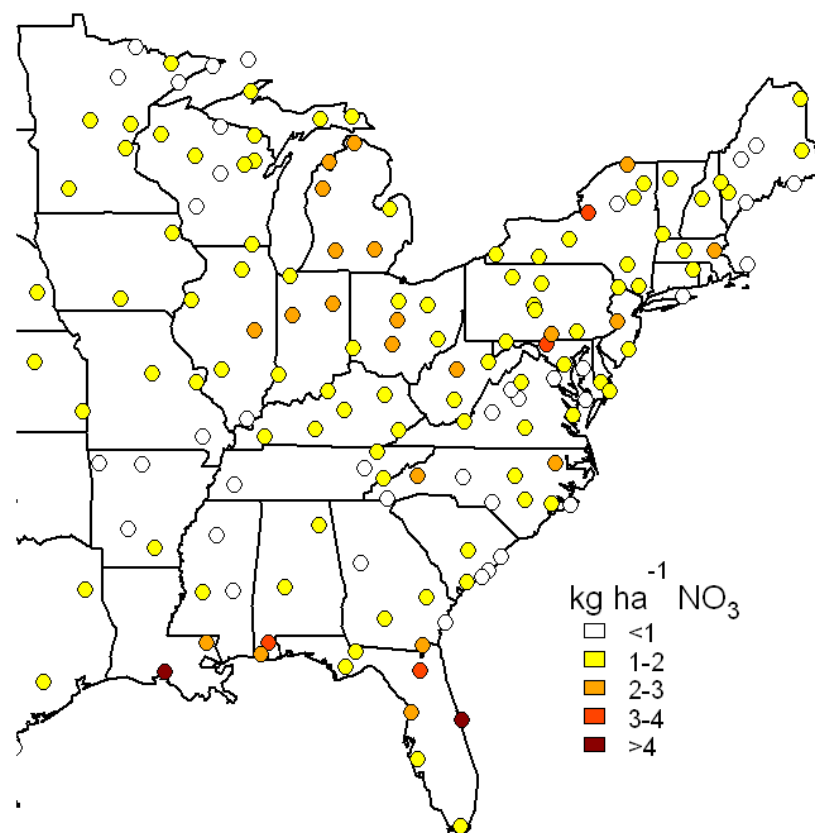


CMAQ Deposition and NO_x SIP Call

CMAQ Summer 2002 total nitrate deposition



CMAQ Summer 2005 total nitrate deposition



RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions

