CASTNET Update

2019 MARAMA Monitoring Workshop

November 21, 2019

Swarthmore, PA

Timothy Sharac

US Environmental Protection Agency

Office of Atmospheric Programs

CASTNET Overview

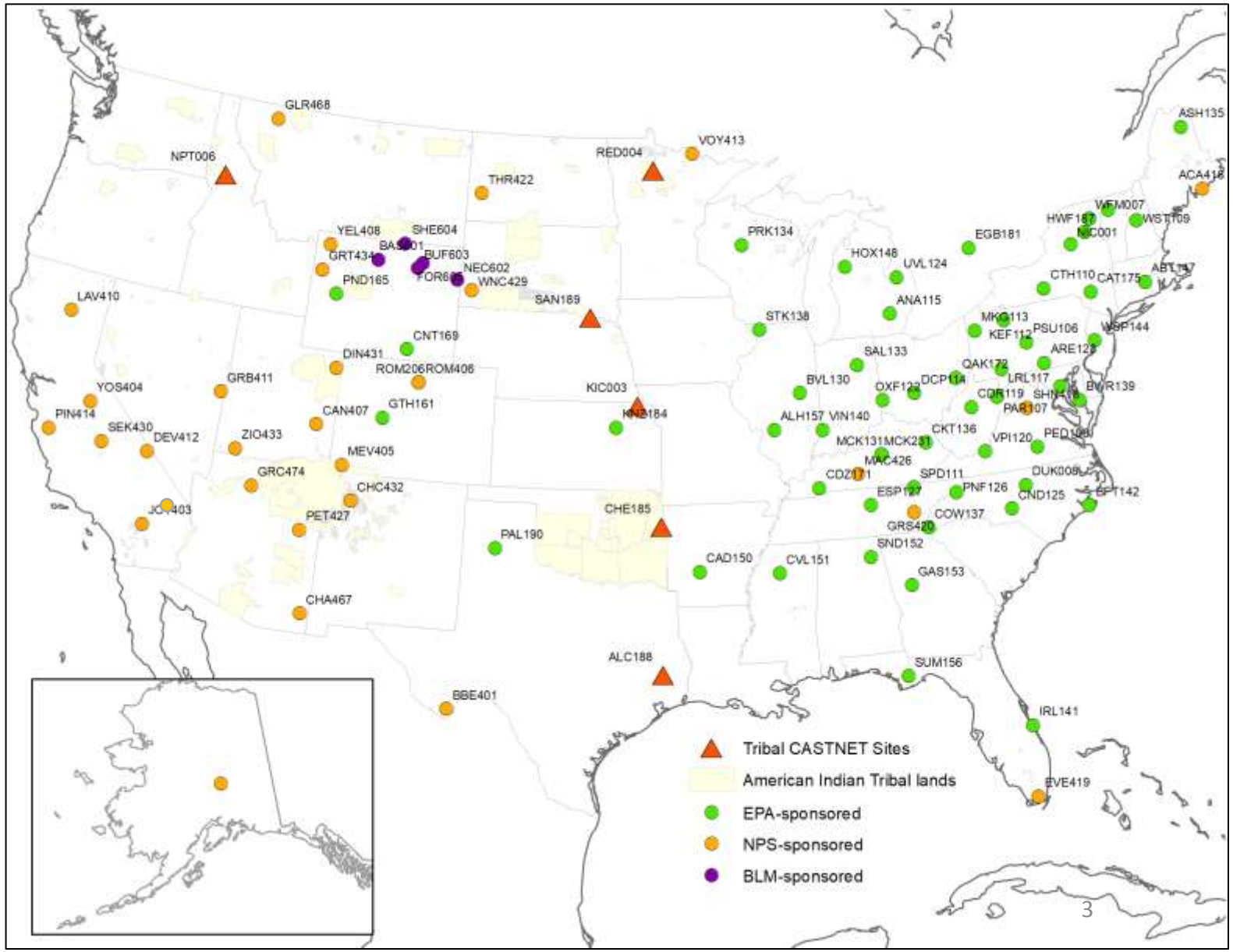
- Network provides data to assess **long-term**, **regionally representative trends** in **sulfur, nitrogen, and O_3** pollutants
  - Gas & particle concentrations in air are measured weekly on filters and used to estimate dry deposition
  - Continuous O_3 concentrations measured to support NAAQS determinations
  - A subset of sites also operate NO/NOy, CO, and SO_2
- Sites are located away from known emissions sources (e.g., EGUs) and often in ecologically important locations including 29 National Parks
- Consistent measurements with a robust quality assurance program

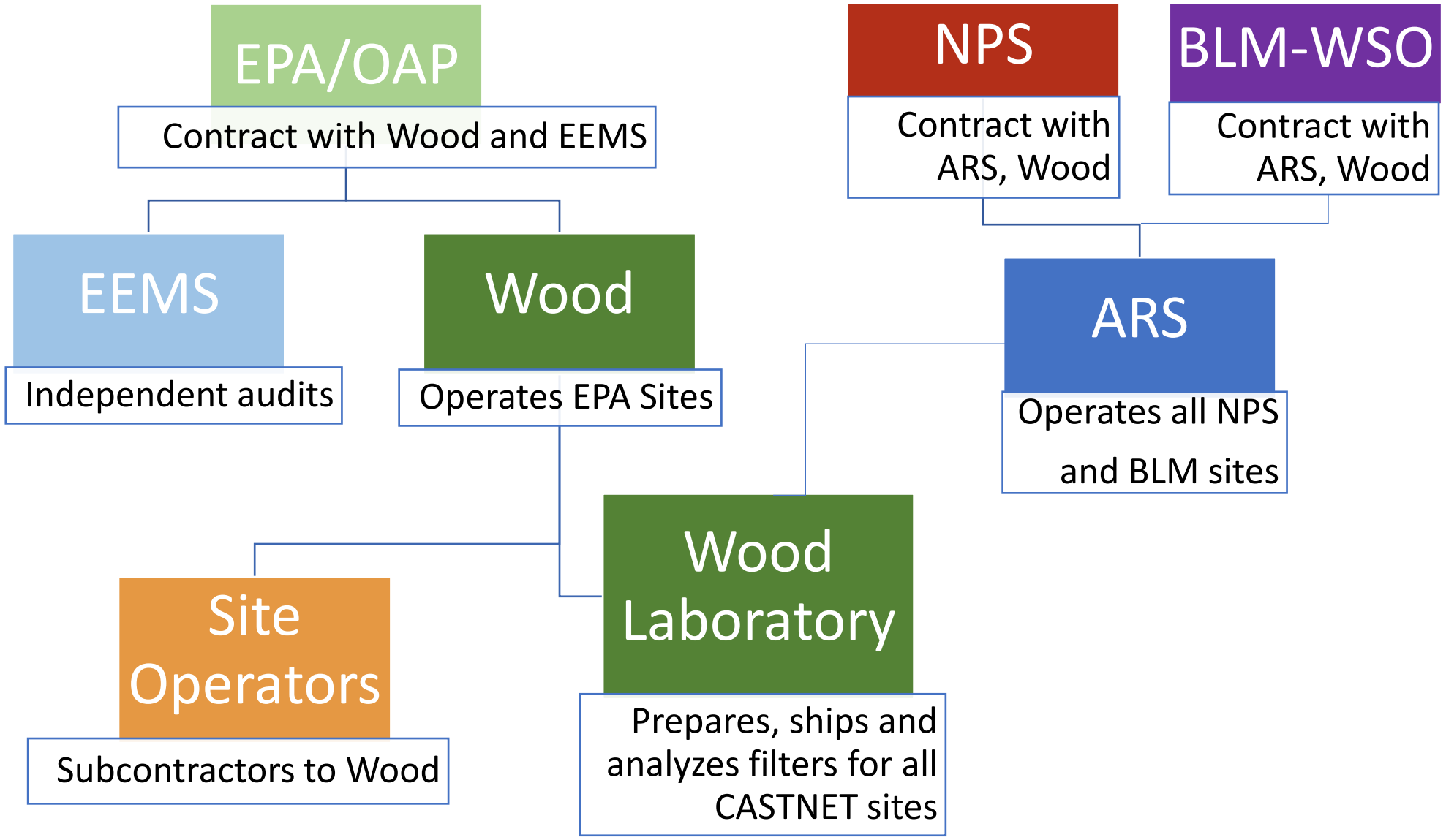
Gases
- HNO_3
- O_3
- NO/NO_y
- SO_2
- CO

Particles
- NO_3
- NH_4^+
- SO_4^{2-}
- Base Cations
- Cl^-

CASTNET Monitoring Network

- **Established in 1987**
  - 97 rural monitoring sites
  - 38 sites w/30+ years of data
- **EPA/Office of Atmospheric Programs**:
  - 63 sites across US
- **National Park Service**
  - 29 sites in National Parks
- **BLM-Wyoming State Office**
  - 5 sites in WY
- **Many partners participate in network:**
  - 6 tribal sites
  - NY DEC supports two sites in NY
  - EPA Region 10 supports O_3 monitoring at Nez Perce, ID
  - Environment & CC Canada
  - Many sites provide in-kind support

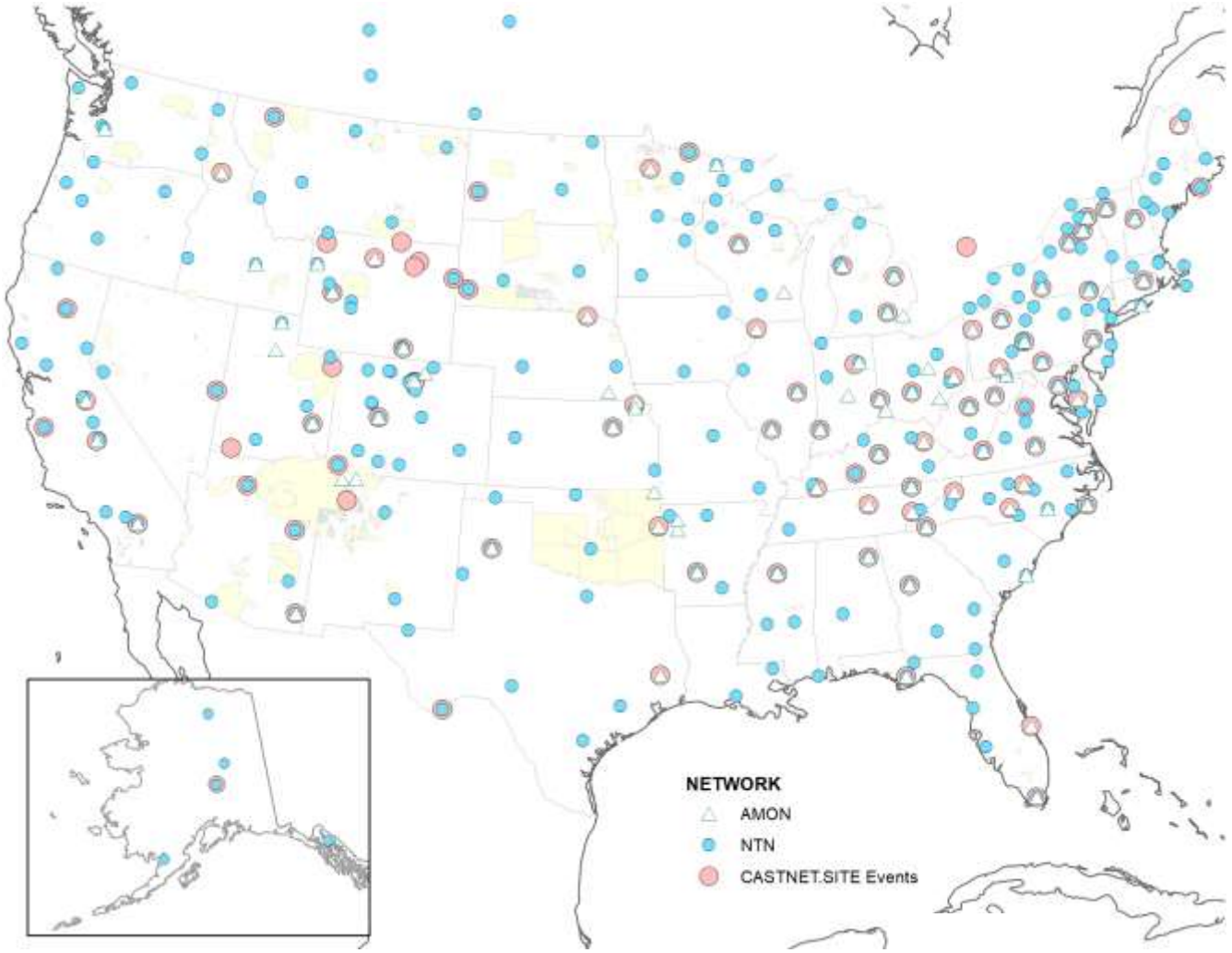



EPA/OAP
Contract with Wood and EEMS
EEMS
Independent audits
Wood
Operates EPA Sites
Site Operators
Subcontractors to Wood
Wood Laboratory
Prepares, ships and analyzes filters for all CASTNET sites
NPS
Contract with ARS, Wood
BLM-WSO
Contract with ARS, Wood
ARS
Operates all NPS and BLM sites

National Atmospheric Deposition Network (NADP)

- Program established in 1978 to measure pollutants in precipitation (acid rain)
  - **National Trends Network (NTN)** measures weekly wet deposition of SO_4^{2-}, NO_3^-, NH_4^+, pH, cations, Cl^- at more than 250 sites
  - Nearly all CASTNET sites are co-located or near an NTN site
  - NTN provides long-term record of consistent measurements from regionally representative sites
- Mercury Monitoring
  - **Mercury Deposition Network (MDN)** provides weekly wet deposition of Hg
  - **Atmospheric Mercury Network (AMNet)** provides concentrations of speciated gaseous Hg
- Ammonia Monitoring
  - **Ammonia Monitoring Network (AMoN)** provides bi-weekly concentrations of ambient NH_3
  - Network was established in 2007 and has grown to more than 100 sites
  - Over 60 AMoN sites co-located with CASTNET

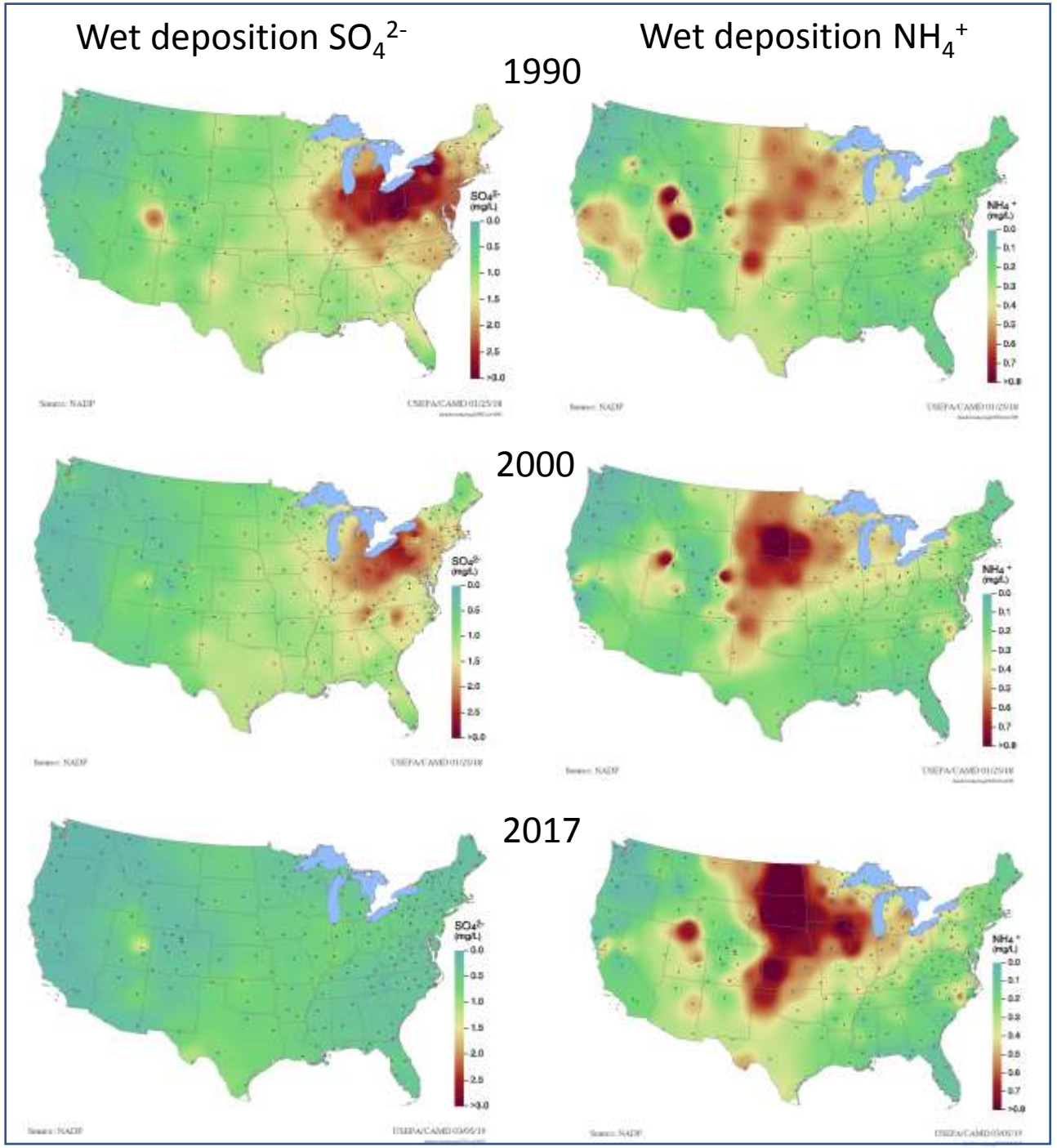
Deposition results from CASTNET + NADP provide accountability for OAP's emission reduction programs



NADP

- Program is supported by 7 federal agencies and 87 subscribers that include universities, state agencies, tribes, cities, and industry
- Data are used by policy analysts, land managers, and researchers to assess environmental program results, link air quality to ecological impacts (i.e. Rocky Mountain National Park initiative), and model development and evaluation
- CASTNET and NADP have advanced the science of **total atmospheric deposition**
  - Data fusion mapping method combines measurement data from CASTNET + NTN and modeled estimates from CMAQ to expand coverage
  - Maps are used to assess critical loads and ecosystem effects in areas where monitoring is sparse
  - Science Needs for Continued Development of Total N Deposition Budgets in the US

    http://nadp.slh.wisc.edu/committees/tdep/reports/NADP_TDep_Nr_Deposition_White_Paper_v3.pdf



Results: Effectiveness of EGU SO_2 Reductions

Emissions

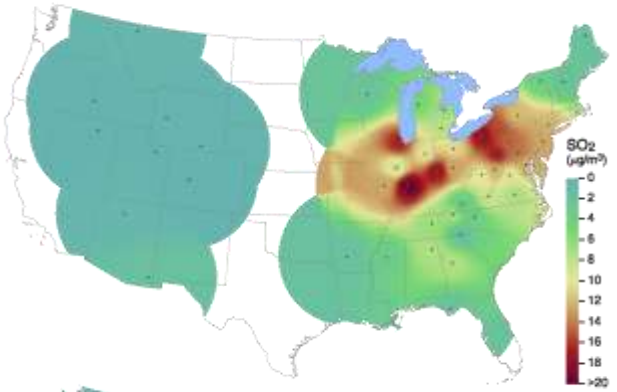
Ambient concentrations

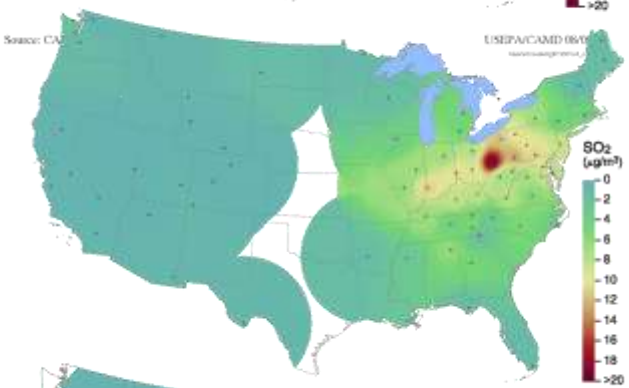
S Total Deposition

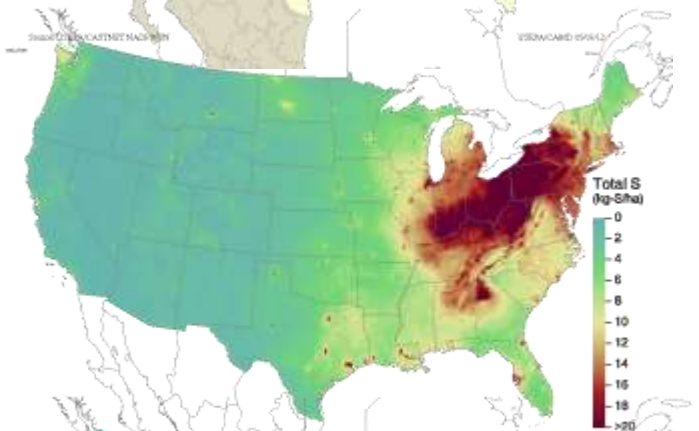
1990

2000

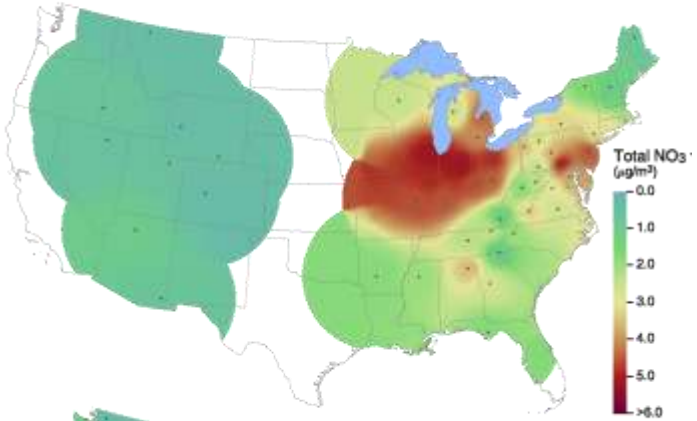
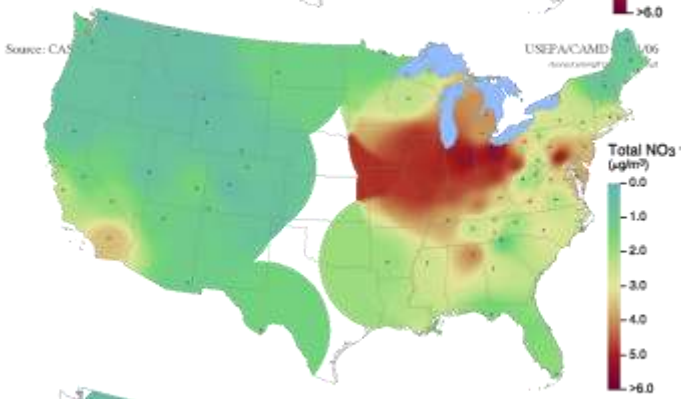
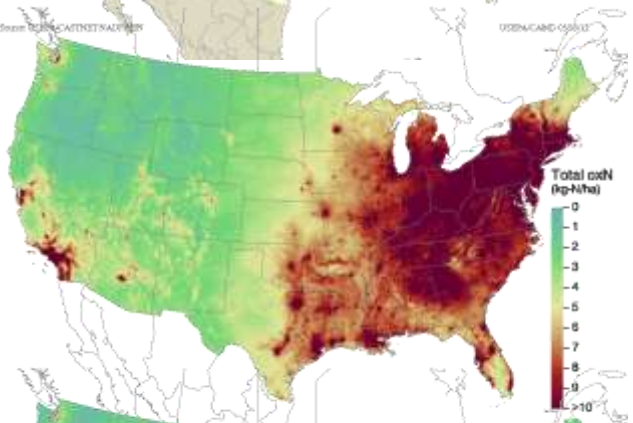
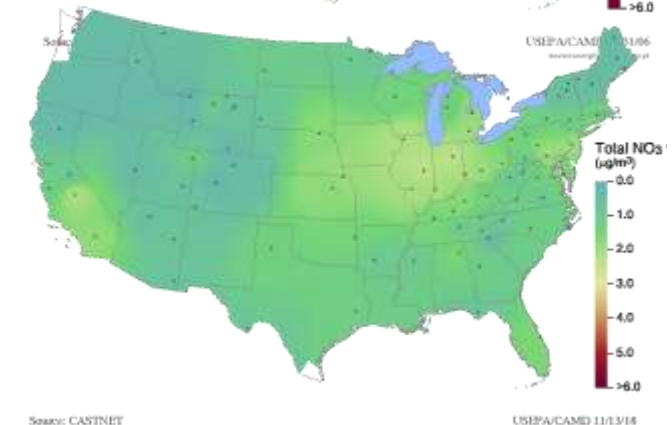
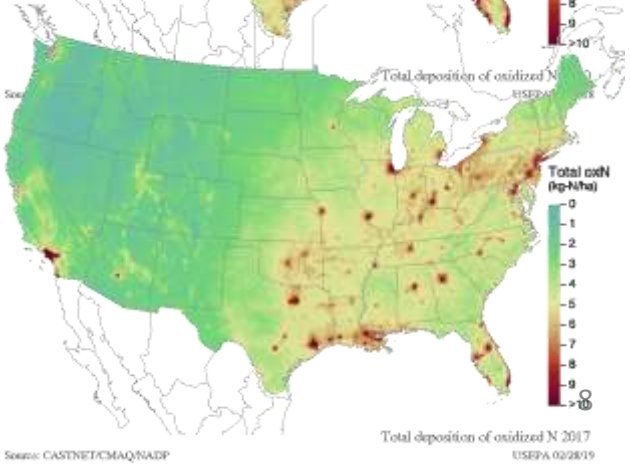
2017







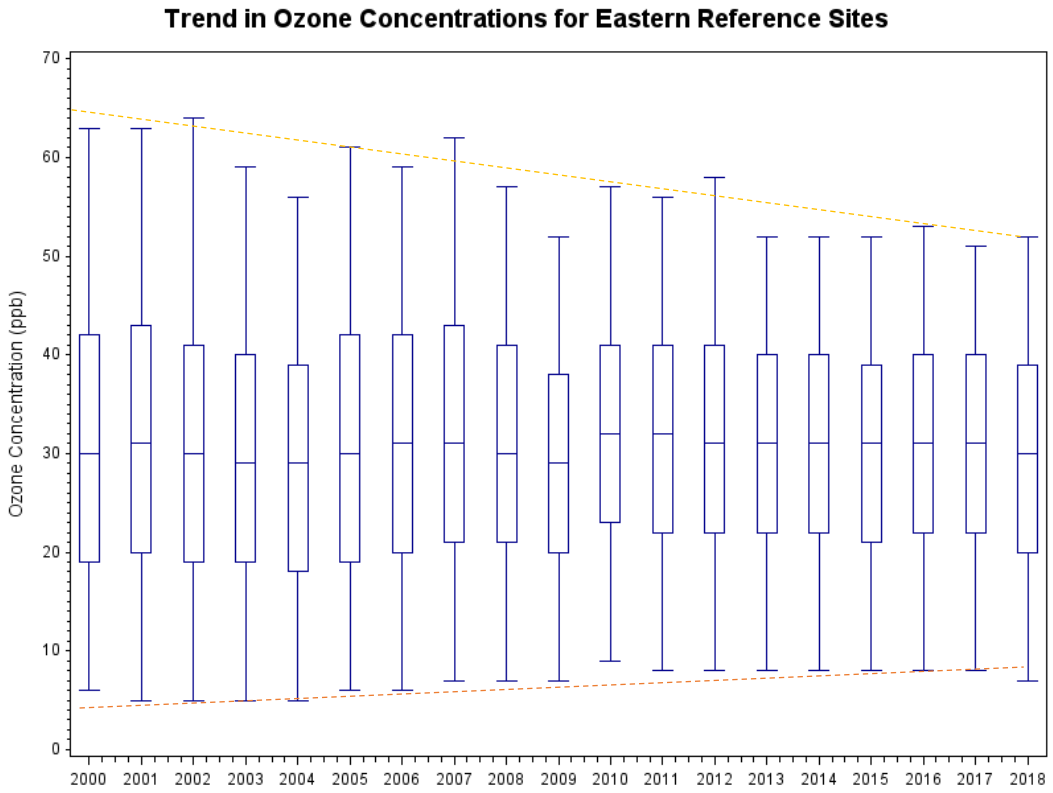
Results: Effectiveness of EGU NO_x Reductions

	Emissions	Nitrate ambient concentrations	Oxidized nitrogen total Deposition
1990	No data available		
2000			
2017			

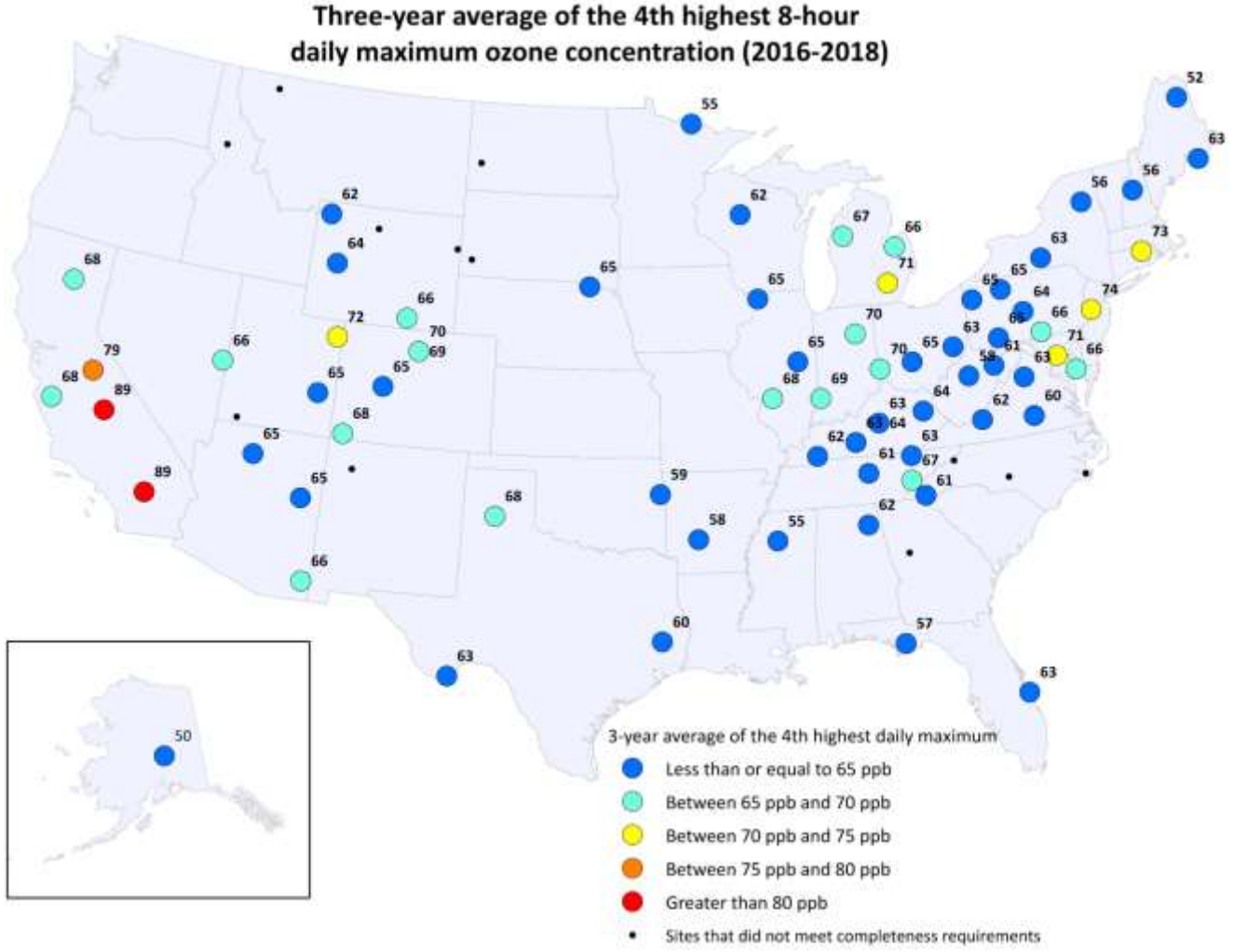
CASTNET Ozone Monitoring Upgrades

- Upgrades since 2011 include:
  - OAP-sponsored sites conform to 40 CFR Part 58 Appendix A requirements
    - NPS-sponsored sites conform since 1987
  - Operate a pair of Thermo Scientific™ Model 49i analyzers in place of Thermo Scientific™ Model 49-103 ozone analyzers
    - One 49i has an onboard O_3-generator for use as a Level 3 on-site transfer standard
  - Perform zero, span, and precision checks nightly instead of weekly
  - Receive independent performance evaluation (PE) and third-party audits
  - Receive independent National Performance Audit Program (NPAP) and Technical Systems Audits (TSA) audits
  - Submit ambient ozone monitoring data, precision checks, and audit results to AQS
    - Continue to post zero, precision, and span checks and TSA reports to the CASTNET website https://www.epa.gov/castnet

Results: Rural Ozone Concentrations

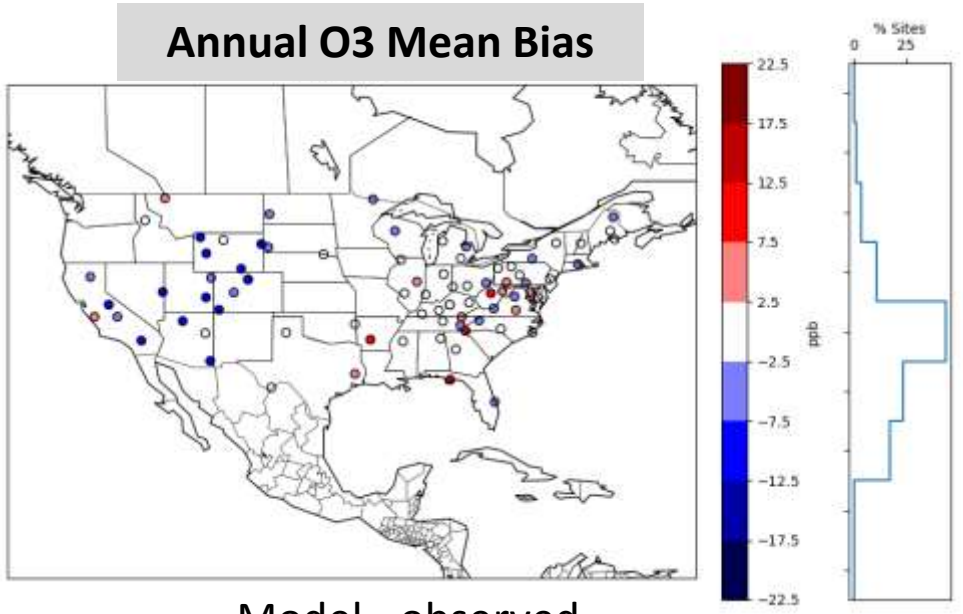


Shifts in distribution reported in: Cooper et al. (2012); Simon et al. (2015)

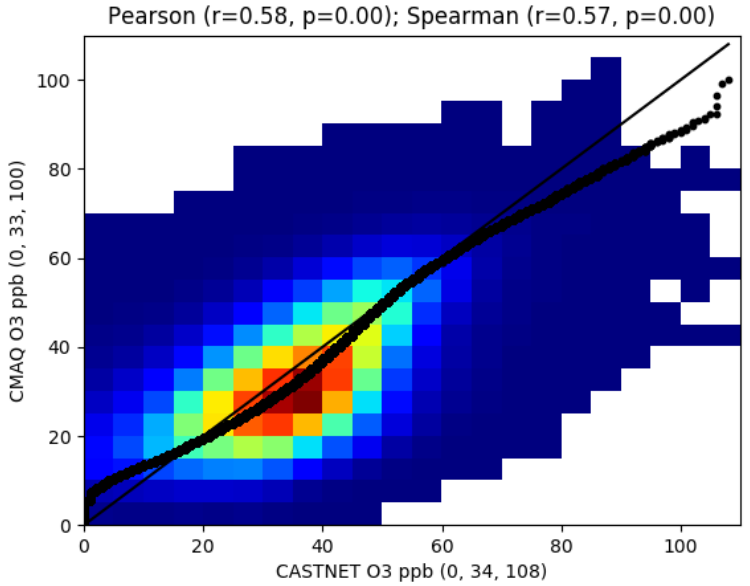


Tools to Characterize Background Ozone

- EPA's Office of Research and Development uses photochemical models to estimate **background ozone** since even the most remote monitors include contributions from US anthropogenic emissions
  - Sufficiently remote monitors can provide information about **Baseline Ozone** which is "the statistically defined lowest abundances of O_3 in the air flowing into a country." (HTAP 2010)
  - Monitors in remote locations over long time periods can help provide information about trends in Baseline Ozone



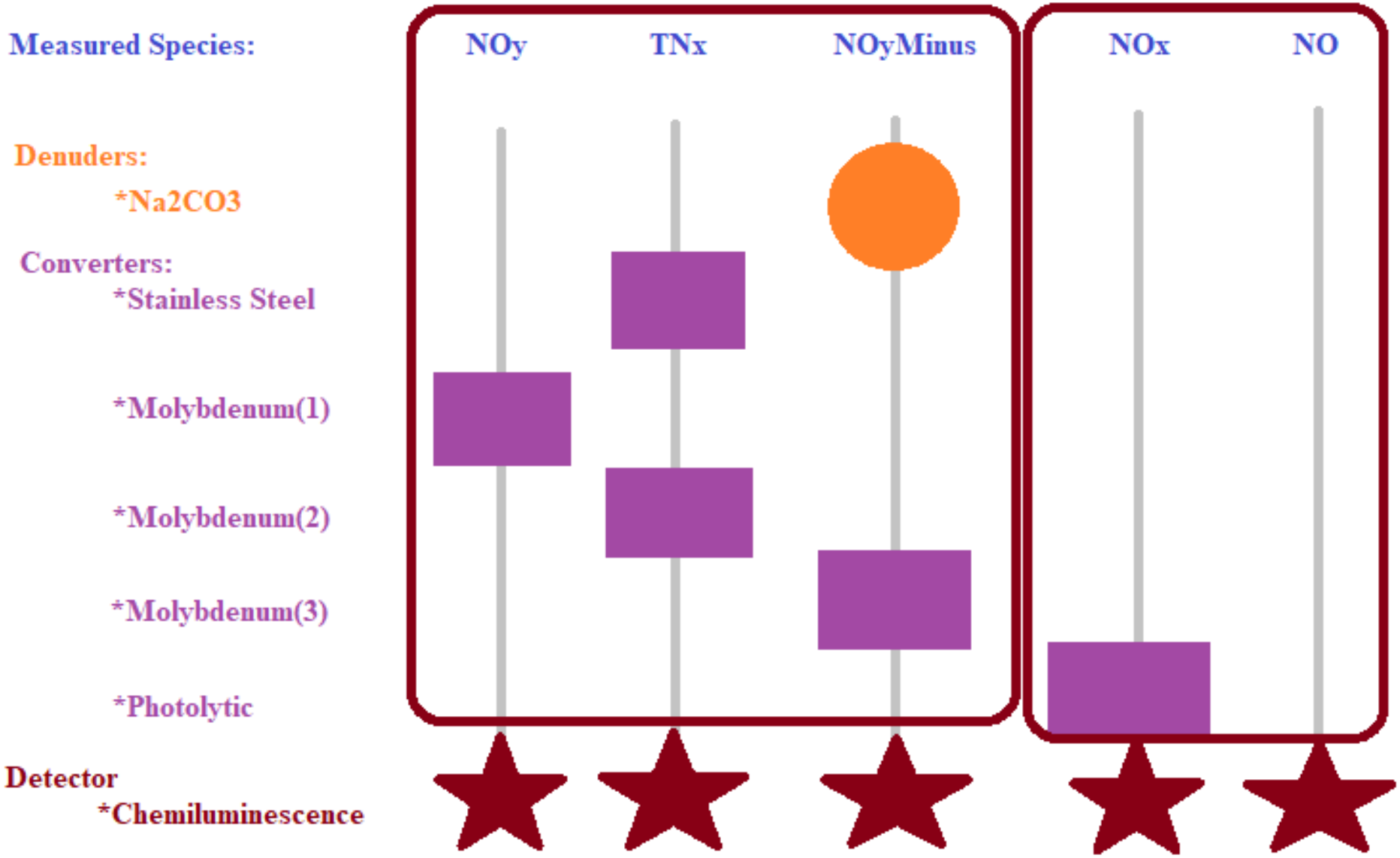
Model - observed



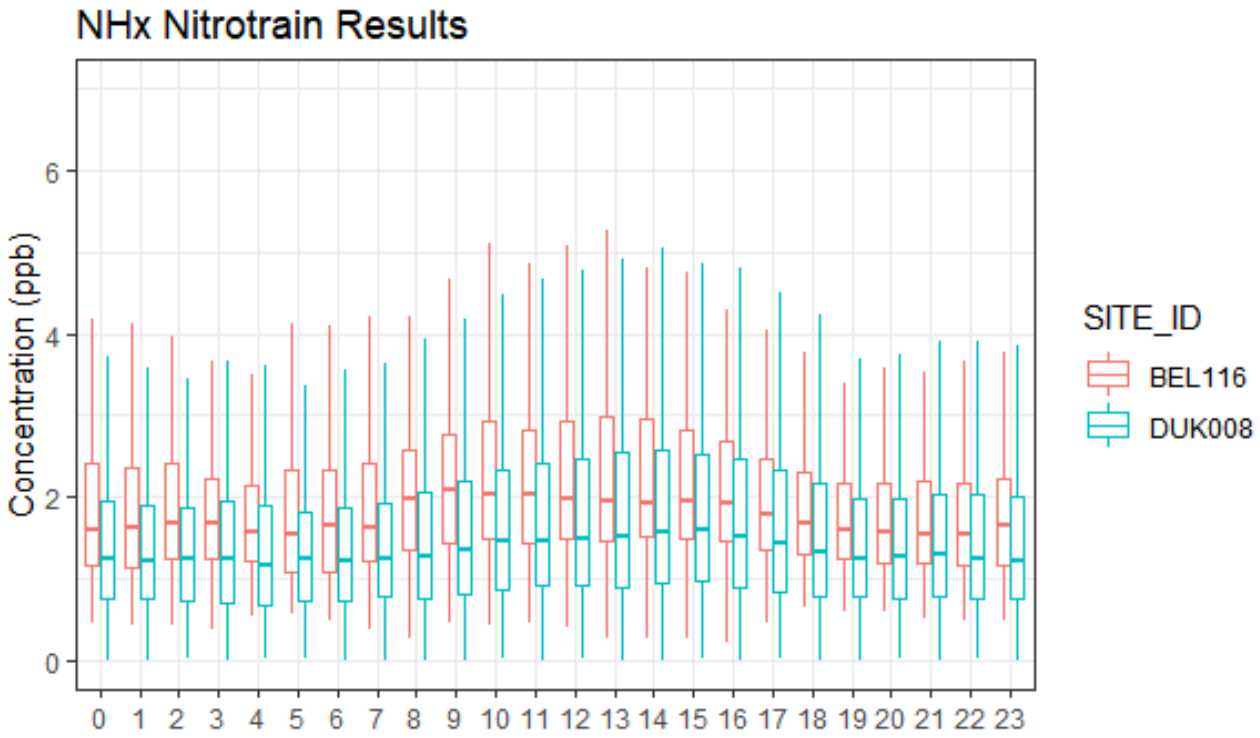
Courtesy of Heather Simon and Barron Henderson

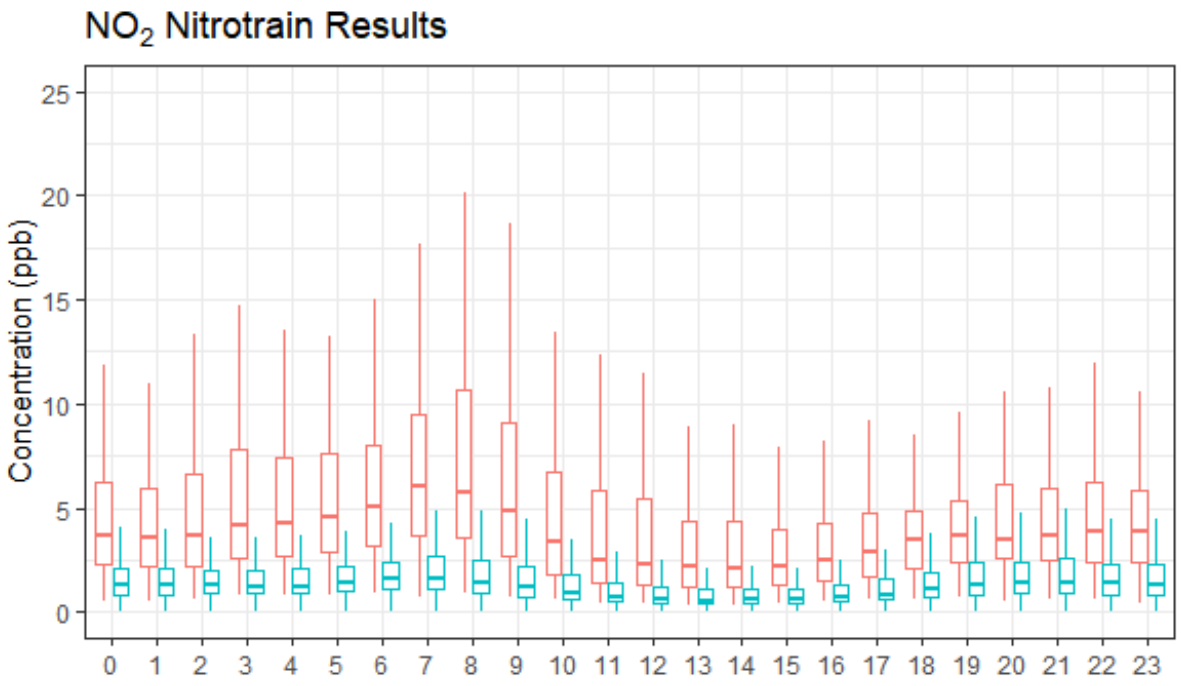
Enhanced NO/NO_y System (Nitrotrain)

Calculated species: NHx (TNx-NOy) HNO_3 (NOy-NOyMinus) NO_z (NOy-NOx) NO_2 (NOx-NO)



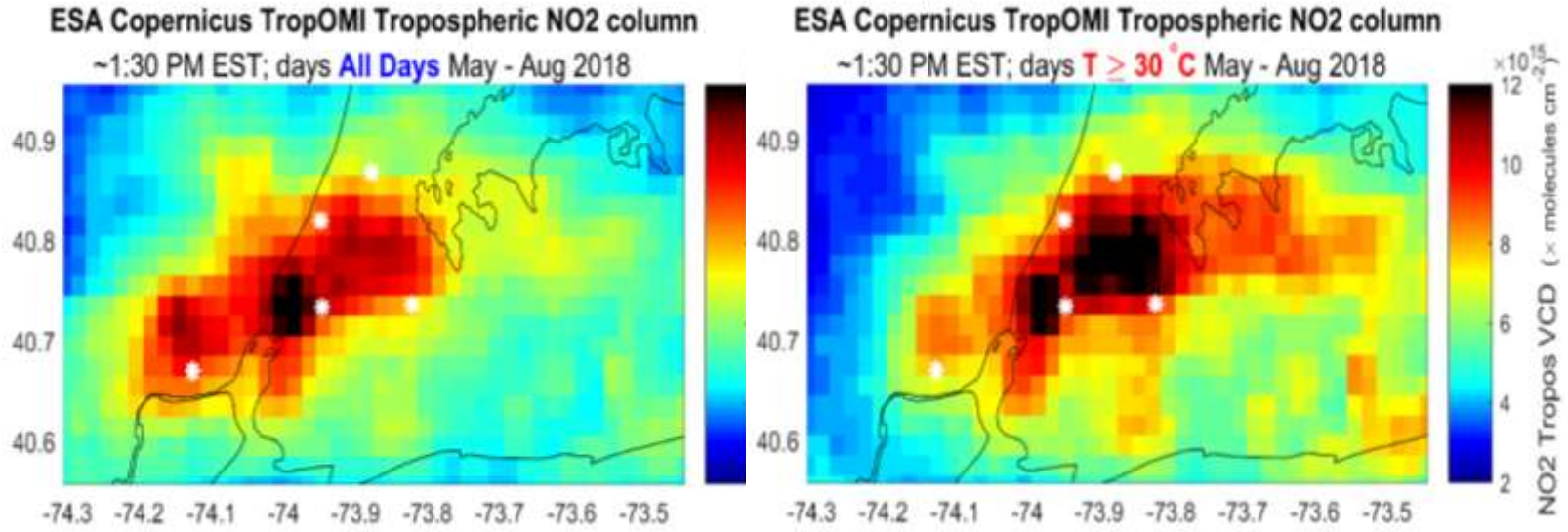
- Using existing technology, we developed a system to provide more complete speciation of nitrogen budget





PANDORA

- NASA developed spectrometer to validate satellite measurements
- 2S model being deployed at PAMS sites, Mid-Atlantic and NE corridor, and hopefully at CASTNET soon
- Measuring O_3, NO_2, HCHO, SO_2 total column using sun
- Data are being processed centrally by Pandonia Global Network (NASA + European Space Agency)



Future Direction of the Program

- Maintain existing monitoring sites to preserve long-term data record
- Continue to improve concentrations and total deposition estimates
  - Utilize expertise of the TDep research community
  - Use TDep white paper (*Science needs for continued development of total nitrogen deposition budgets in the United States)* as a guide to prioritize research
  - http://nadp.slh.wisc.edu/committees/tdep/reports/NADP_TDep_Nr_Deposition_White_Paper_v3.pdf
  - Collaborate with ORD on future method and model development
- PANDORA deployment
- Engage with federal, state and tribal partners who may utilize CASTNET infrastructure for testing or deploying measurements

Disclaimer

The views expressed in this presentation are those of the author and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency

Timothy Sharac
sharac.timothy@epa.gov
202-343-9180