Air Quality - Theme Overview

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Air Resources Laboratory

Air Resources Laboratory Review

May 3-5, 2011

Scope and Goals of ARL's Air Quality Program

- Modeling

  Goal: To improve the ozone and particulate forecasting capabilities of air quality models for the United States

  Goal: Development and use of special purpose models to estimate concentrations and deposition of harmful materials

- Measurements of Mercury, Nutrients, & Atmospheric Deposition

  Goal: Application of advanced measurement techniques to short-term intensive field studies to improve understanding

  Goal: Improve measurement approaches and understand trends and impacts on policies through participation in long-term programs

  Goal: Support forecast model development and assessment activities to protect human and environmental health

Drivers

Laws

- 1990 Clean Air Act Amendments
- Harmful Algal Bloom and Hypoxia Research Control Act

Federal Plans

- US Ocean Action Plan
- NOAA Next Generation Strategic Plan

Agreements

- Memorandum of Understanding between EPA and NOAA
- NOAA is the US representative to the World Met. Organization
- Formal agreements with EPA, NPS, universities and foreign govt's

Brief History of ARL Air Quality Efforts: **Observations**

- 1970s -- Led the first extensive research study of air pollution in an American urban area-St. Louis, MO
- 1970s -- Initiated measurements of pollutants in precipitation, in collaboration with EPA and other federal agencies
- 1980s --Initiated global precipitation chemistry monitoring at remote locations
- 1990s --Established methodologies for estimating nitrogen deposition to coastal ecosystems
- 1990s -- In collaboration with Oak Ridge National Lab, developed techniques to measure the flux of mercury between the air and land
- 2000s -- Conducted a comprehensive measurement and modeling study of atmospheric nitrogen pollutants around Tampa Bay
- 2000s --Deployed four sites for measuring multiple mercury compounds in the atmosphere
- Current – Operates five speciated mercury sites, conducts numerous short field intensives

Brief History of ARL Air Quality Efforts: **Models**

- 1950s – Began adapting dispersion models to air quality applications
- 1960s – Pasquill-Gifford Stability Classes developed to address vertical movement of pollutants
- 1970s --Developed air quality models to predict effects of proposed air quality regulations
- 1980s --Initiated development of the HYbrid Single-Particle Lagrangian Integrated Trajectory model
- 1990s -- Developed air quality models for regional/urban ozone, particulate matter, mercury, and other pollutants
- 2000s -- Developed wildfire smoke forecast system
- 2000s – Refined models of mercury and dioxin and carried out policy-relevant source-receptor assessments for sensitive ecosystems
- 2000s -- Operationalized forecast systems for ozone and wildfire smoke
- Current – Focus on forecasting fine particulates and experimental dust forecasts

Primary models being used and developed by ARL

HYSPLIT

HYbrid **S**ingle-**P**article **L**agrangian **I**ntegrated **T**rajectory model

Trajectory and Fate/Transport

Primarily Lagrangian but new Eulerian capabilities

Used at ARL for emergency response, volcanic ash, dust and smoke, air toxics, …

Used around the world via ARL's **READY** system

CMAQ

Community **M**ulti-scale **A**ir **Q**uality model

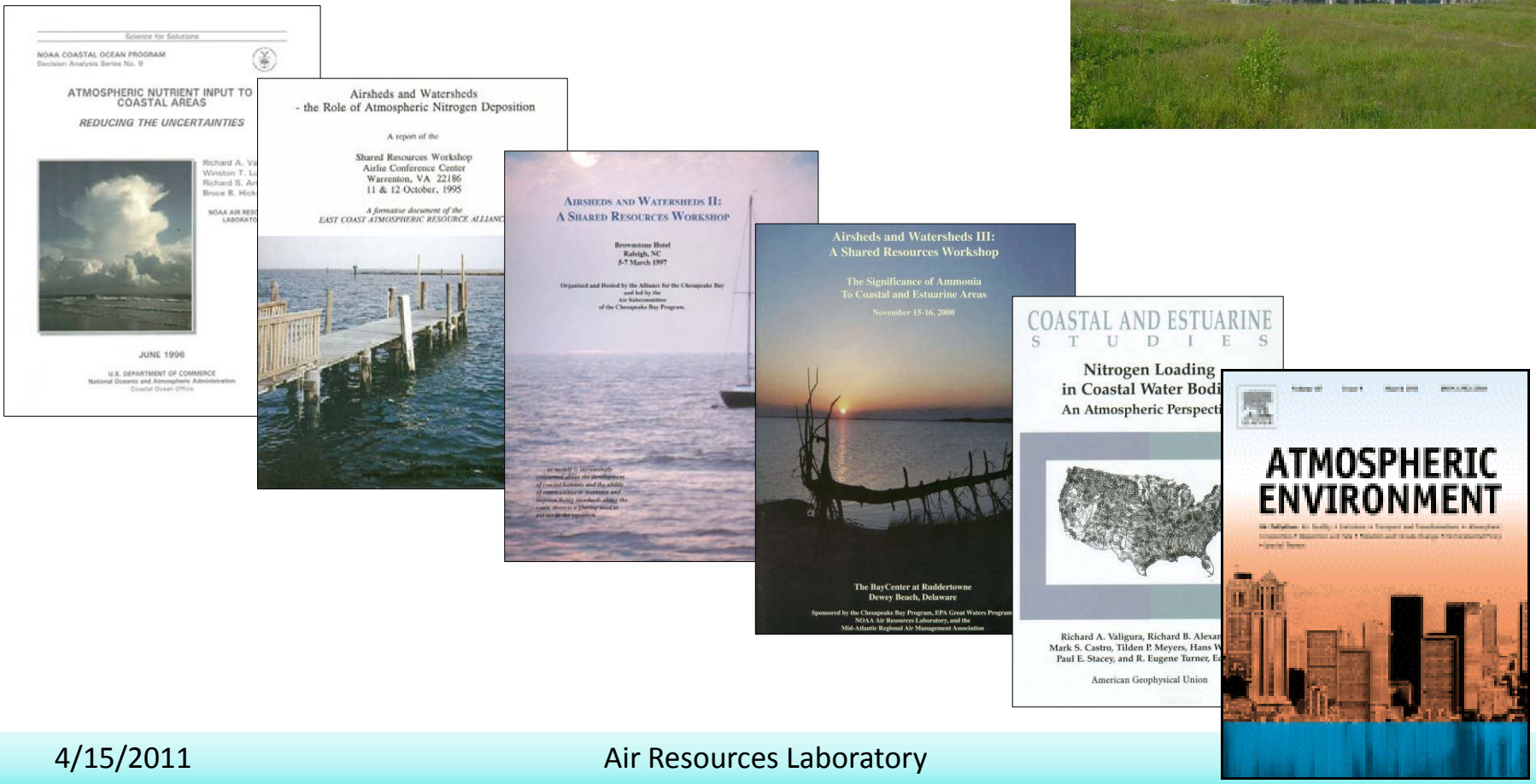
Fate/Transport

Eulerian

Used at ARL for Air Quality Forecasting (ozone and particulate matter)

Close historical and current collaboration with EPA

Atmospheric Nitrogen Deposition in Estuarine Ecosystems



ARL's Airborne Studies

From approximately 1985 through 2000, ARL operated with two aircraft, utilized in

- over-water studies to study air-sea exchange
- terrestrial air-surface exchange studies
- studies of atmospheric nitrogen
- mercury pollution studies

The Sky Arrow is a commercially available flux aircraft developed as a result of our flux research.

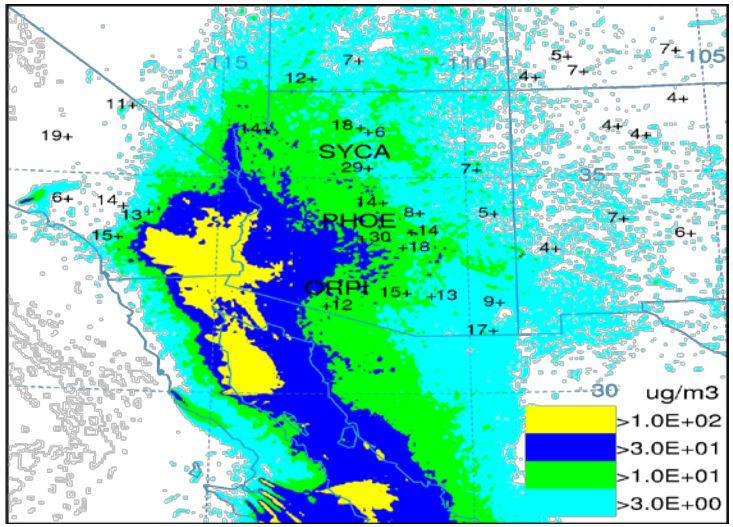
Current aircraft needs are met using a Piper Navajo aircraft via an agreement with the U. Tennessee Space Institute. The key air quality applications presently focus on mercury chemistry in the atmosphere.

Guiding Philosophies

- **Targeted Research Topics**
  - Emerging issues with significant impacts
  - Policy relevant
  - Operational applications
  - Potential significant contributions by ARL
  - Significant human health and ecosystem research linkages

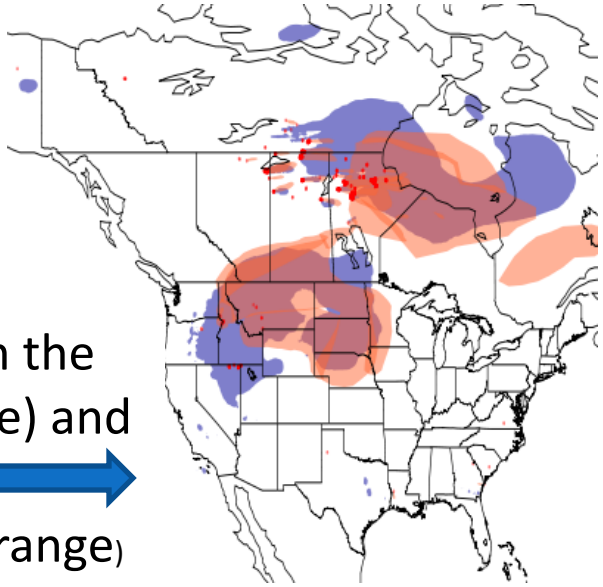
- **Research Approach**
  - Best available science
  - Broad collaboration
  - Maintain long-term data sets
  - Conduct short-term intensive studies as required
  - Communicate via peer-reviewed literature
  - On time and within budget

Forecasting Transport of Dust and Smoke

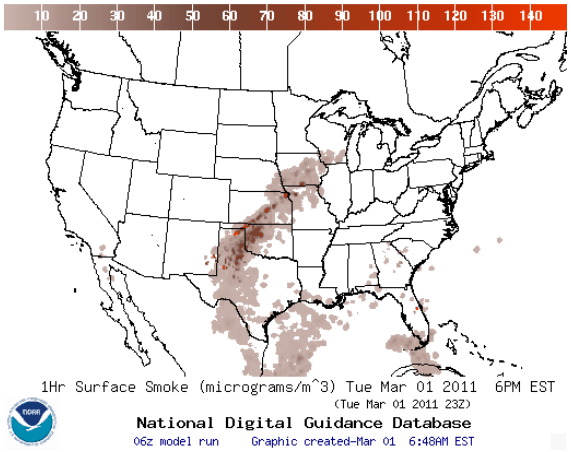


ARL Experimental dust forecast

Smoke column from the HYSPLIT model (blue) and NESDIS Hazardous Mapping System (orange)

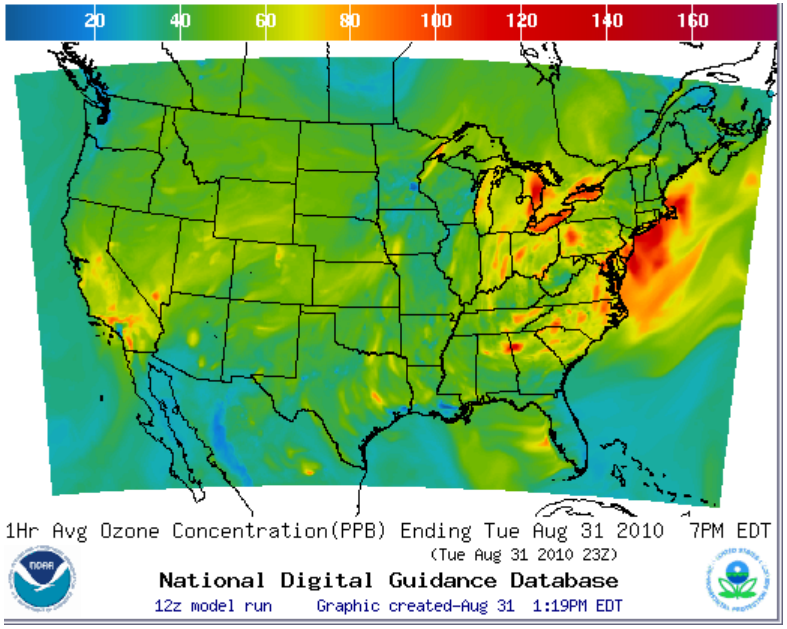


- Light scattering properties of particles influence climate
- Particulate matter contributes to air quality degradation
- Most dust/smoke is emitted from intermittent sources of natural origin
- Smoke and dust influence air quality on local to global scales
- ARL studies smoke release height and new dust emissions algorithms
- ARL's primary customer is the NWS National AQ Forecast Capability

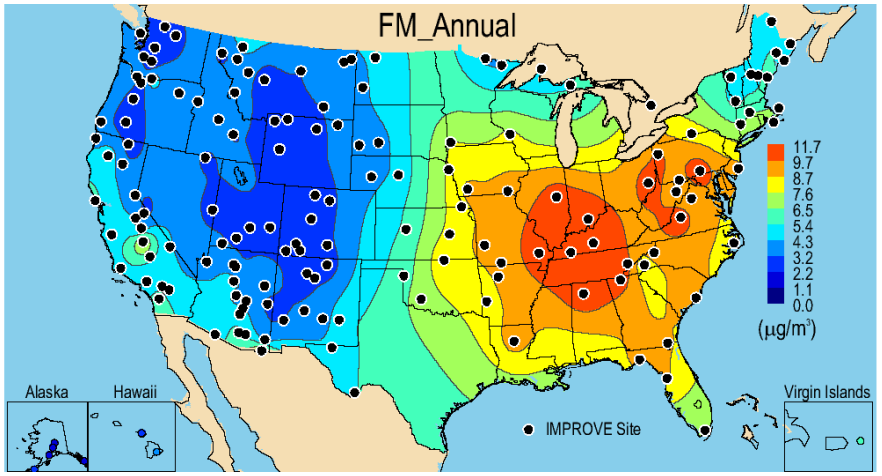


NOAA/NWS Air Quality Forecast Guidance

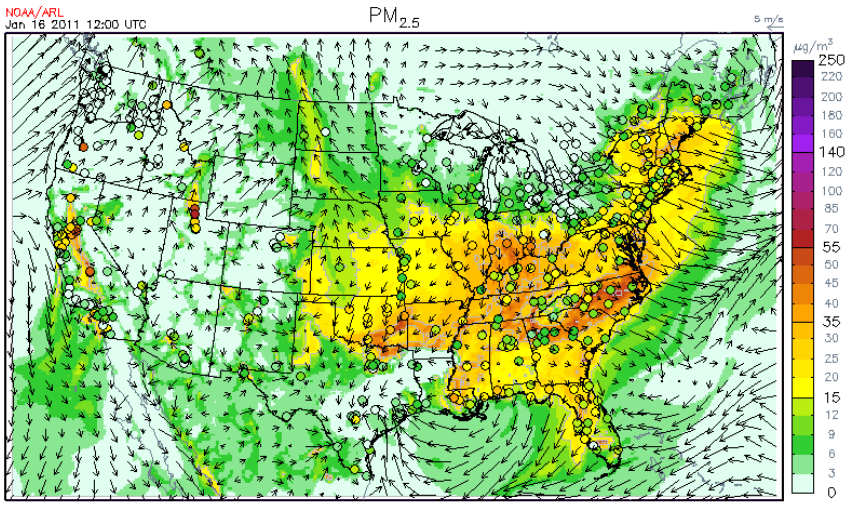
Air Quality Forecasting Program



Ozone



Mean $PM_{2.5}$ mass concentration for IMPROVE monitoring sites, 2005 through 2008.



Fine particulate matter

Mercury: Measurements and Modeling

MEASUREMENTS

- speciated atmospheric mercury
- other air pollutants, e.g., SO_2, O_3, CO
- wet deposition
- air-surface exchange

Modeling used to aid in data interpretation and measurement planning

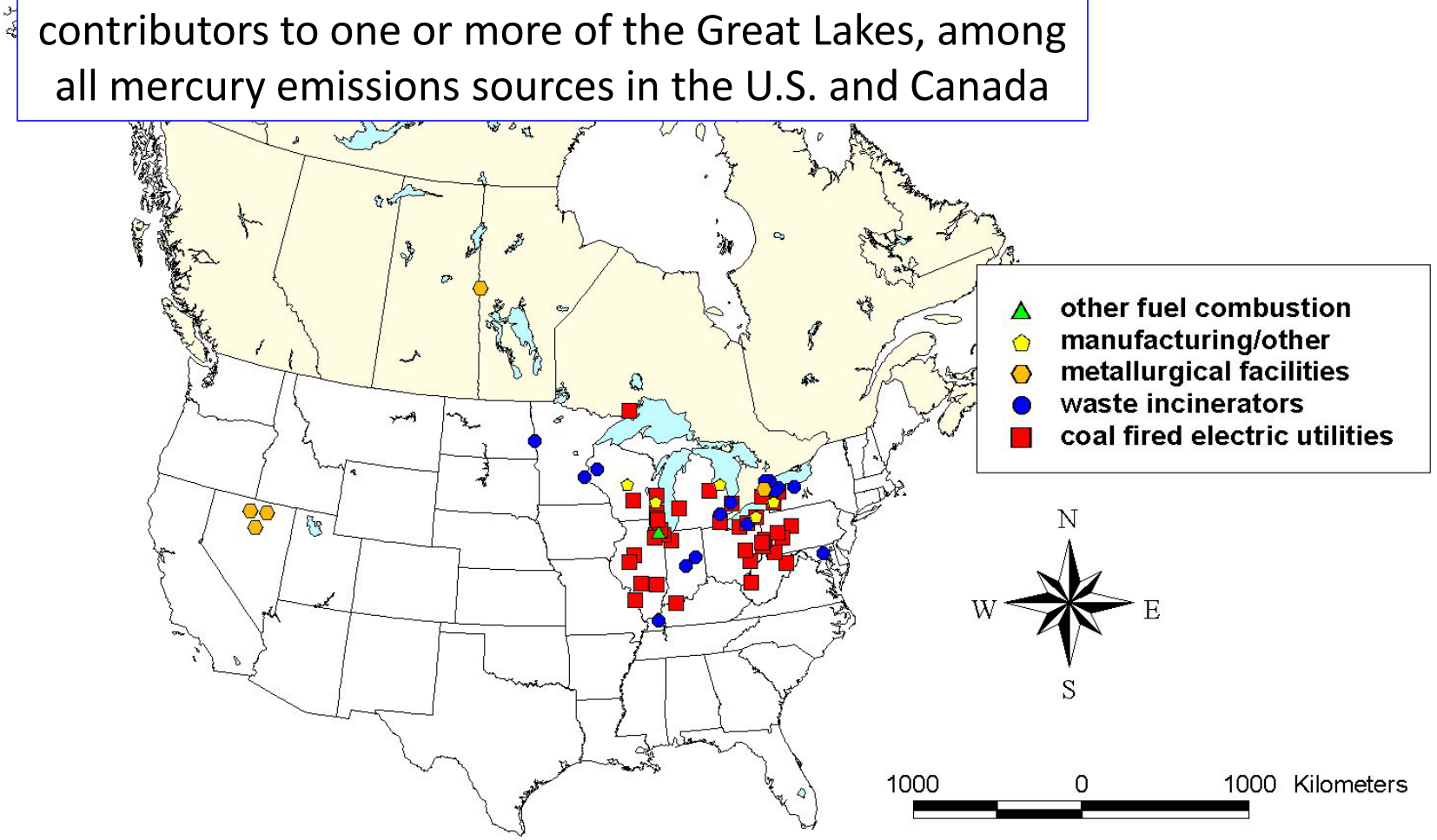
Measurements used for model evaluation and improvement

MODELING

- back trajectories
- comprehensive fate and transport
- source-attribution for deposition

Policy Relevance

Sources which are among the top-25 model-estimated contributors to one or more of the Great Lakes, among all mercury emissions sources in the U.S. and Canada



Chicago Tribune
ONLINE EDITION

http://www.chicagotribune.com/services/site/premium/interceptlogin.register

Nearby coal plants said to harm lake

By Michael Hawthorne
Tribune staff reporter

September 19, 2005

Contradicting a key part of the Bush administration's environmental policy, a new federal study estimates most of the mercury falling into Lake Michigan comes from smokestacks close to the shoreline.

Sixteen of the top 25 sources of mercury dropped into the lake are coal-fired power plants, according to the study by the National Oceanic and Atmospheric Administration (NOAA). Some of the toxic metal comes from as far away as Nevada and Texas, the study found, but most blows toward the lake from coal plants and factories in Illinois, Wisconsin, Michigan and Indiana.

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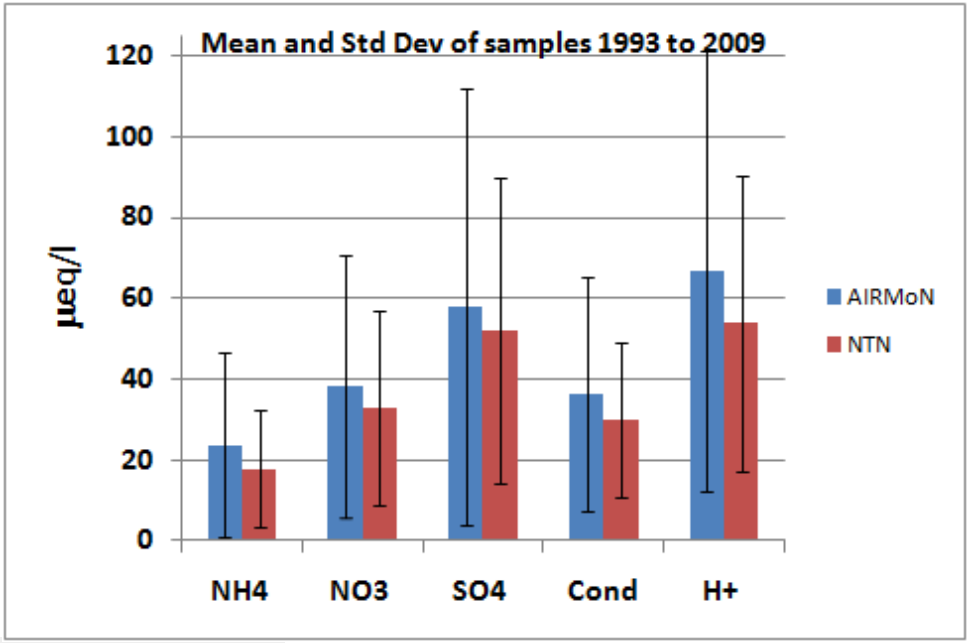
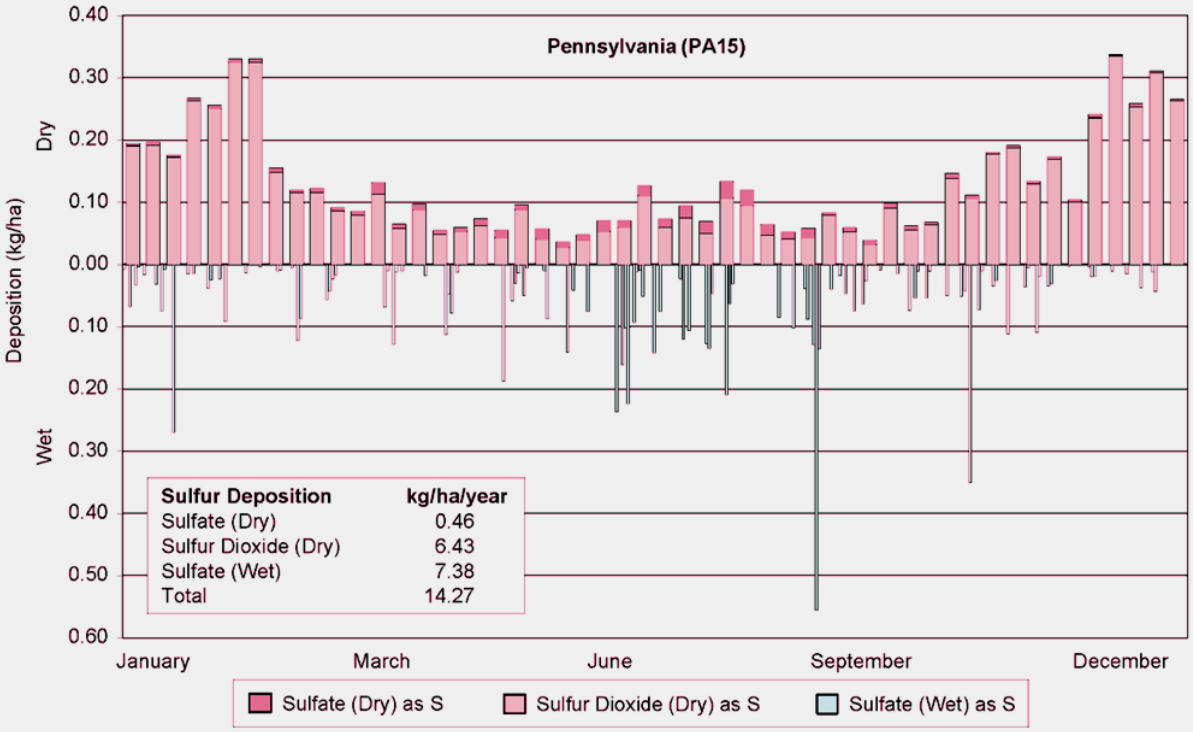
Atmospheric Nitrogen Research

- Short-term Research Intensives
  - Fast-response trace gas measurements
  - Extensive involvement with process studies to better understand the cycling of nitrogen compounds
  - R&D with private industry partners

Precipitation Chemistry Deposition

- Trends
- Ecosystem studies
- Model support
- Policy applications
- Global leadership





Air Quality Theme

Topic	Speaker
Smoke and Dust Forecasts	Ariel Stein
Ozone and Particulate Matter Forecasting	Rick Saylor
Mercury Program	Mark Cohen
Atmospheric Nitrogen Research	LaToya Myles
Atmospheric Deposition	Rick Artz

Air Quality Poster Session

Room 3404

- Chemical data assimilation (Chai)
- Improving modeled ozone predictions using satellite data (Choi)
- Understanding differences in modeled ozone chemistry (Saylor)
- Comparison of modeled and measured particulate data (Saylor)
- Using smog chamber data to improve aerosol understanding (Stein)
- Emissions processing (Tong)

Room 5836

- Polar mercury (Brooks)
- Mercury research Intensives (Luke)
- Dioxin atmospheric fate and transport (Cohen)
- 2008 Roadway Sound Barrier Tracer Study (Finn)
- IMPROVE (Pitchford)