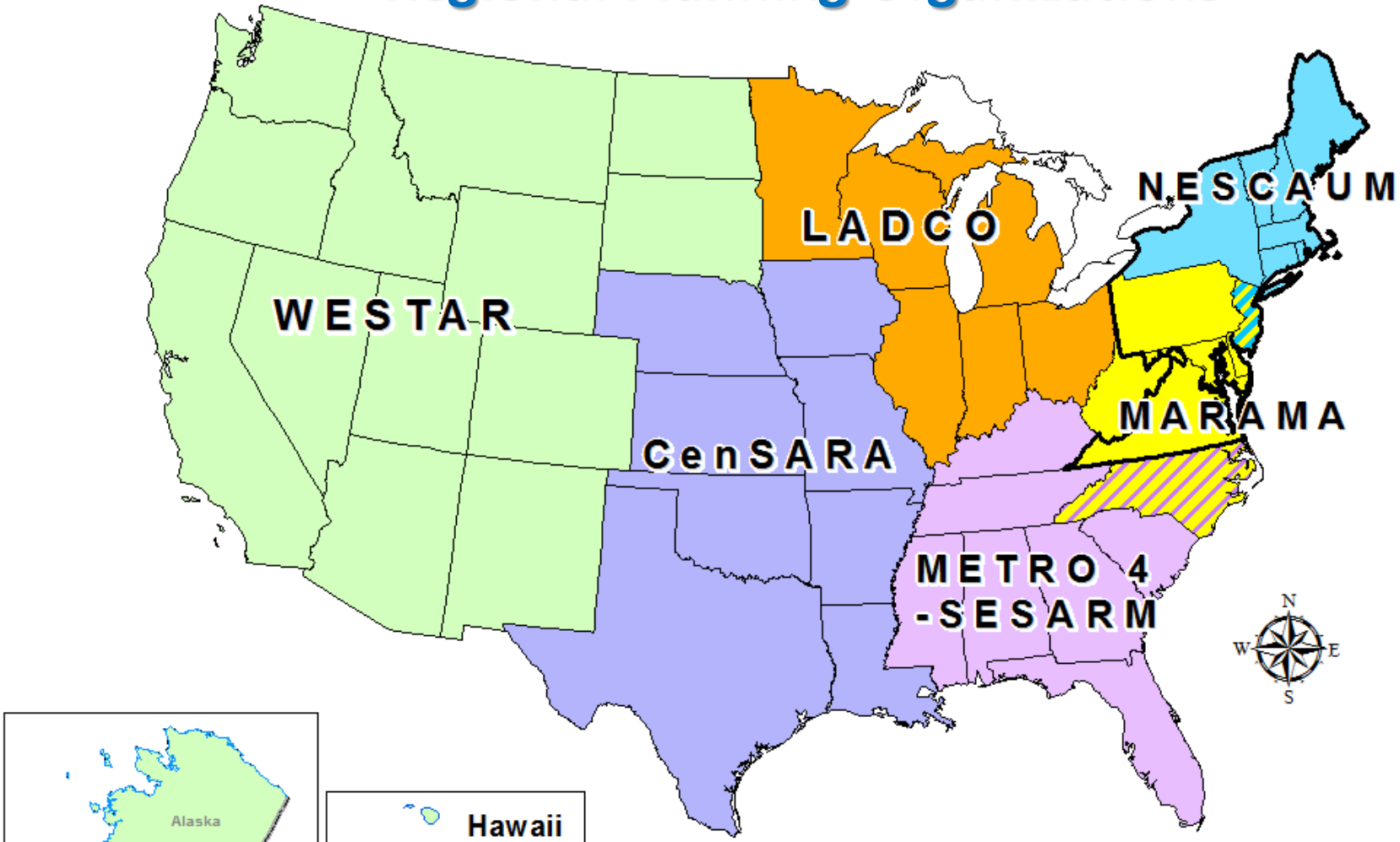
Regional Air Quality Issues in the Central U.S.

Rob Kaleel
Lake Michigan Air Directors Consortium
February 22, 2016

Overview

- About LADCO
- Ozone, Fine Particles, and Regional Haze
- Modeling Challenges and Policy

Regional Planning Organizations

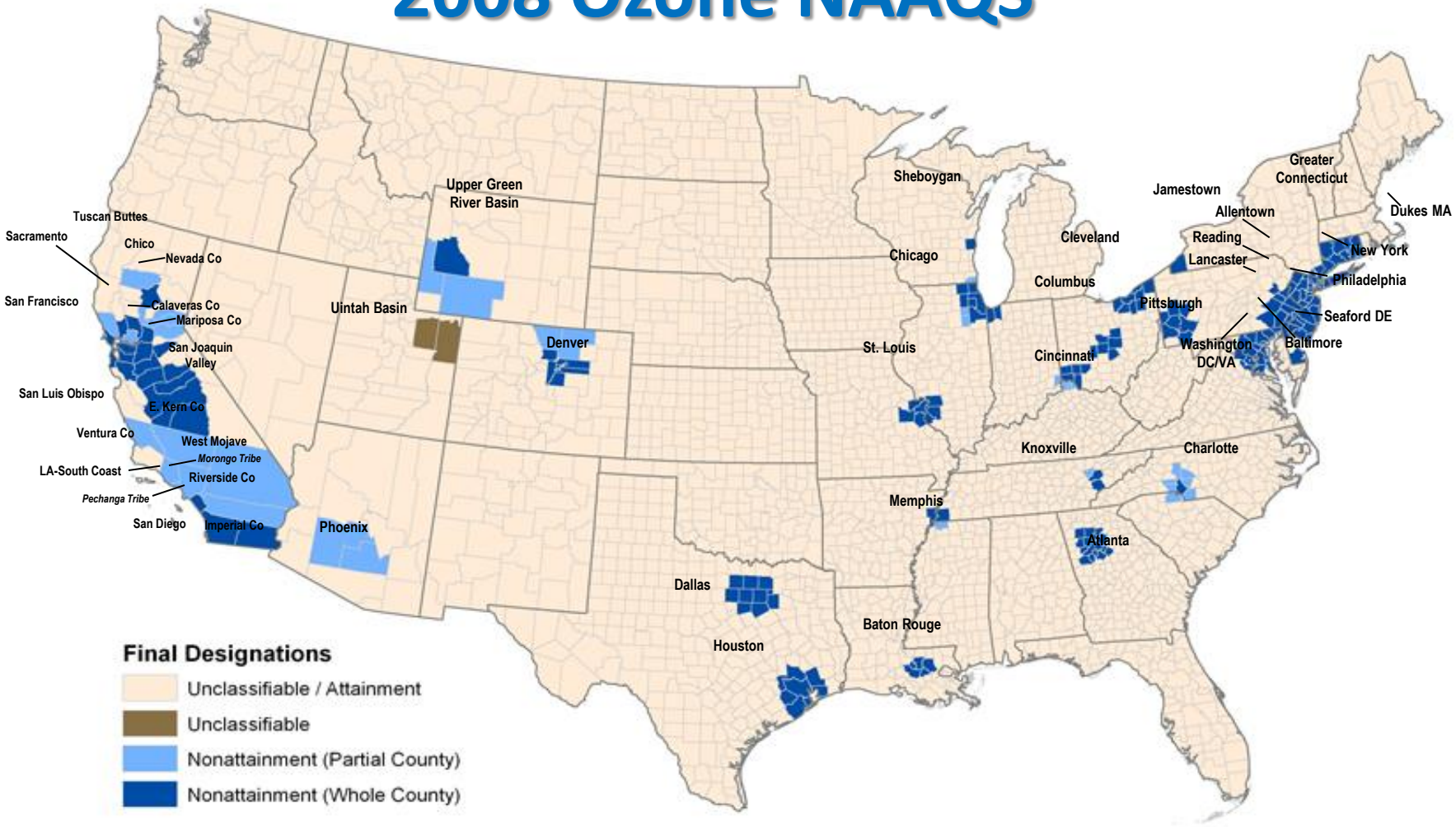


The Lake Michigan Air Directors Consortium

- Established in 1989
- Original members**: IL, IN, MI, & WI**
- **OH** joined in 2004**; MN** joined in 2012**.**
- Purpose:
  - **technical assessments** on problems of air quality**;**
  - **provide a forum** for discussion and coordination;
  - **coordinate training** activities for member states.
- **Regional** focus

OZONE

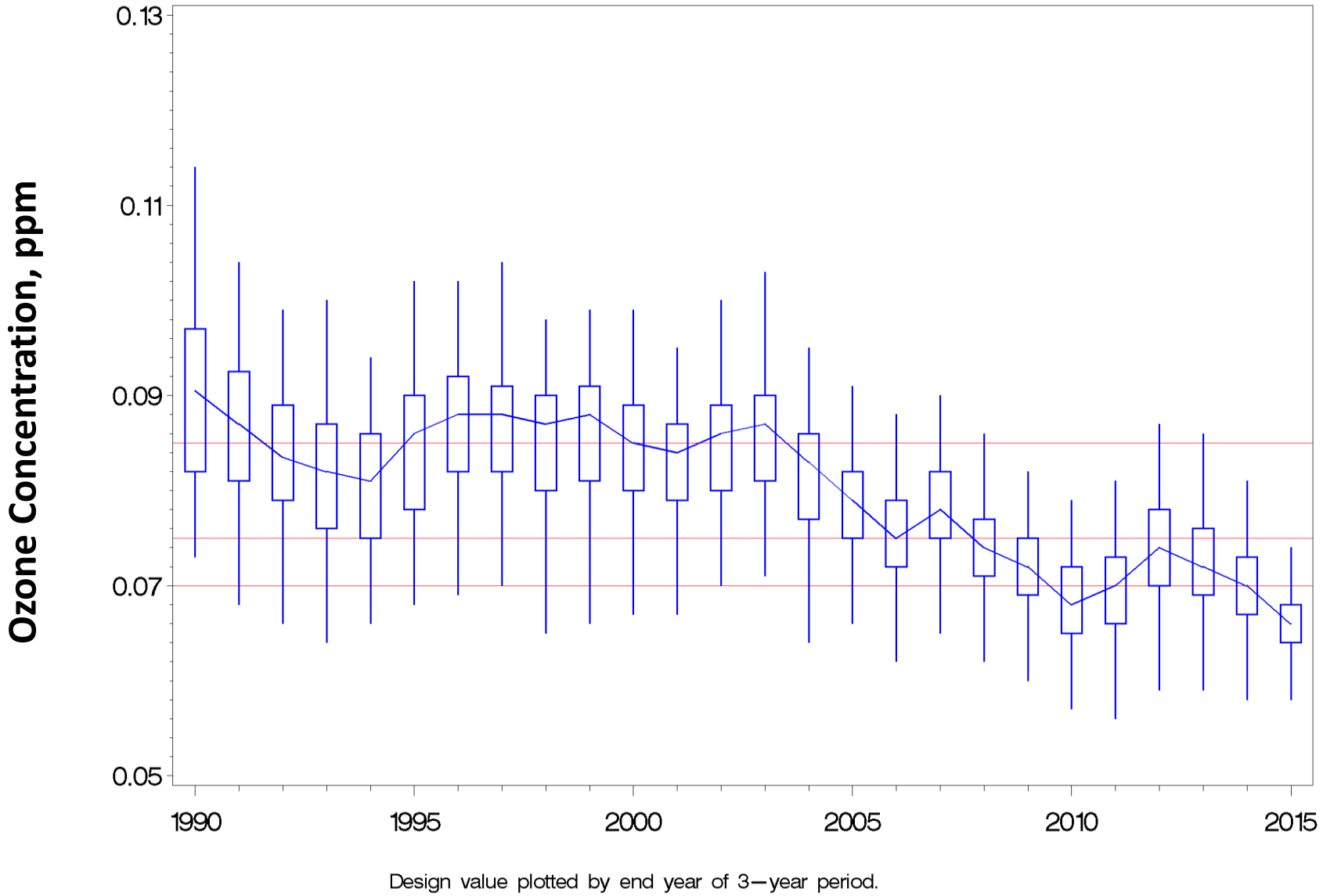
Nonattainment Areas for 2008 Ozone NAAQS



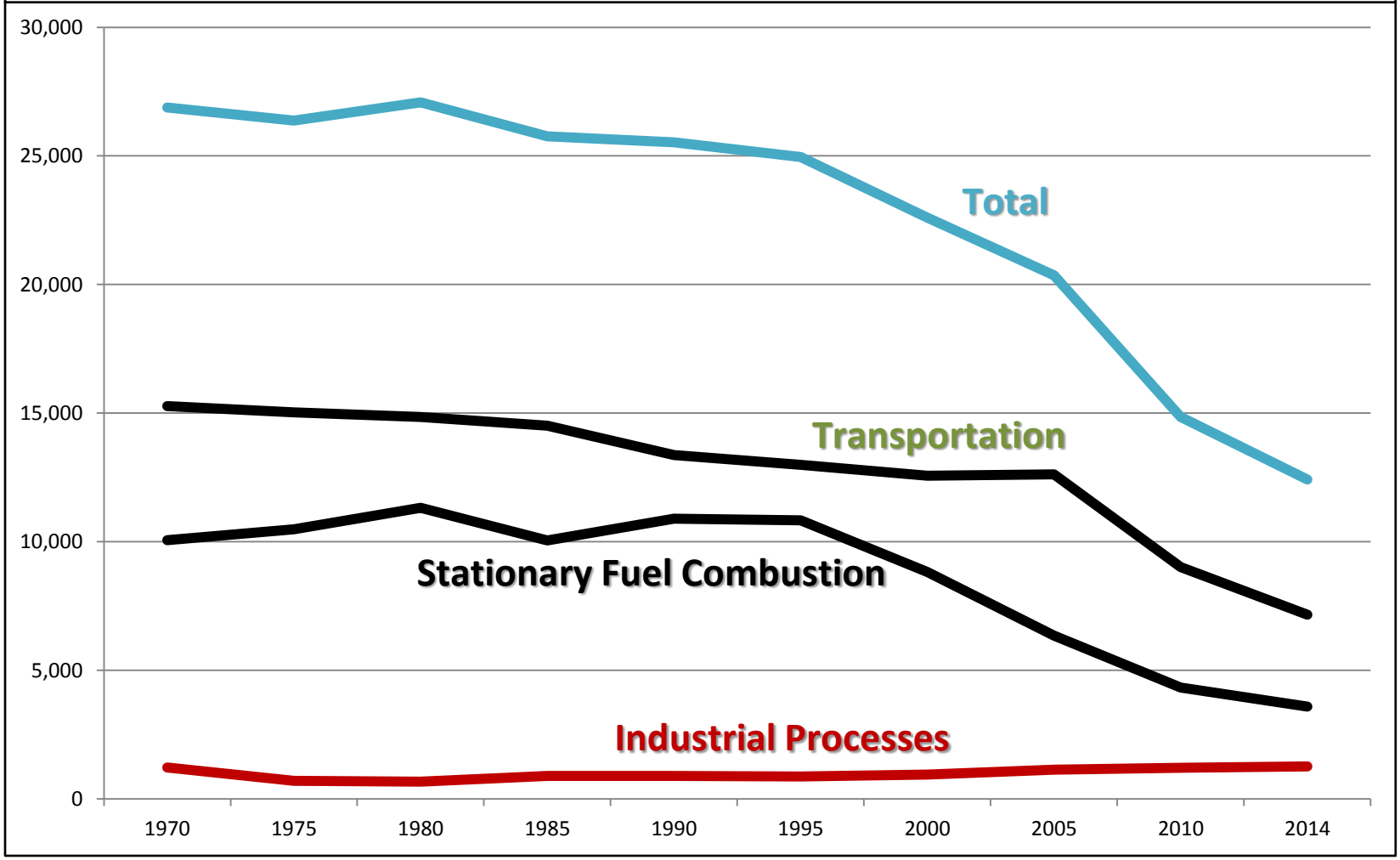
Notes:

EPA has not designated as nonattainment any areas outside the Continental US.

8-Hour Ozone Design Value Trends 1990-2015, LADCO States

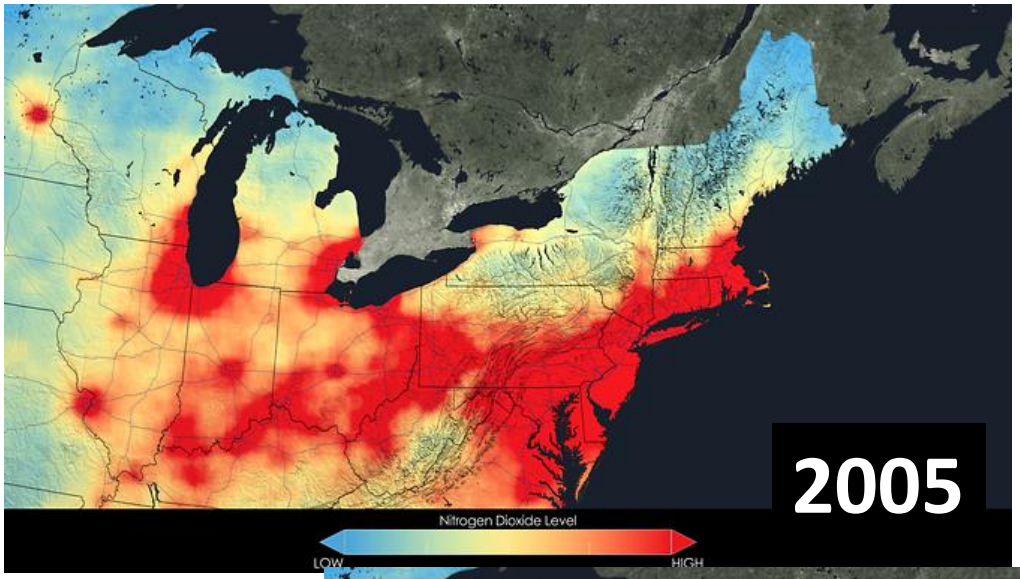


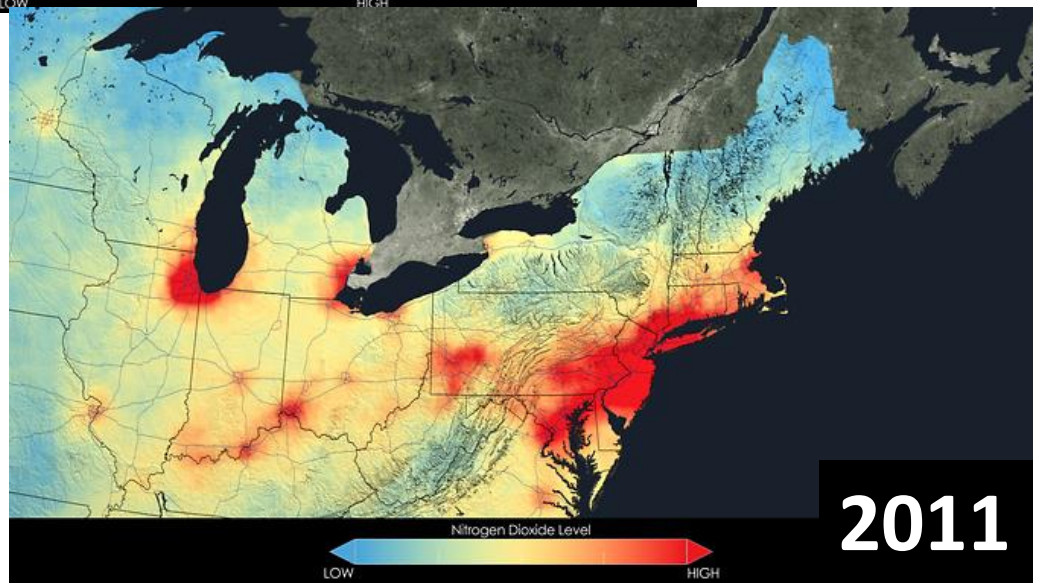
NOx Emissions Trends in the US, 1970-2014



EPA, NEI - 2014

NO_2 Air Quality Improvements Shown by NASA Satellite Data



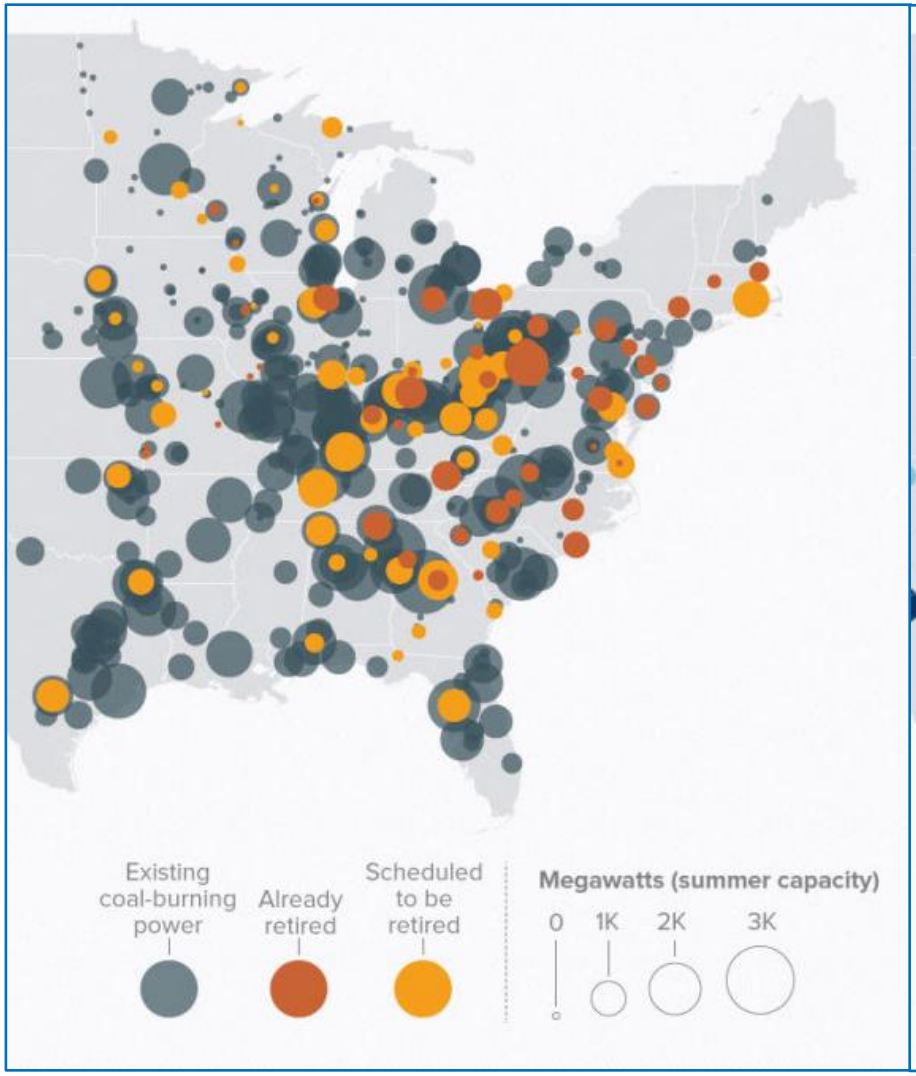


AQAST
NASA Air Quality Applied Sciences Team

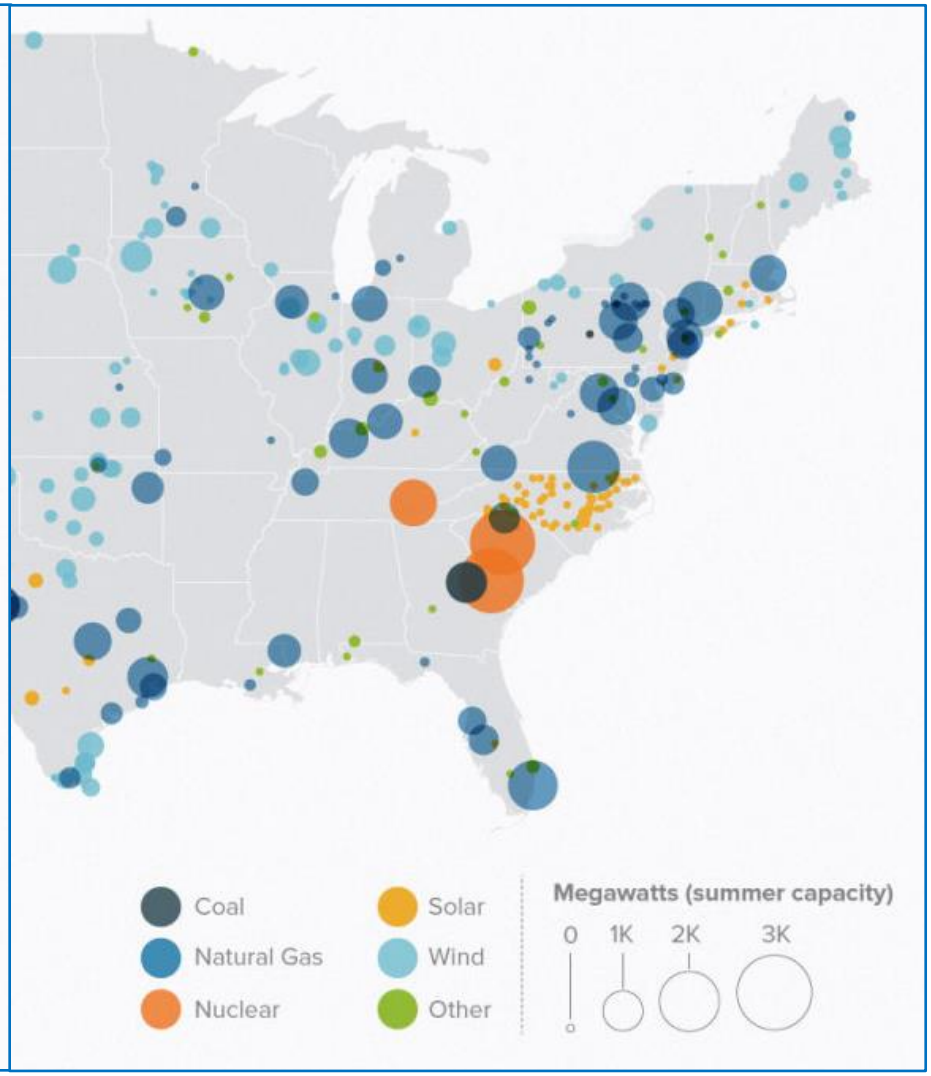
NASA

Goodbye coal, hello… what?

Coal Power Retirements (2012-2023)

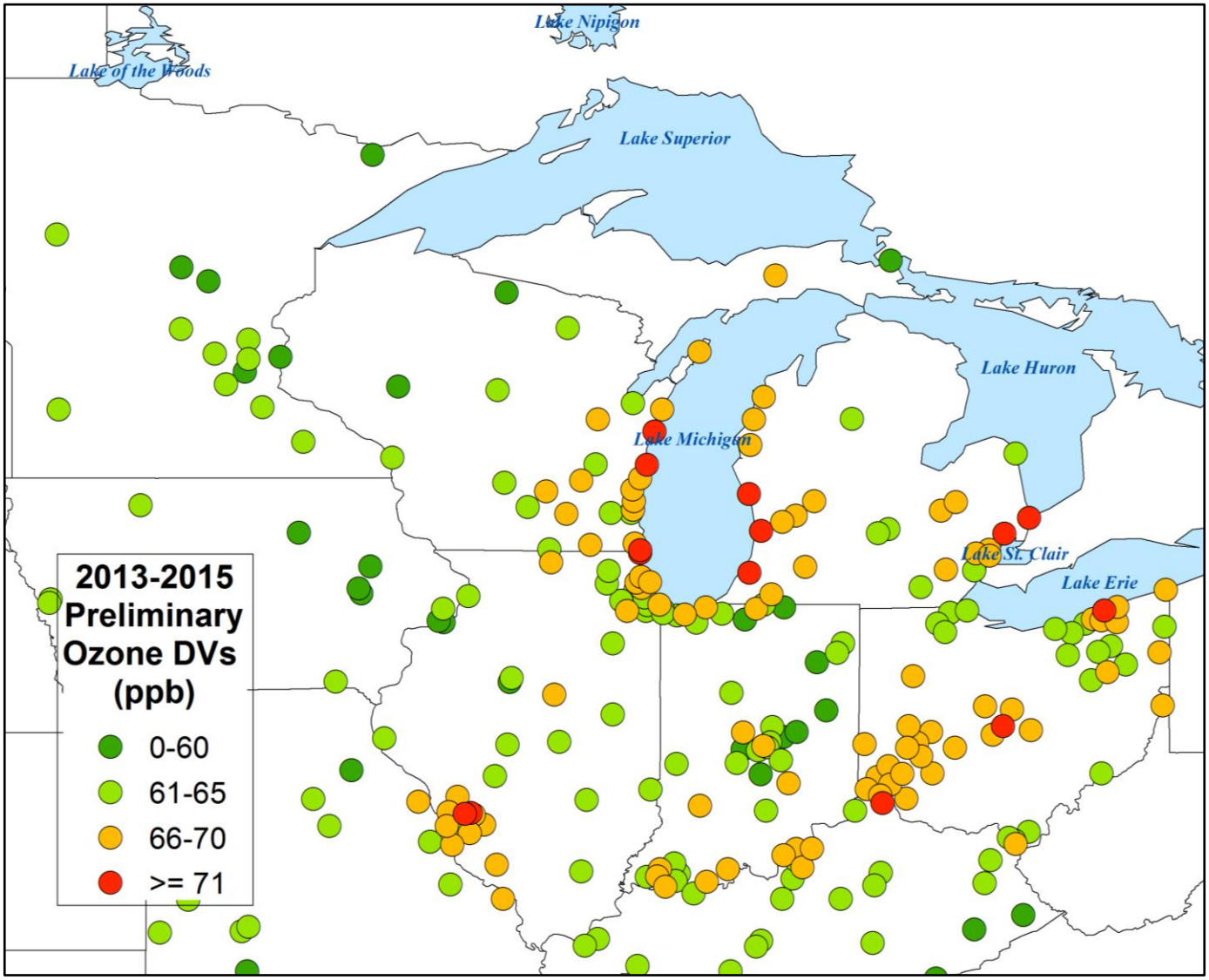


Power Capacity Being Added (2015-2023)



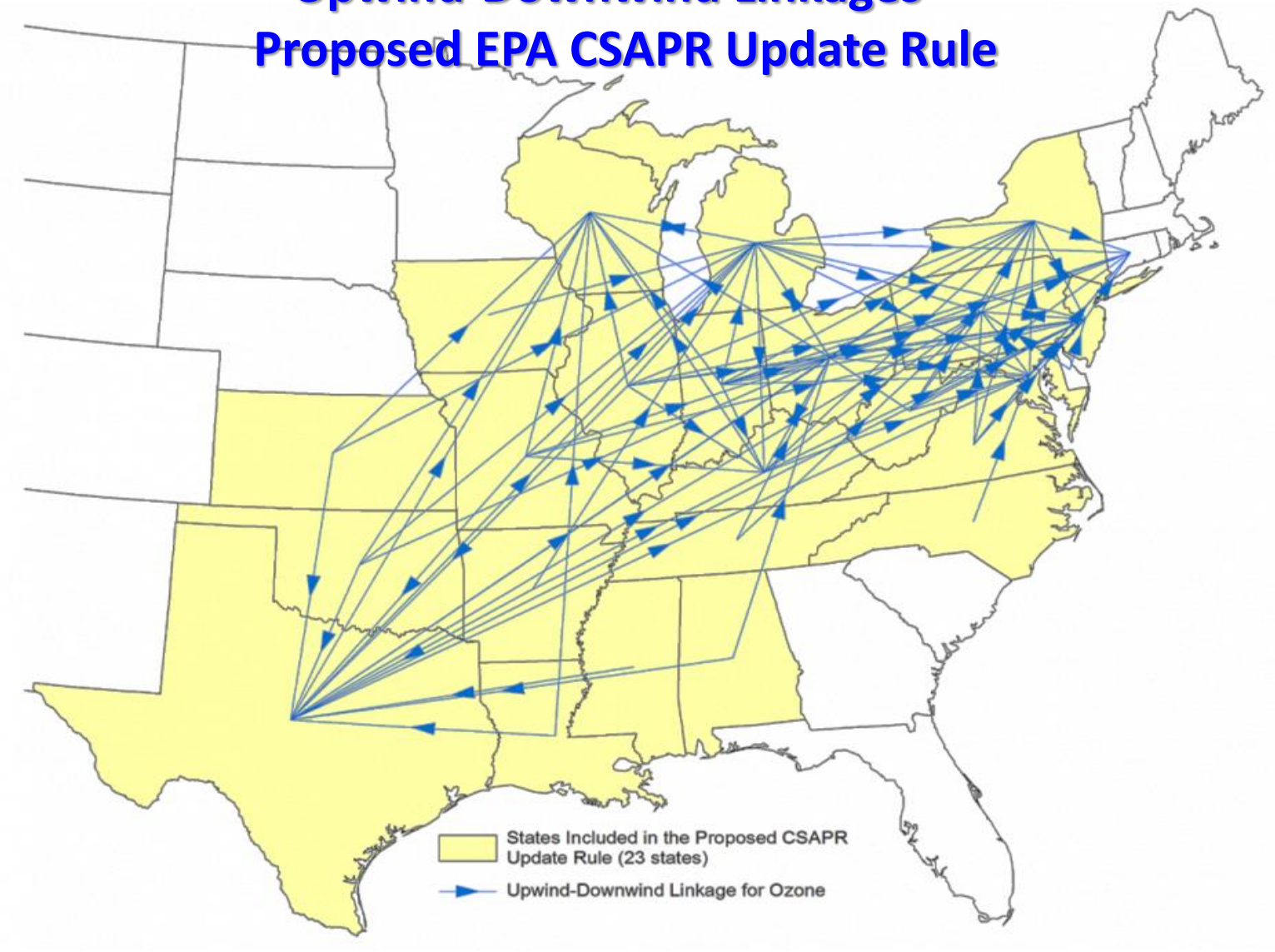
Source: POLITICO analysis of data from EIA

2013-2015 - 8-Hour Ozone Design Values
New U.S. Ozone Standard – 70 ppb



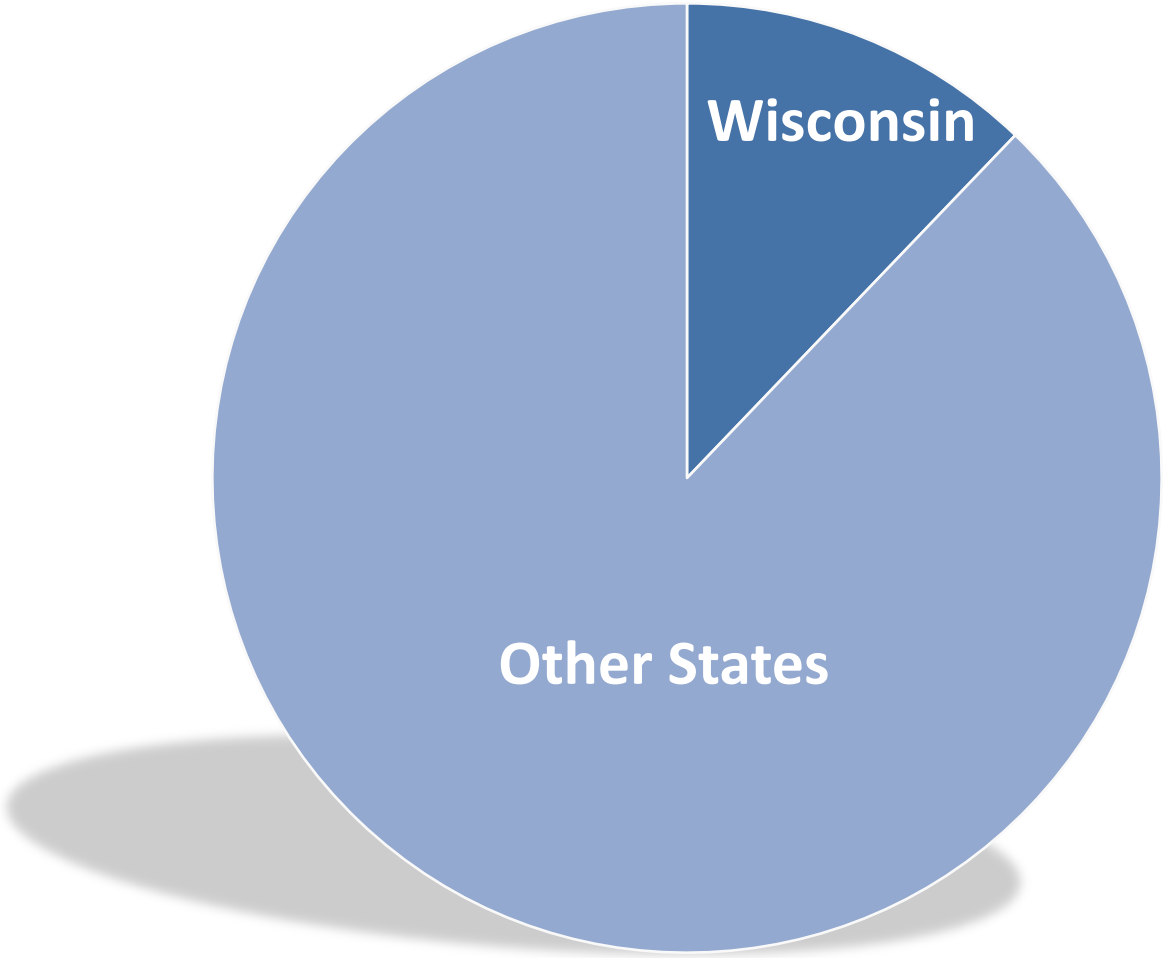
Where Is The Ozone Coming From?

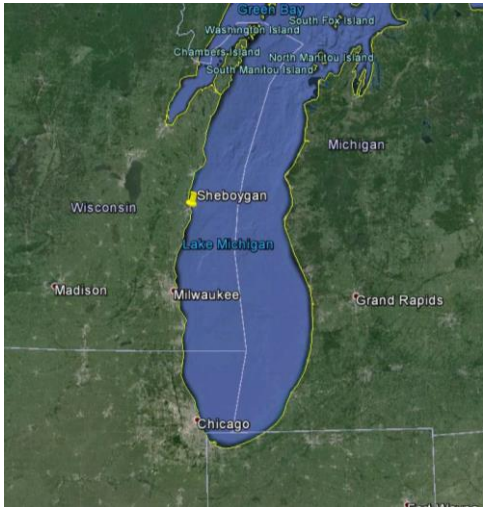
Upwind-Downwind Linkages – Proposed EPA CSAPR Update Rule



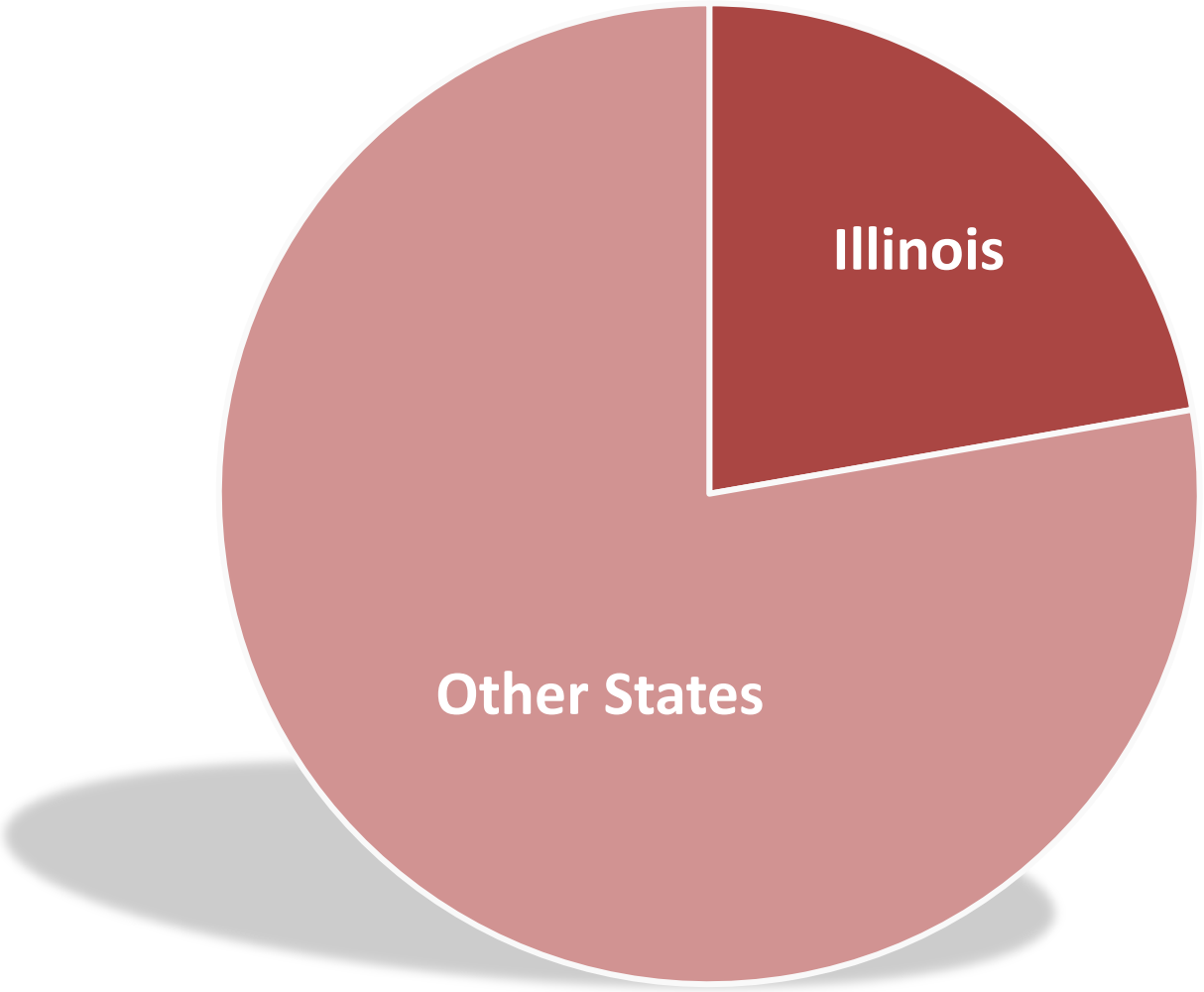
Where is the Ozone Coming From?

States' Ozone Contributions: At Sheboygan, WI

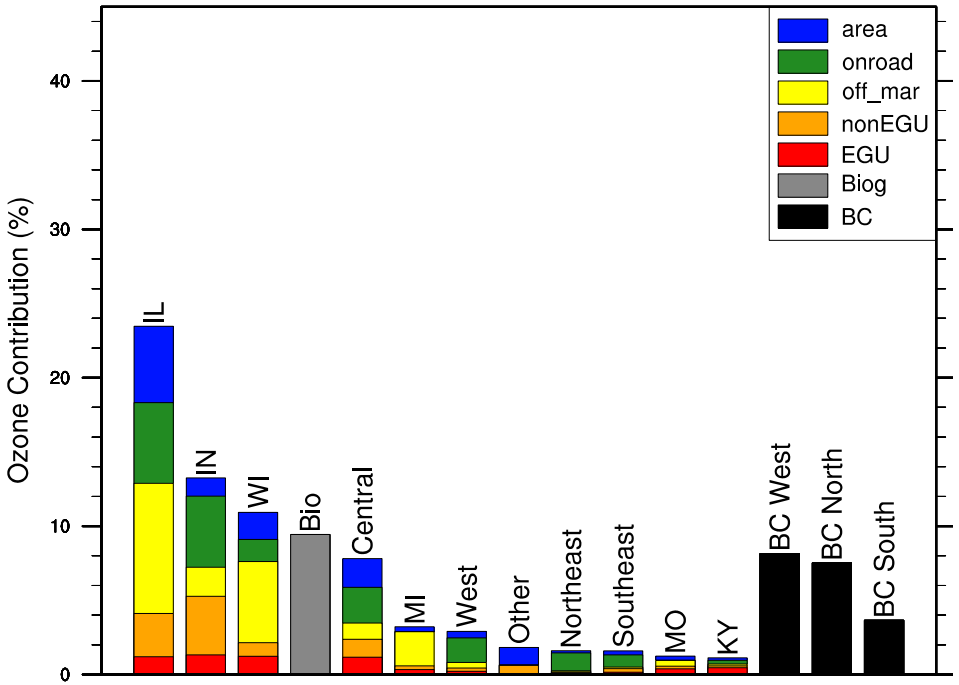


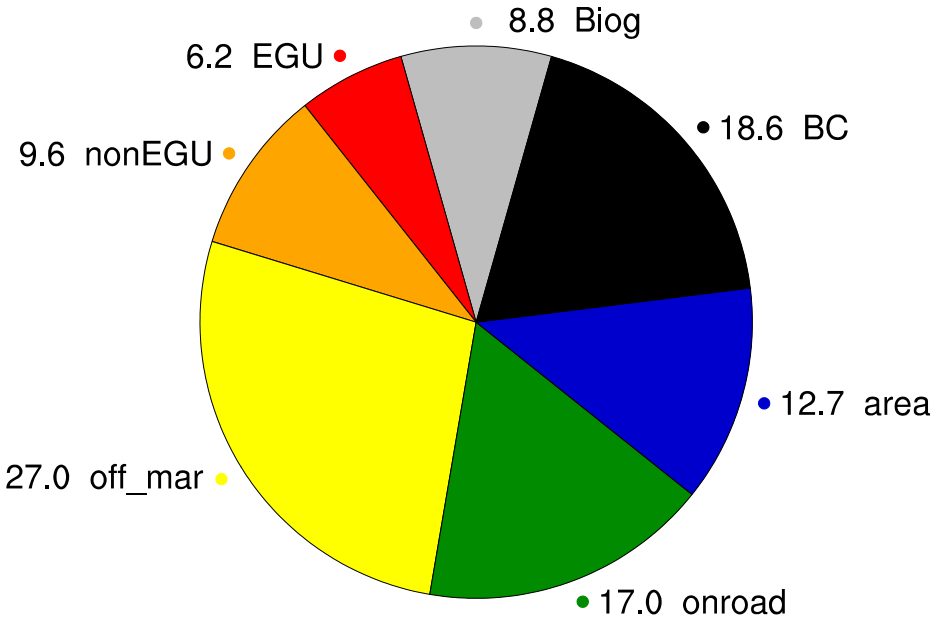


States' Ozone Contributions: At Chicago

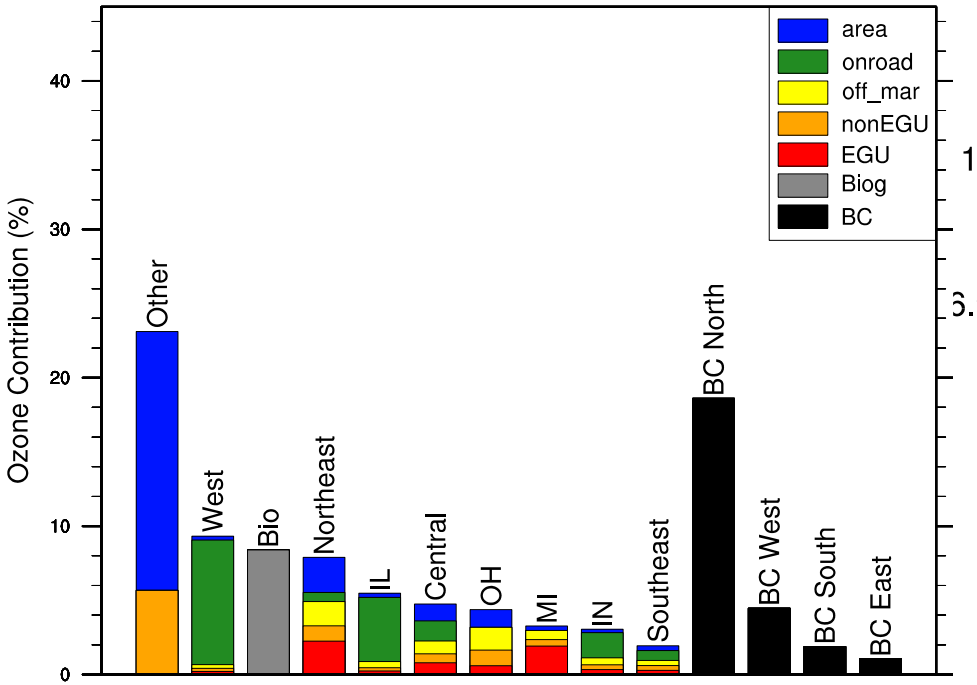


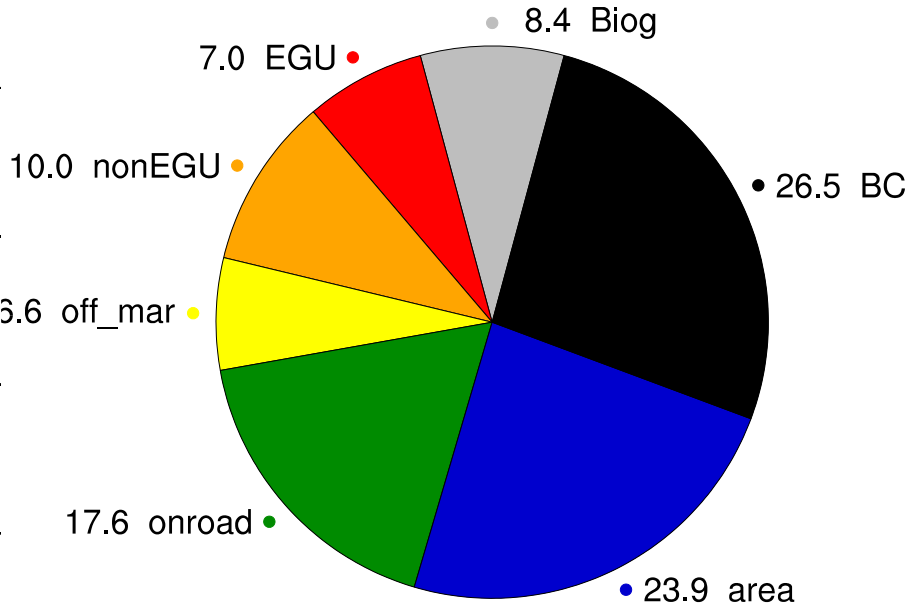
States' Ozone Contributions: Sheboygan



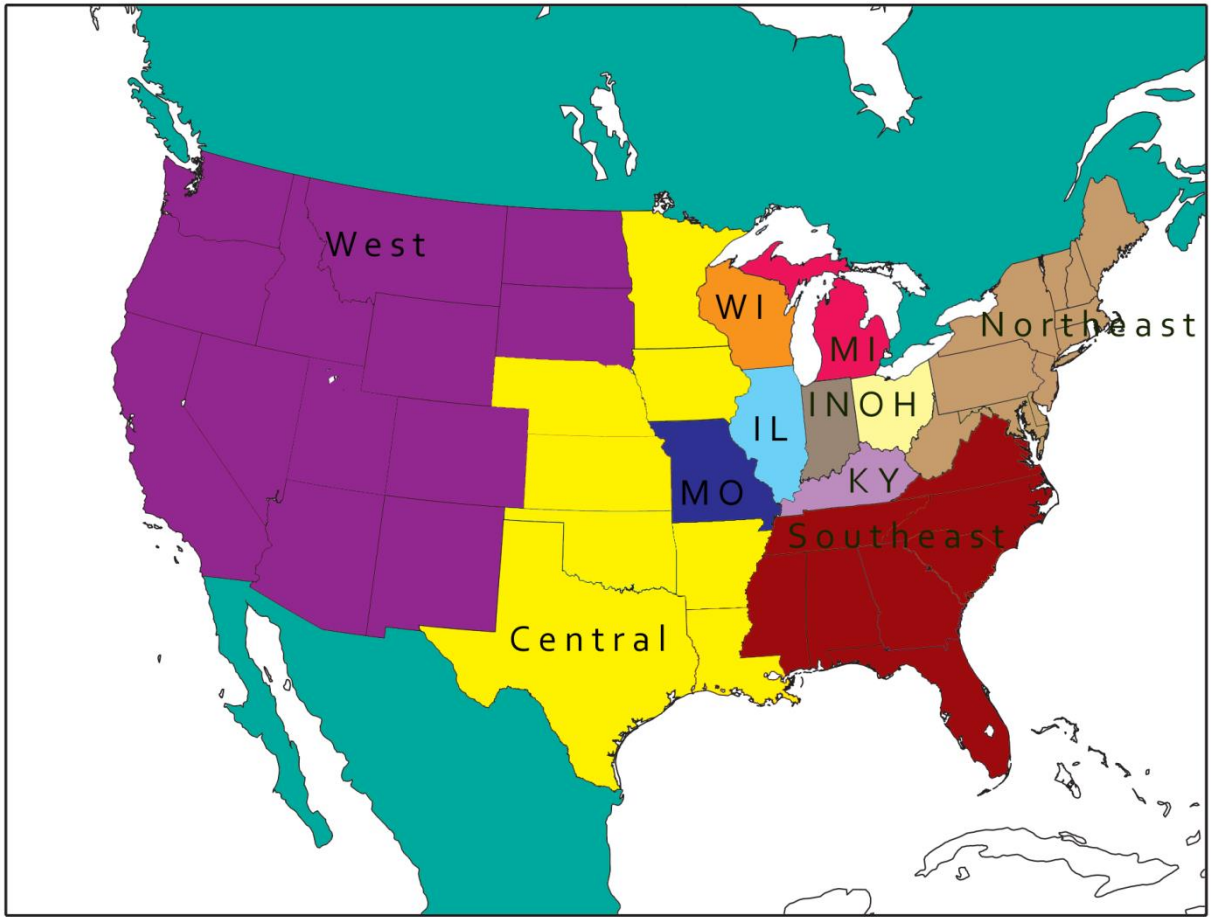


Ozone Contributions: Hamilton



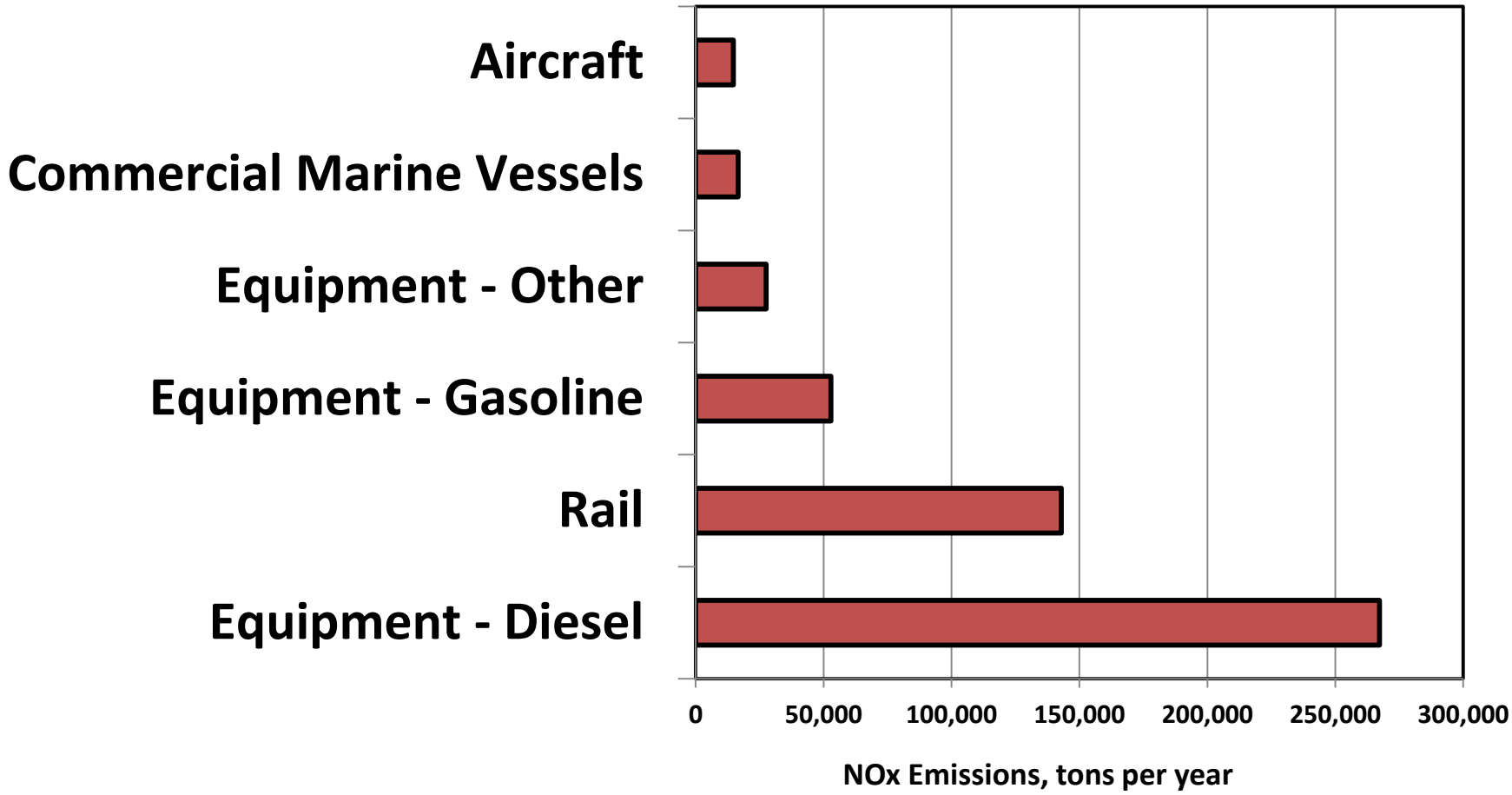


Tracking Regions



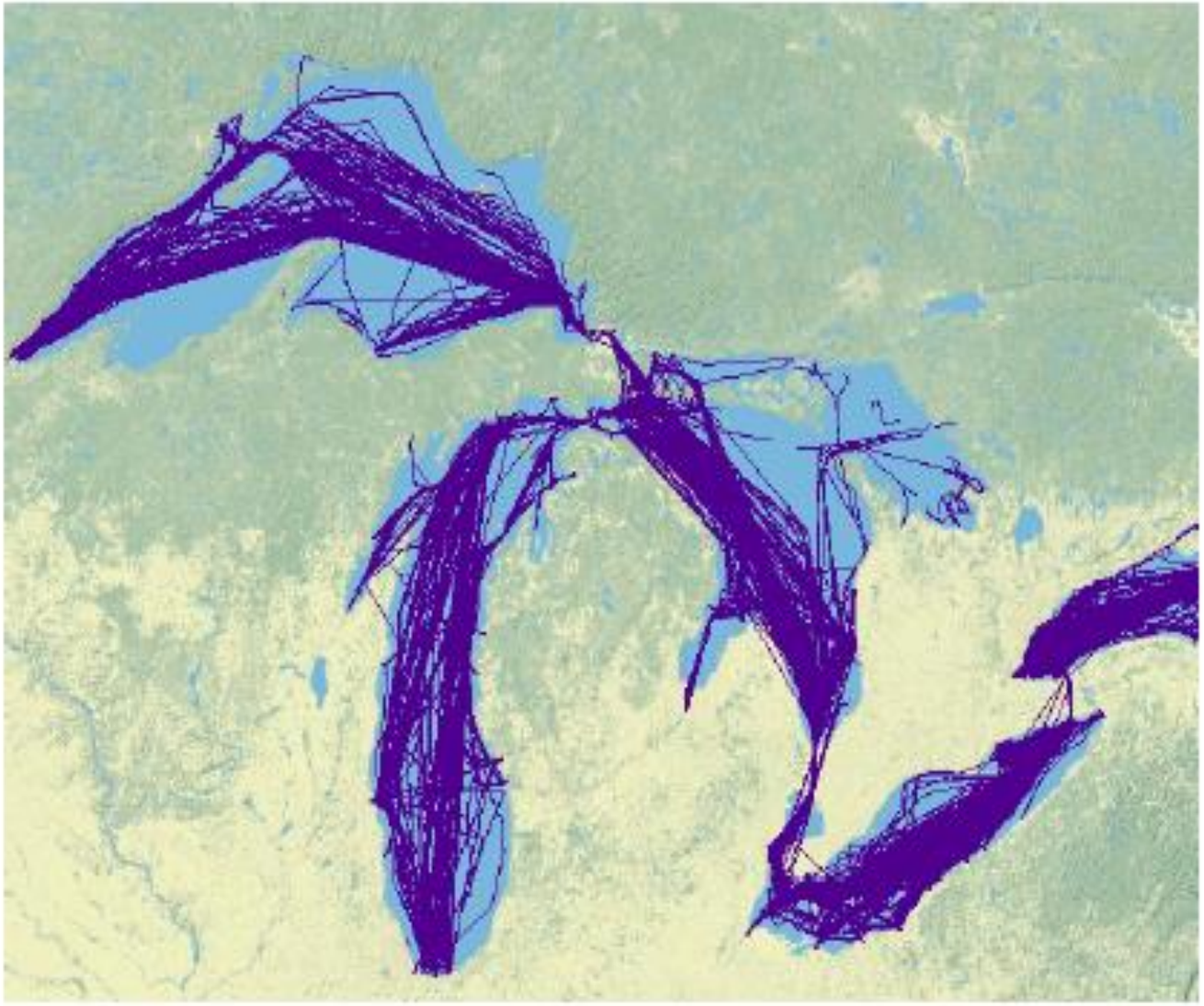
- "Other" includes Canada, Mexico, ocean marine vessels, drilling platforms, tribes, and fires

2014 NOx Emissions
Non-Road Mobile Sources - LADCO States



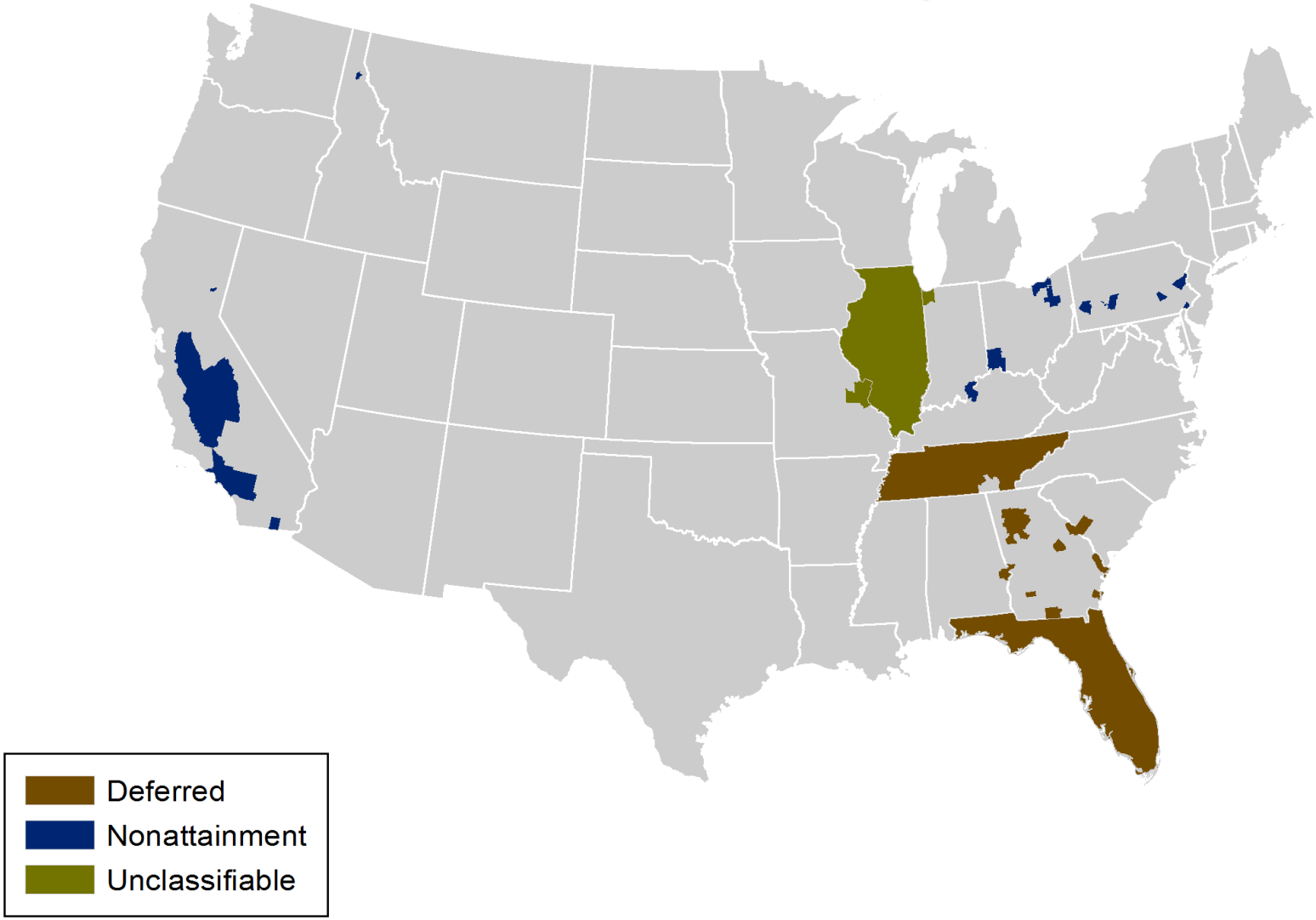
EPA, NEI - 2014

Commercial Marine Vessels on the Great Lakes

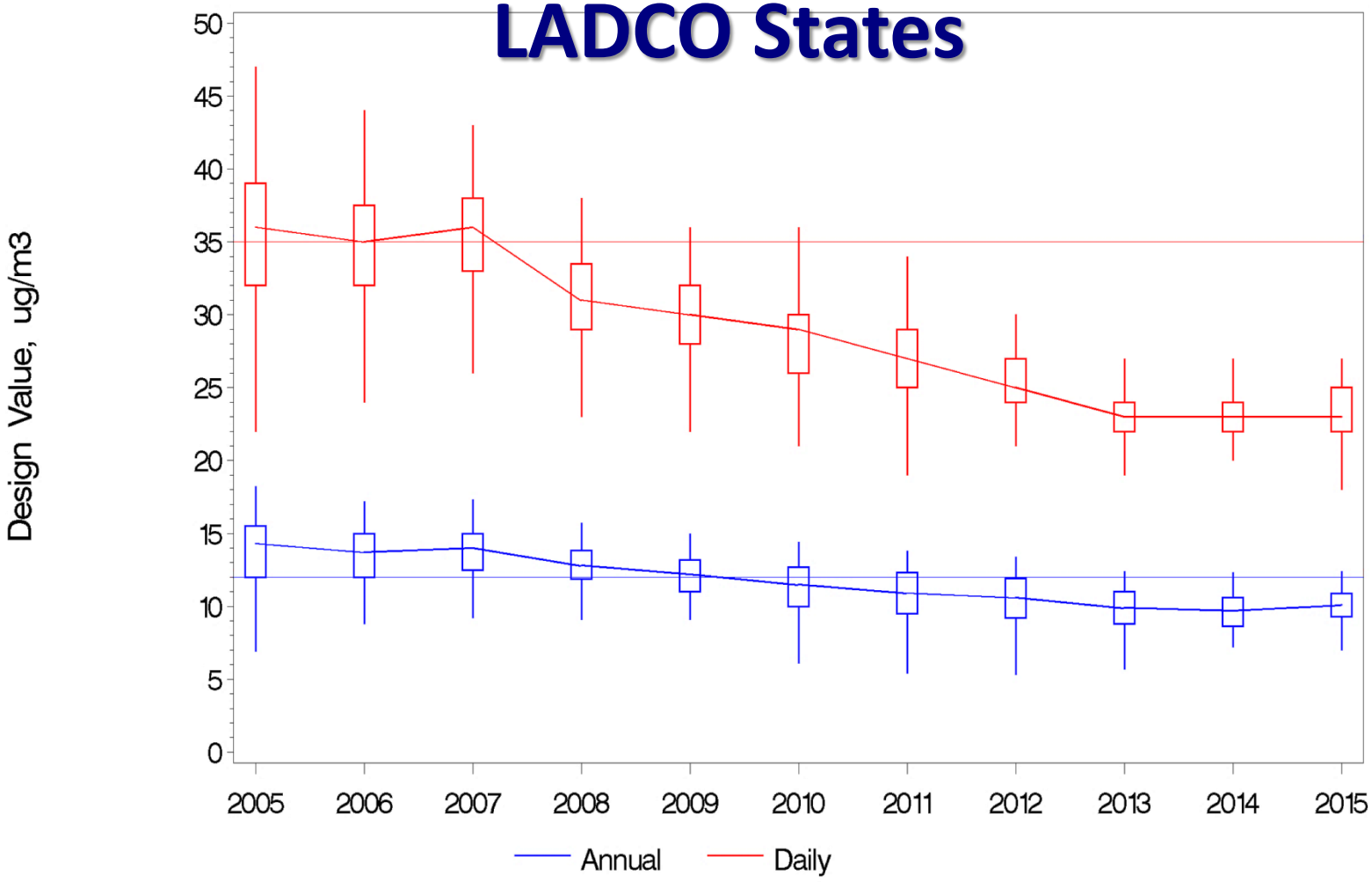


PM2.5

Nonattainment Areas for PM2.5 NAAQS

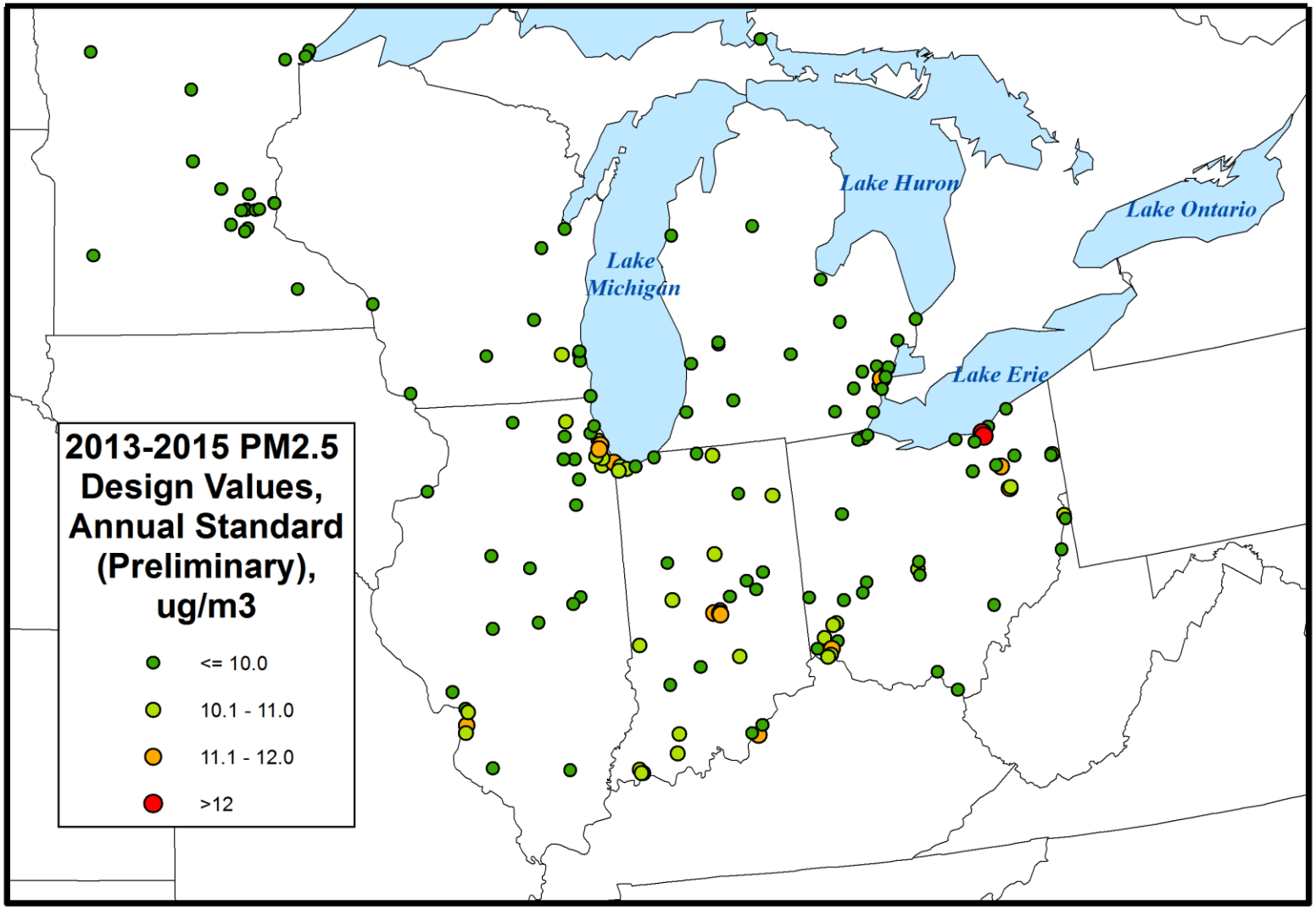


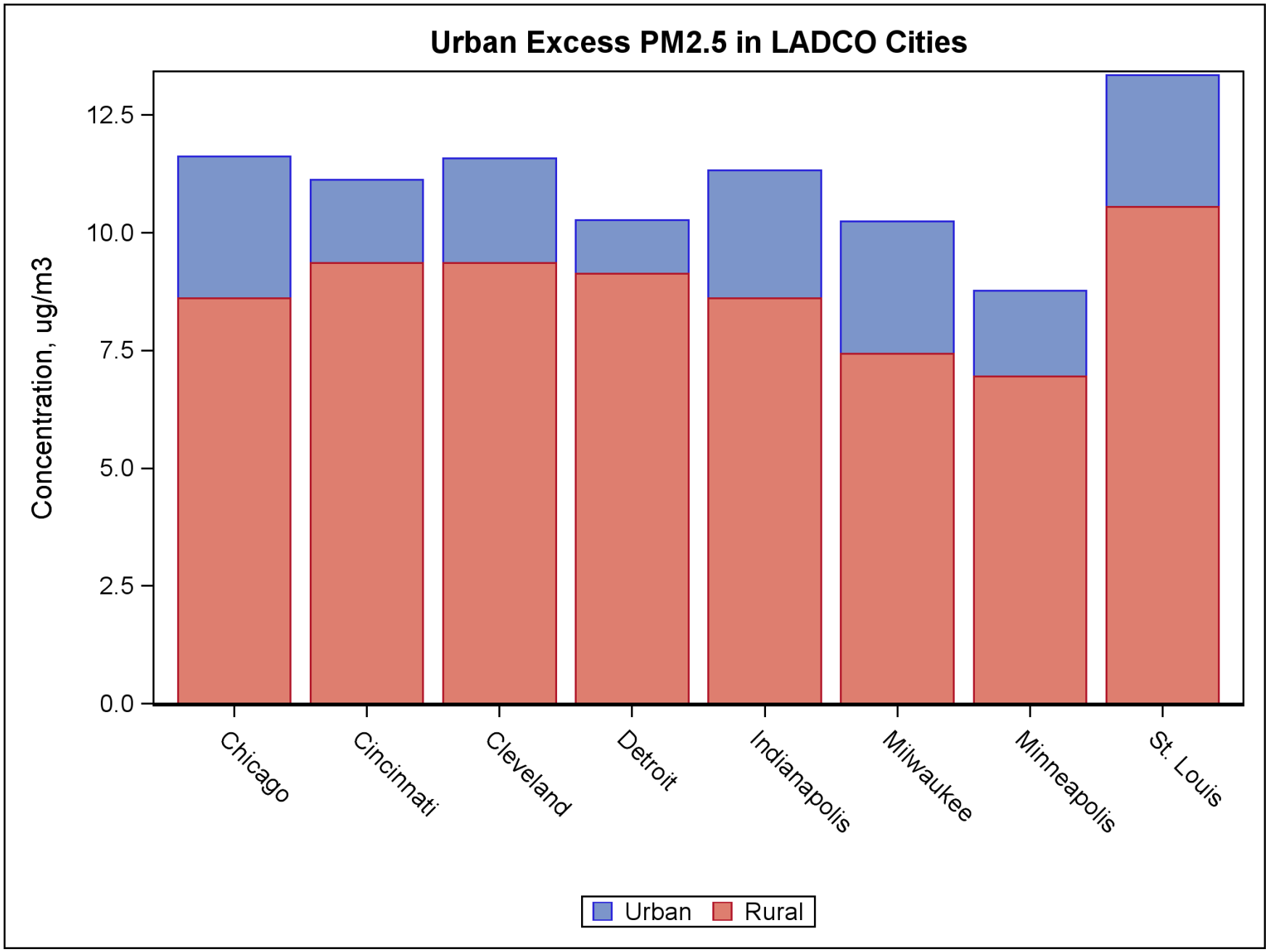
PM2.5 Design Value Trends
LADCO States

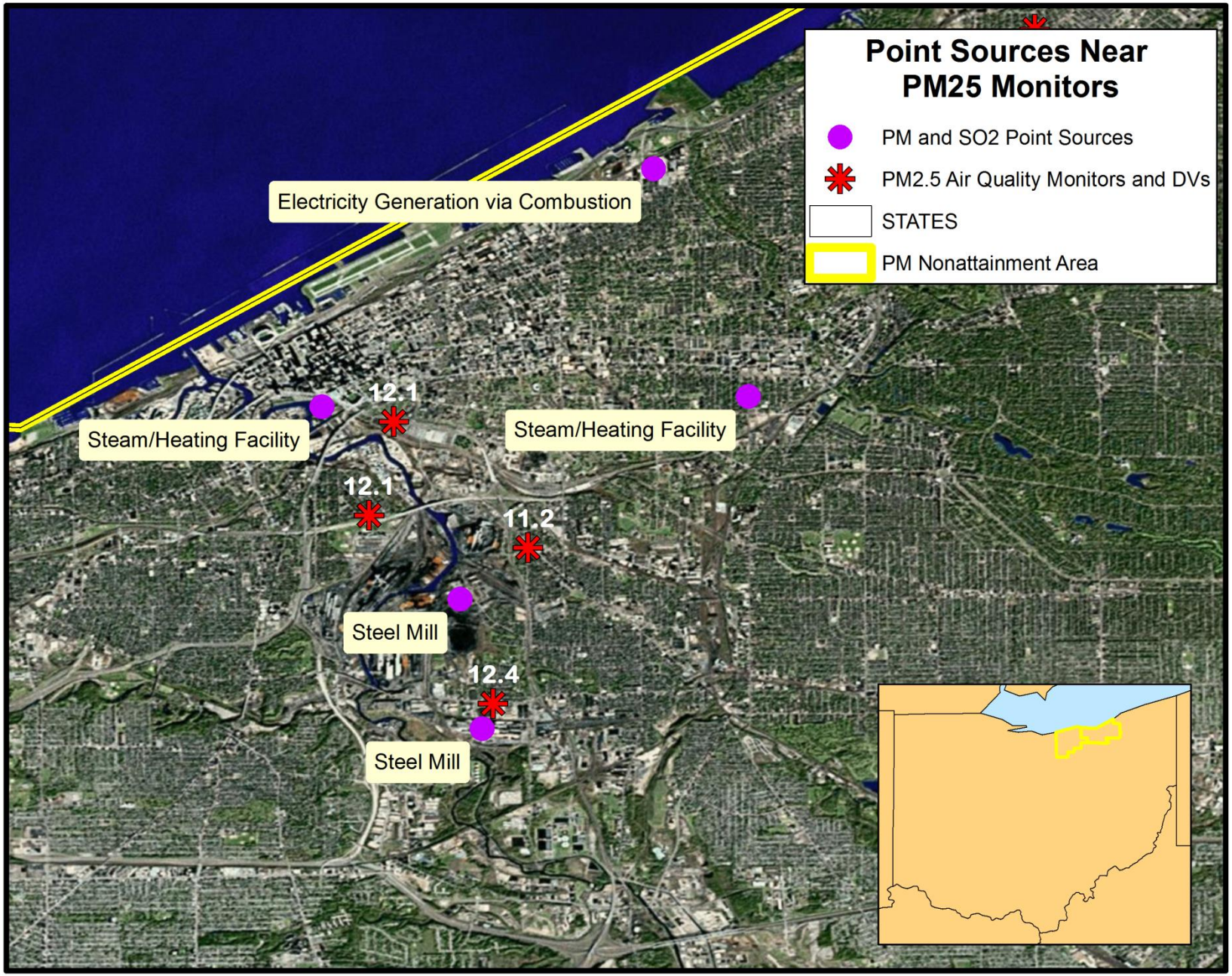


Only monitors with 10 or more years of complete data
Design value plotted by end year of 3–year period.
2015 Data are Preliminary

2013-2015 – PM2.5 Design Values
LADCO States




Urban Excess PM2.5 in LADCO Cities
Concentration, ug/m3
12.5
10.0
7.5
5.0
2.5
0.0
Chicago
Cincinnati
Cleveland
Detroit
Indianapolis
Milwaukee
Minneapolis
St. Louis
Urban
Rural


Point Sources Near PM25 Monitors
PM and SO2 Point Sources
PM2.5 Air Quality Monitors and DVs
STATES
PM Nonattainment Area
Electricity Generation via Combustion
Steam/Heating Facility
Steam/Heating Facility
12.1
12.1
11.2
Steel Mill
12.4
Steel Mill

REGIONAL HAZE

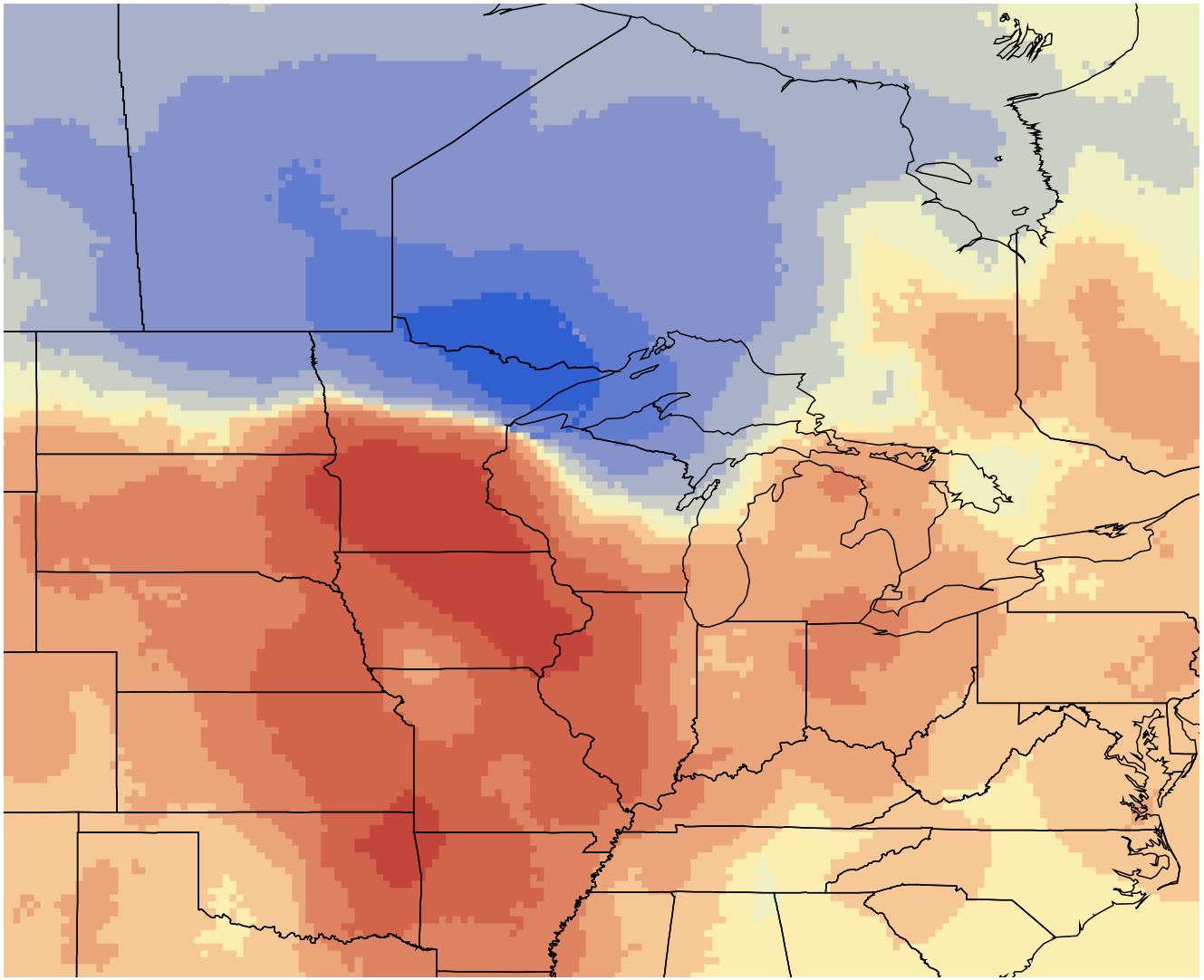
Mandatory Class I Areas

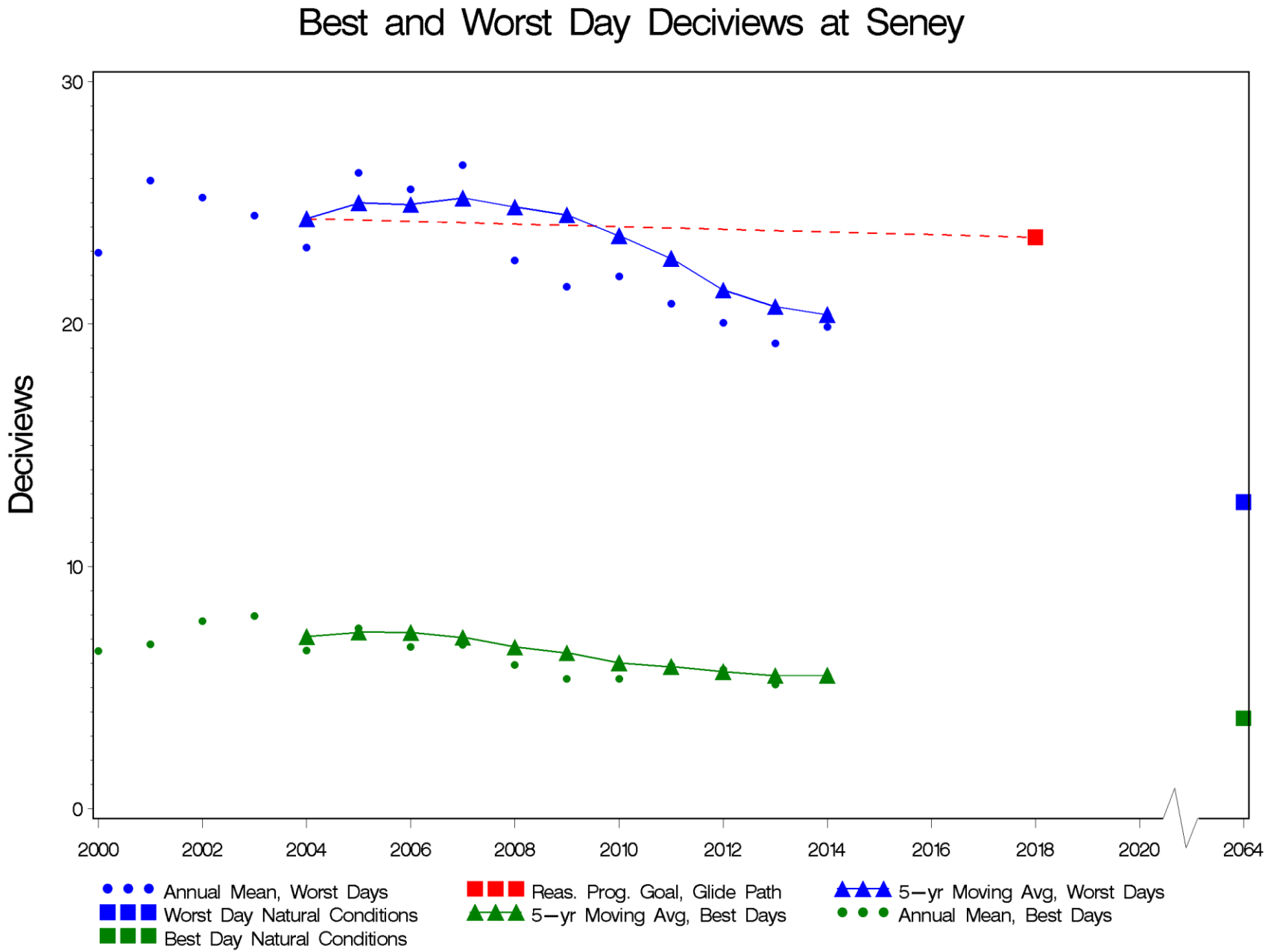
*** Rainbow Lake, WI and Bradwell Bay, FL are Class 1 Areas where visibility is not an important air quality related value**

Produced by NPS Air Resources Division

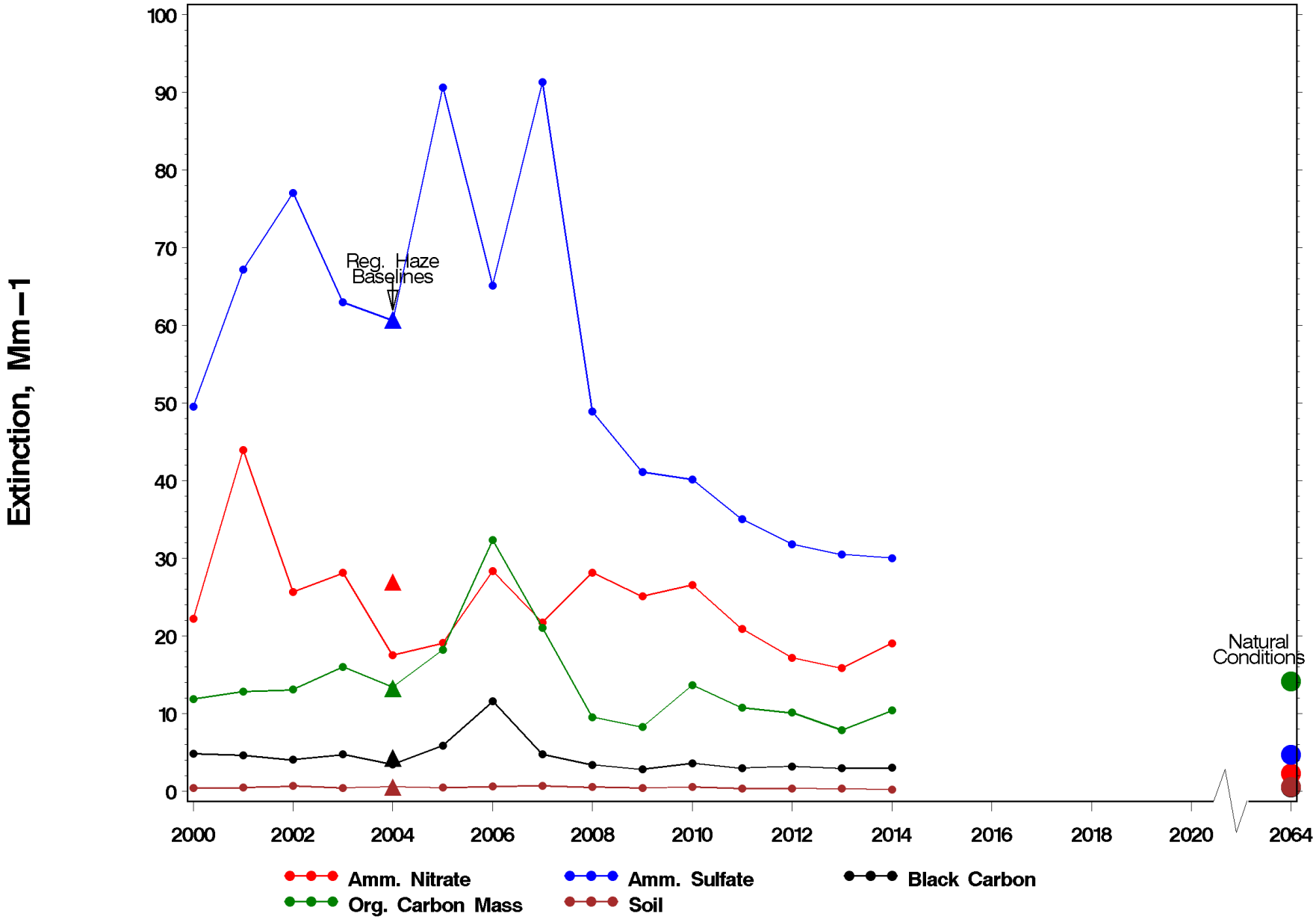
Regional Haze - Probability of 20% Best/Worst Day Conditions

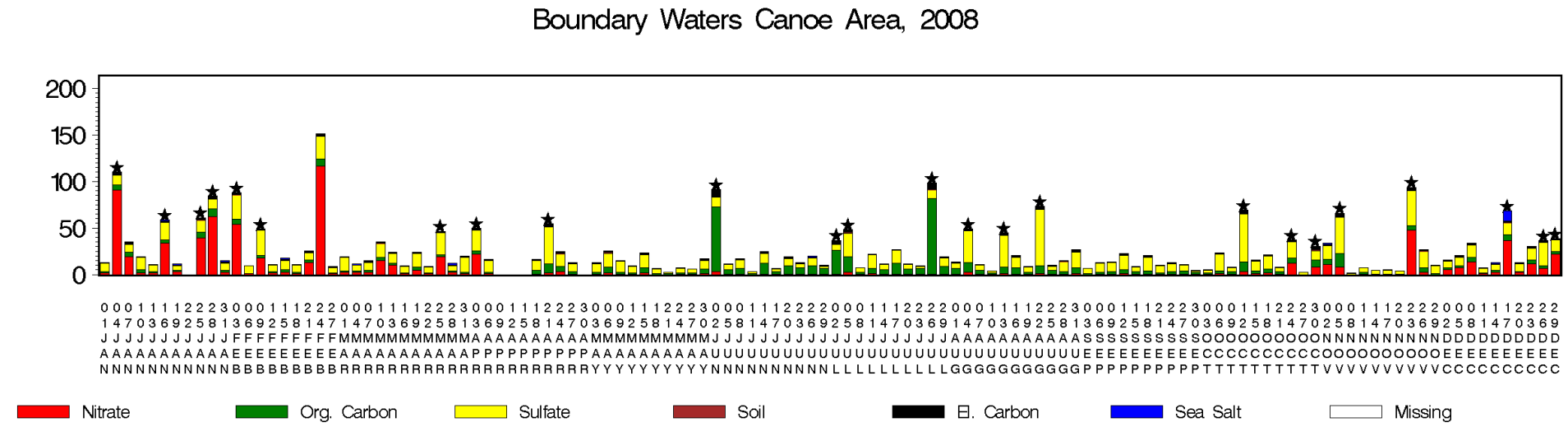
Boundary Water Canoe Area, MN

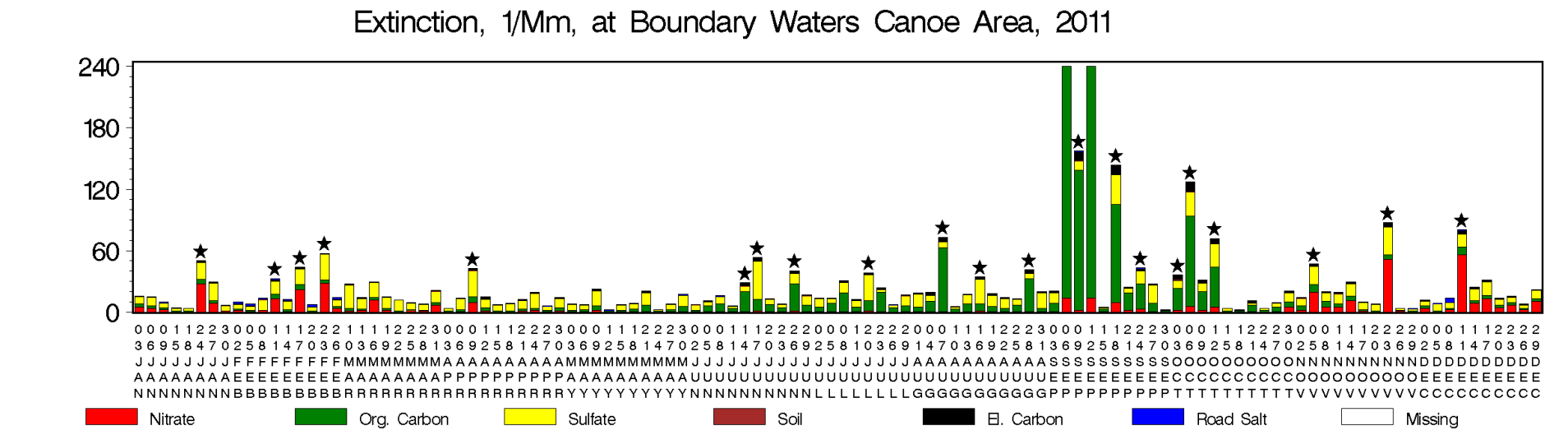



Best and Worst Day Deciviews at Seney
Deciviews
30
20
10
0
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2064
Annual Mean, Worst Days
Worst Day Natural Conditions
Best Day Natural Conditions
Reas. Prog. Goal, Glide Path
5−yr Moving Avg, Best Days
5−yr Moving Avg, Worst Days
Annual Mean, Best Days

Worst Day Extinction, by Species, at Seney




Boundary Waters Canoe Area, 2008
200
150
100
50
0
Nitrate
Org. Carbon
Sulfate
Soil
El. Carbon
Sea Salt
Missing

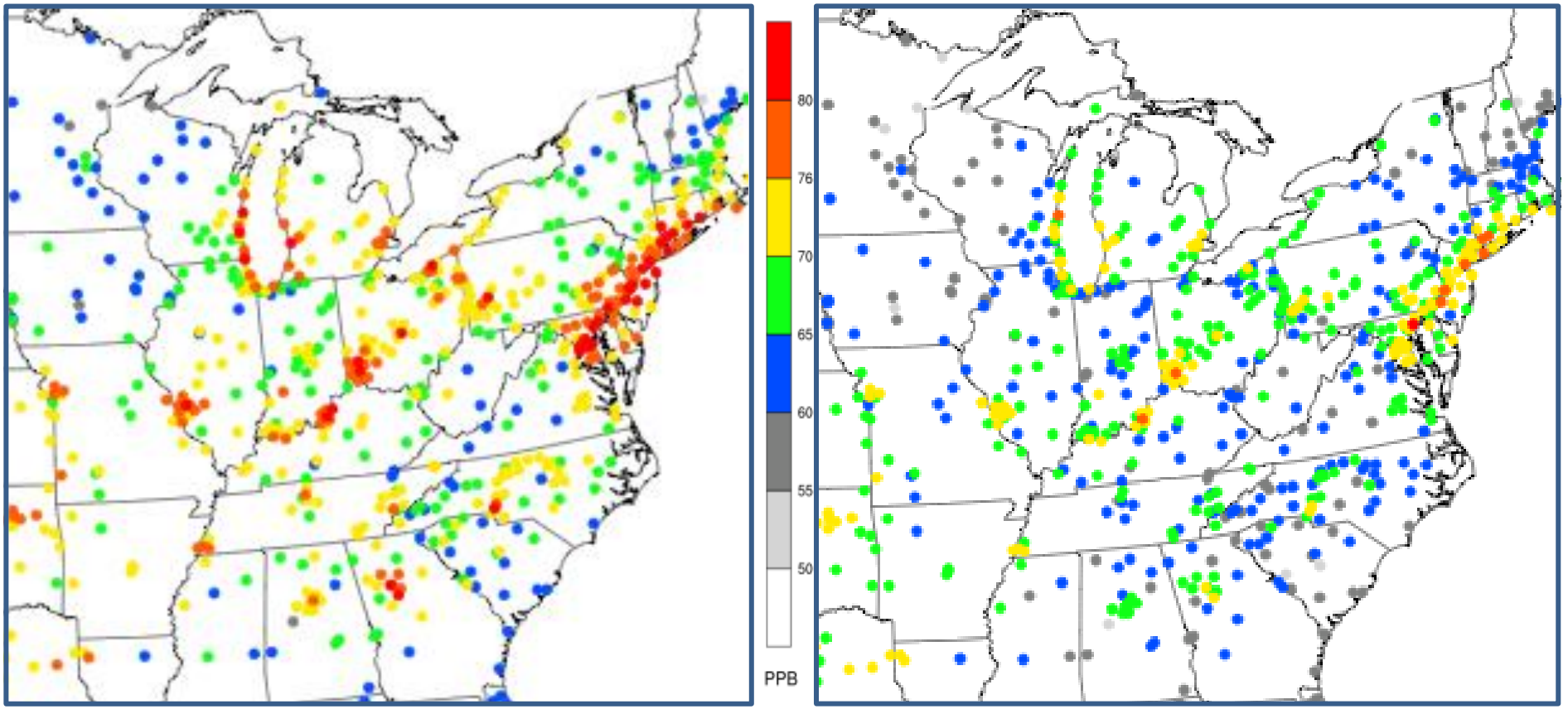

Extinction, 1/Mm, at Boundary Waters Canoe Area, 2011
240
180
120
60
0
Nitrate
Org. Carbon
Sulfate
Soil
El. Carbon
Road Salt
Missing

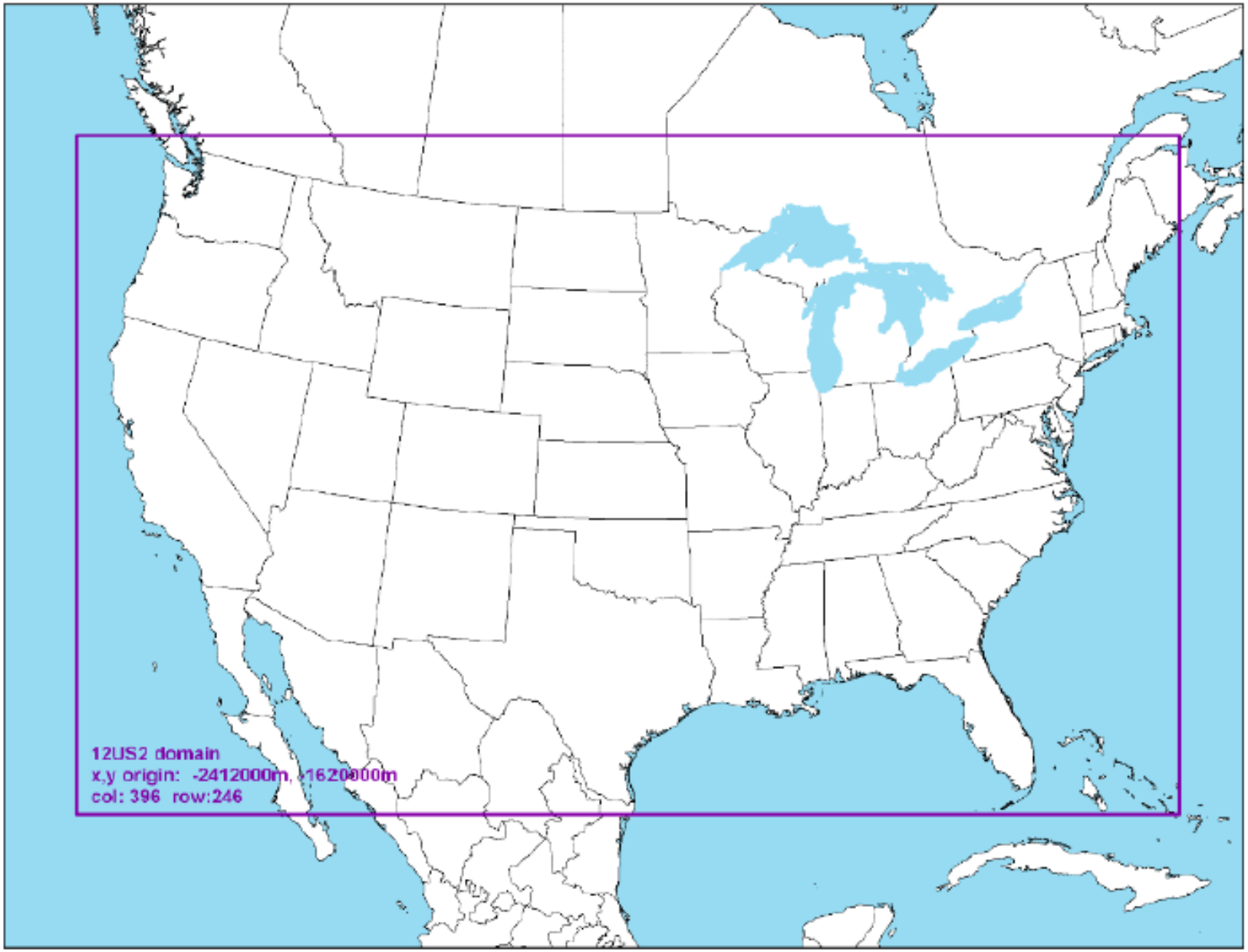
MODELING CHALLENGES AND POLICY

Using Models to Project Future Ozone

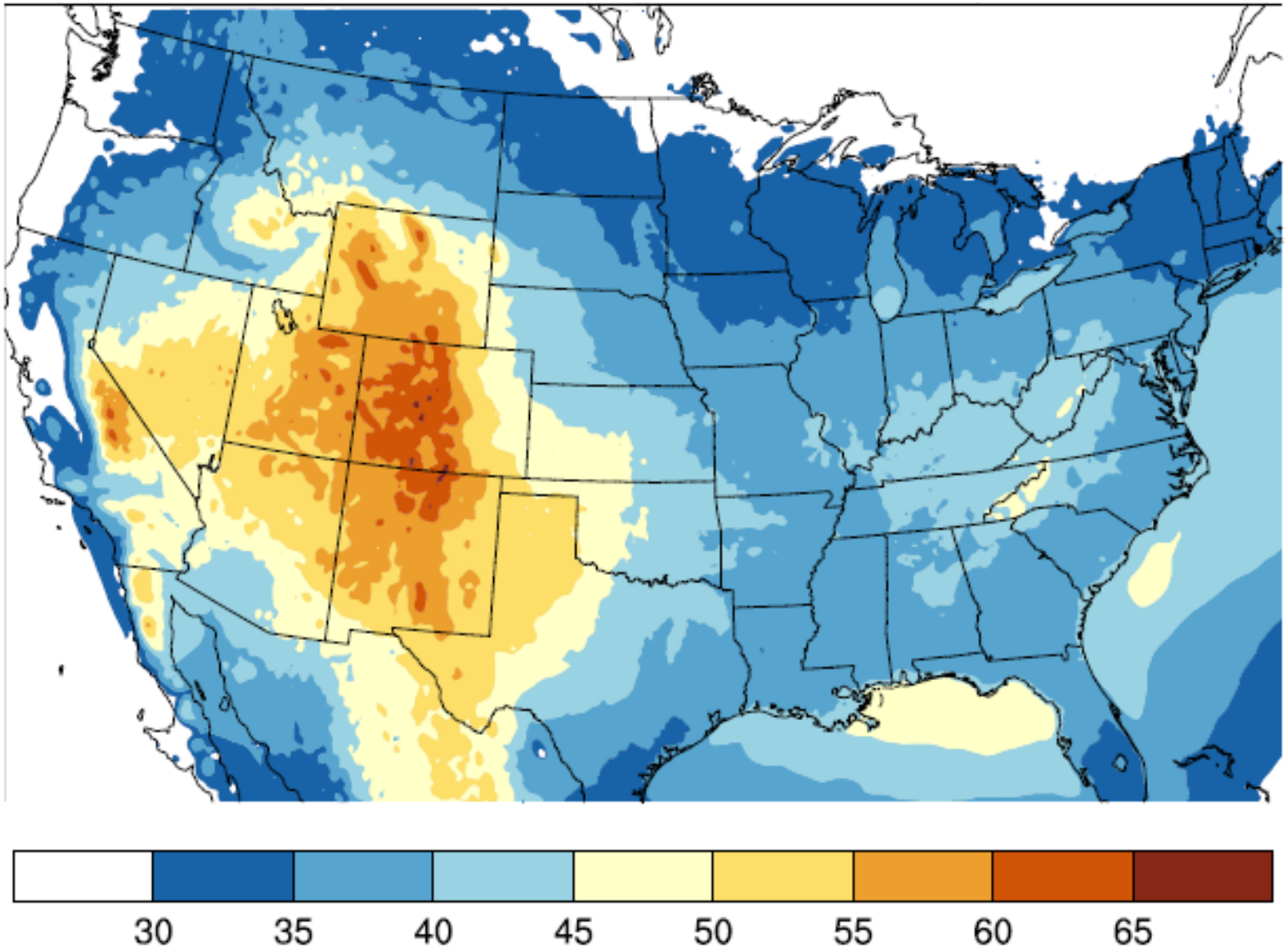
2011 “Base Year”

2017 “Attainment Year”



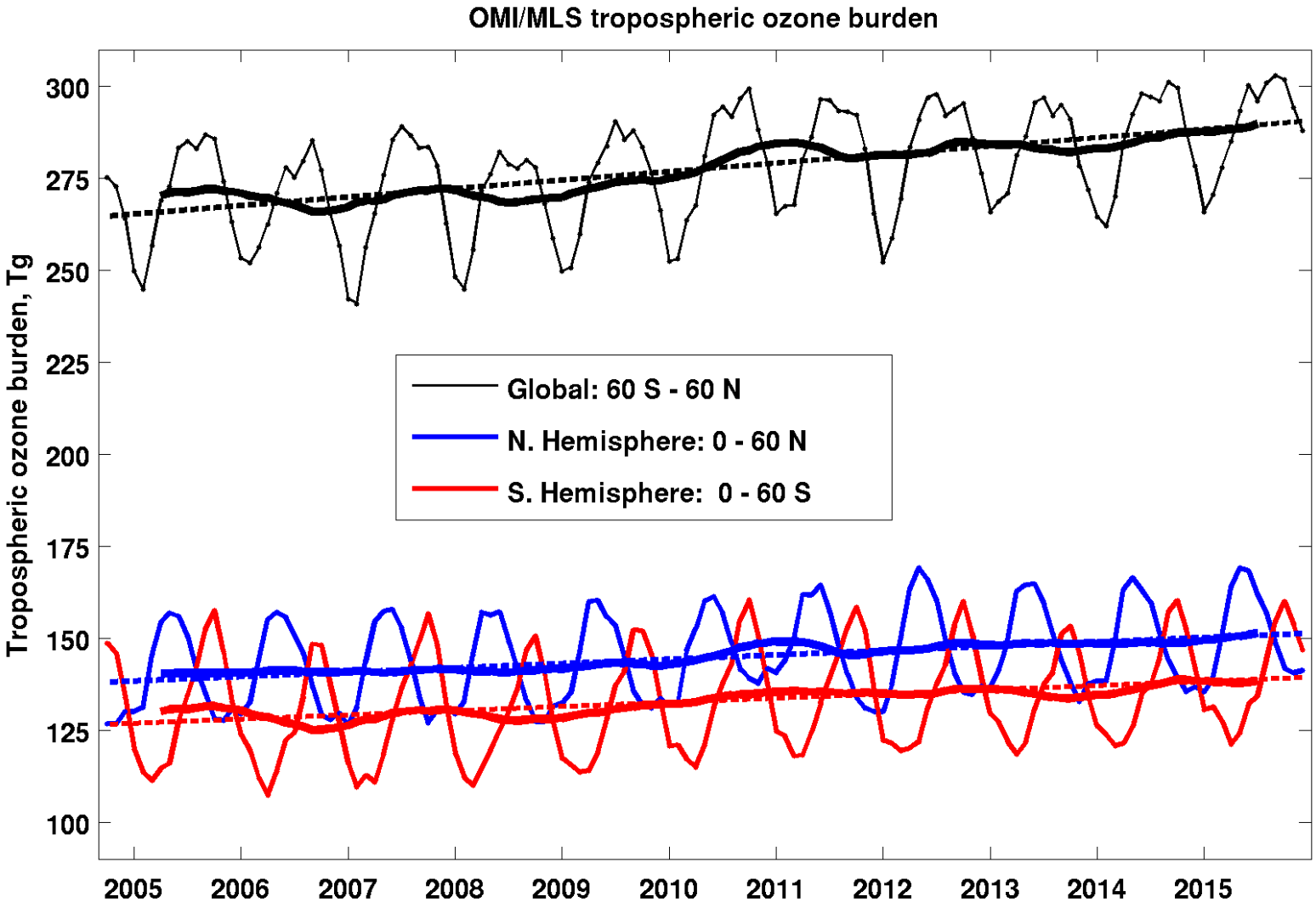

12US2 domain
x,y origin: -2412000m, -1620000m
col: 396 row:246

Model Performance Issue: Importance of Boundary Conditions



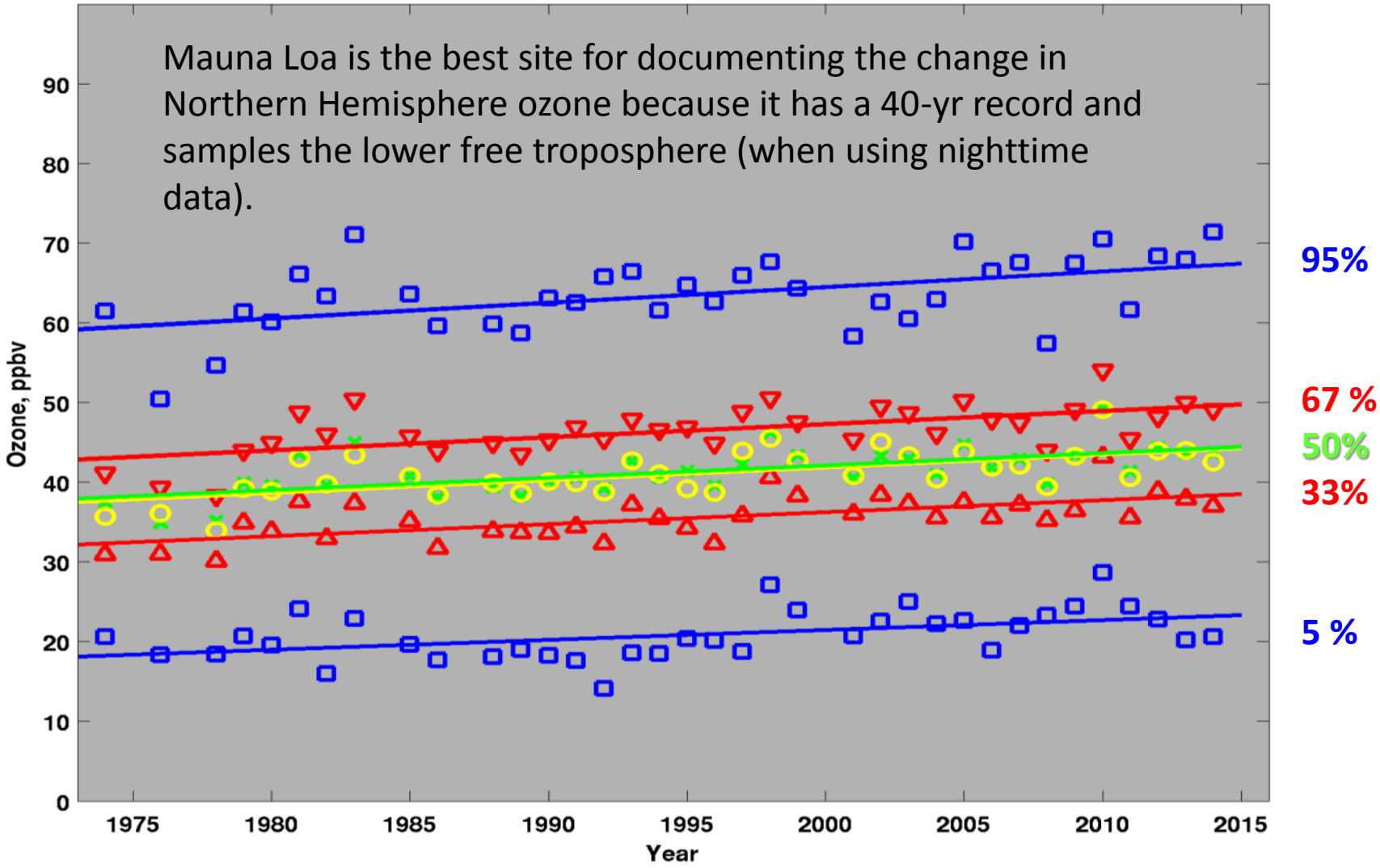
OMI/MLS tropospheric ozone burden, 2005-2015

The global (60°N –60°S) tropospheric ozone burden has increased by 9% (25 Tg) over 11 years



Data produced by Jerry Ziemke, Morgan State U./NASA Goddard

Nighttime O_3 trend at Mauna Loa Obs., Hawaii, 3.4 km above sea level



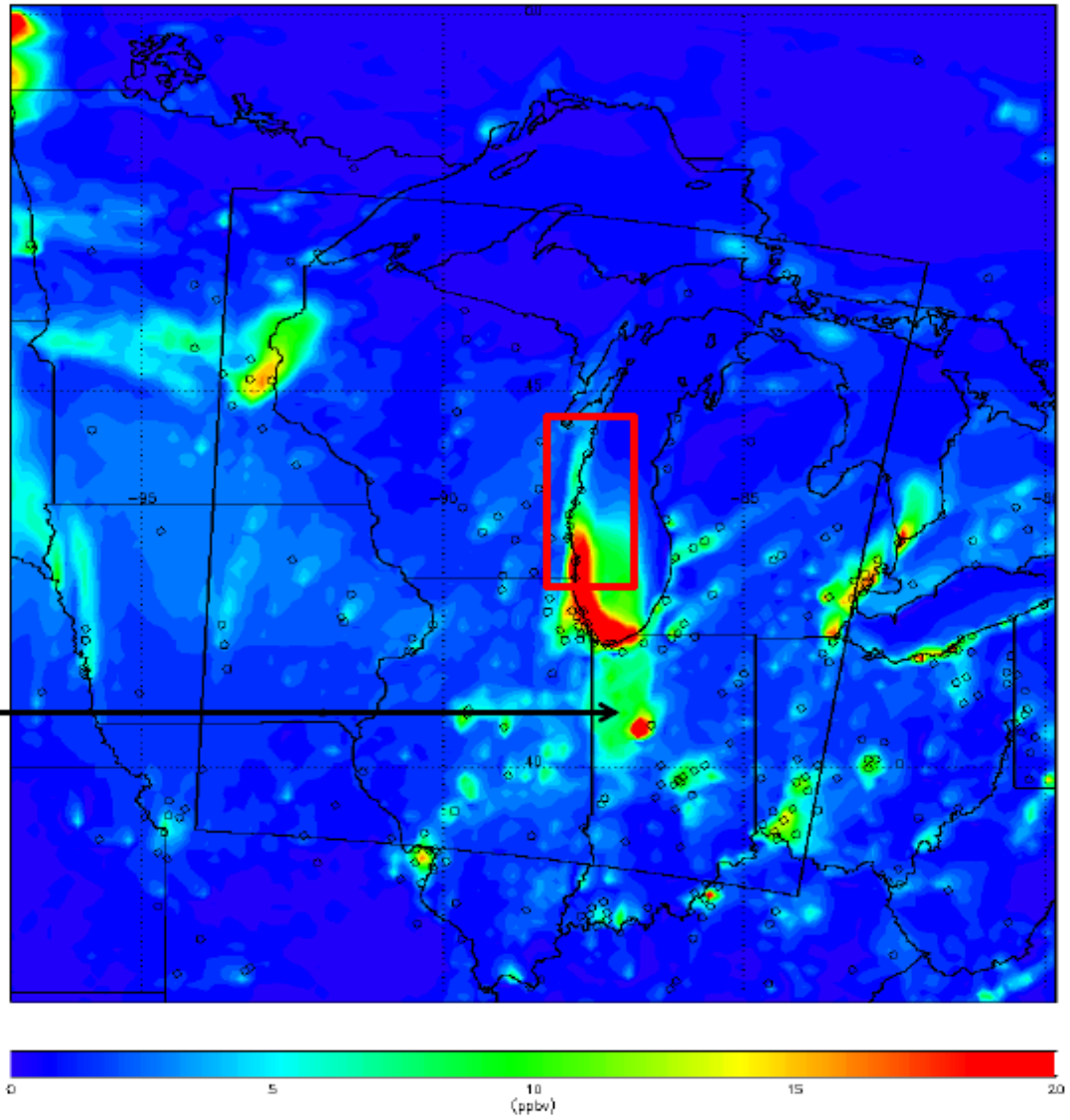
Data collected by NOAA Global Monitoring Division

Model Performance Issues: Too much NOx?

WRF-CHEM 12km Surface NOx 22Z (5:00pm Central) July 17, 2011

12km WRF-CHEM shows broad region of higher surface NOx over southern Lake Michigan and NW Indiana

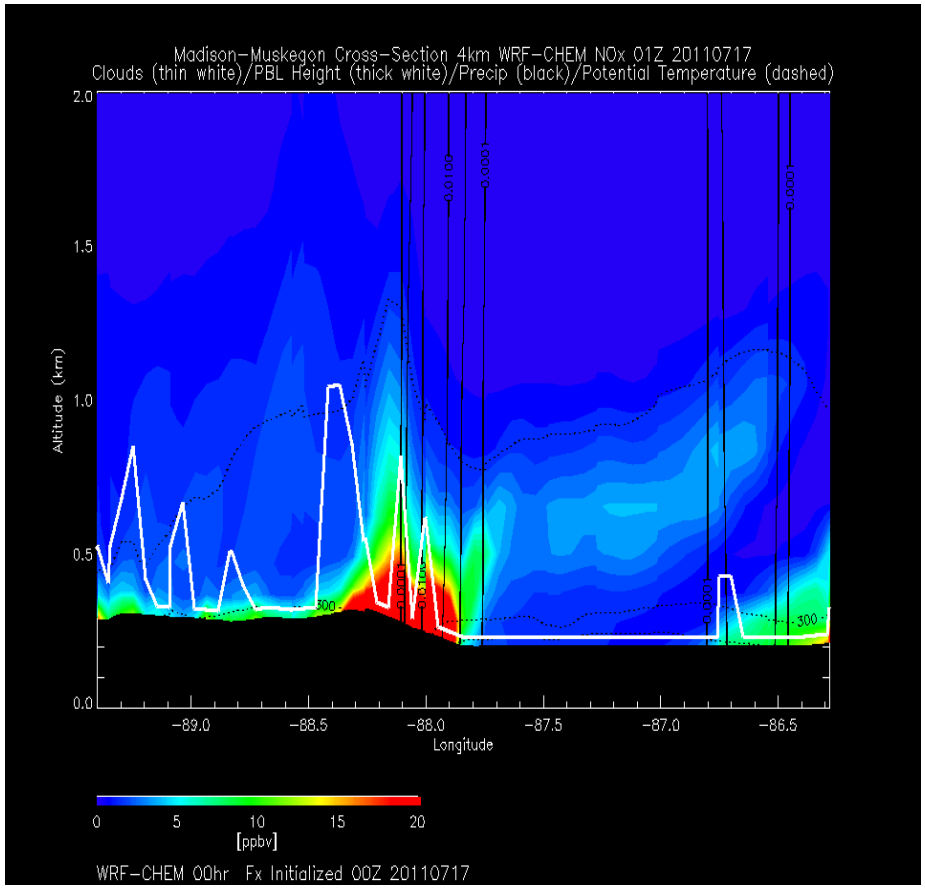
12km NOx high over NW Indiana due to low PBL

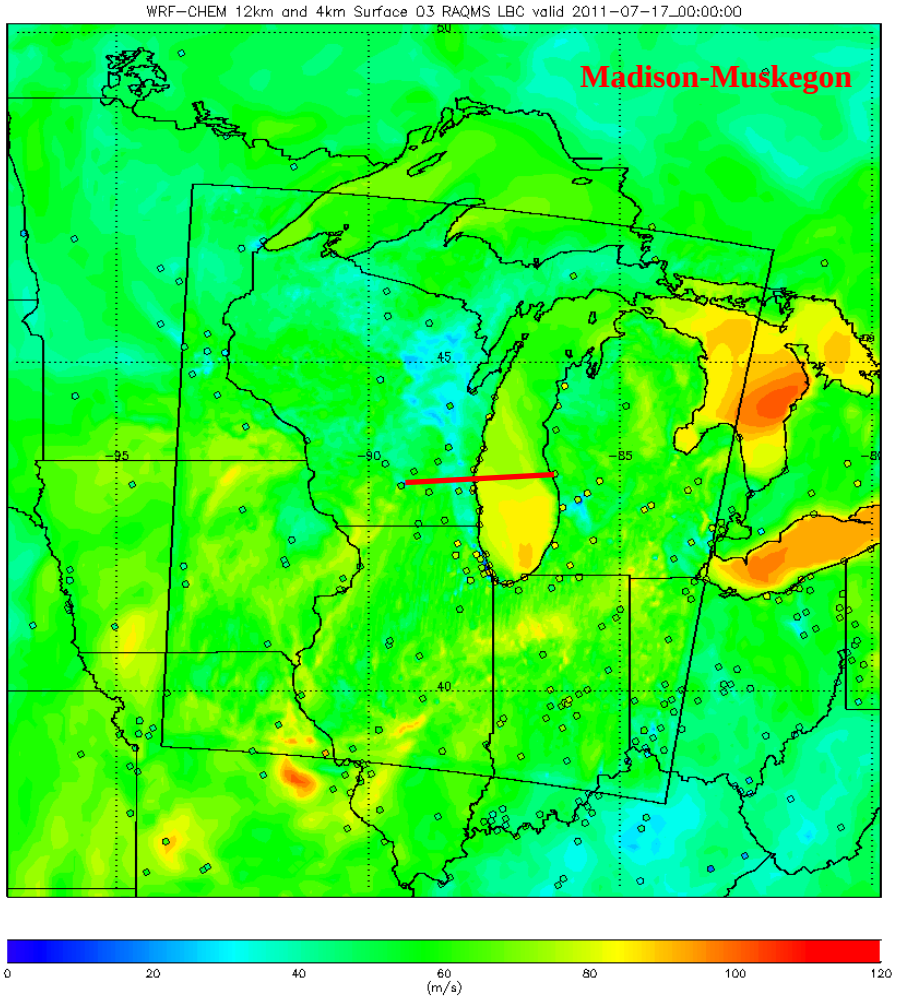


Source: Brad Pierce, NOAA

Model Performance Issue: Characterizing the Lake Breeze

- Photochemical models have historically been unable to reproduce the lake breeze, which is a major driver of ozone concentrations along the lakeshore, so it is difficult for states and LADCO to accurately predict ozone concentrations along the Lake Michigan lakeshore.





Great Lakes Ozone Study Planning Overview

Brad Pierce (NOAA/NESDIS)
Angela Dickens (WDNR)
Rob Kaleel (LADCO)
Tim Bertram (UW-Madison)
Charles Stanier (U-Iowa)

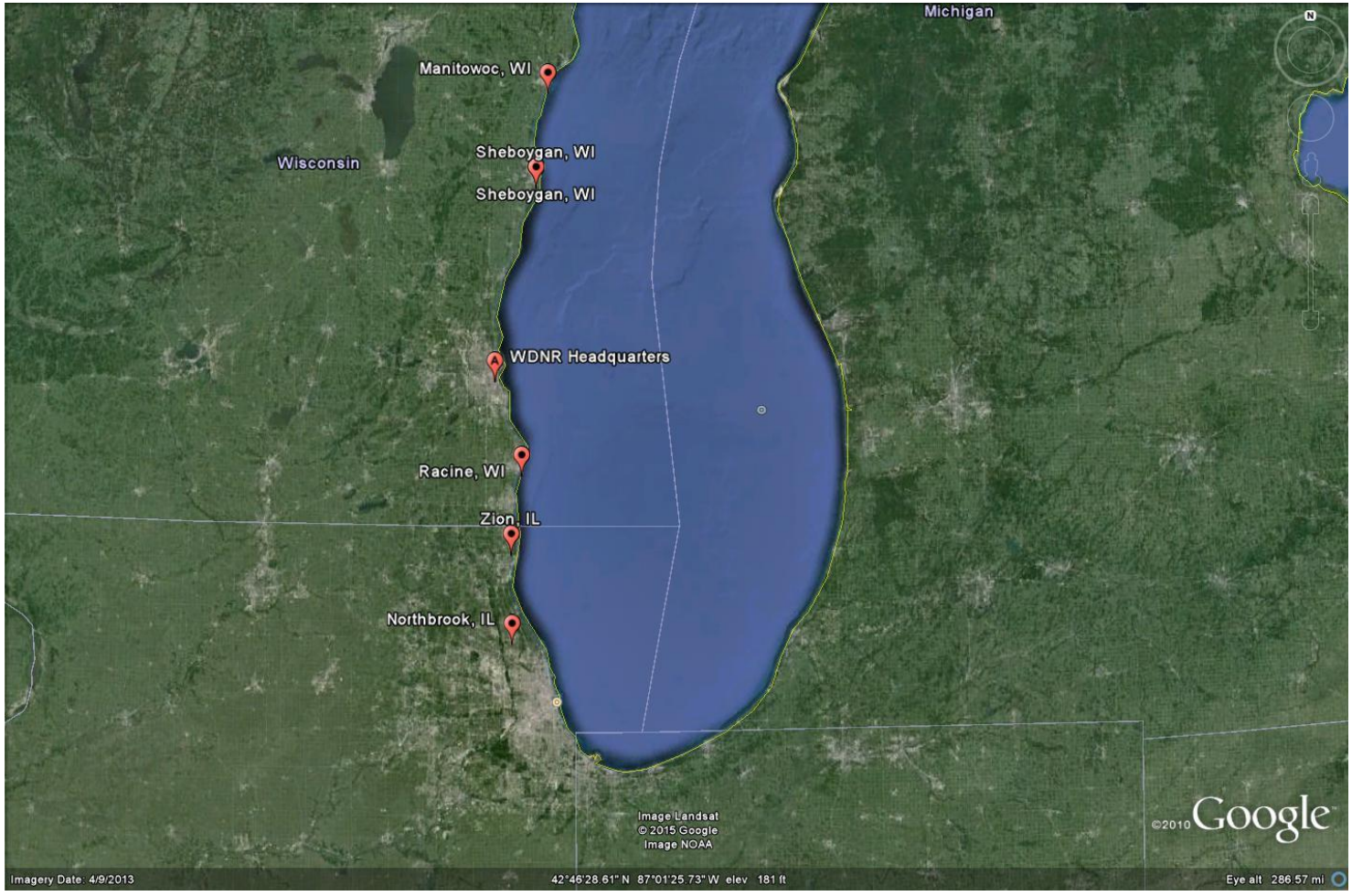
A small to medium size ground/airborne/satellite campaign[1] in summer 2017 with primary science objectives focusing on characterizing the recirculation, aging, and mixing of the Chicago and Milwaukee urban plumes as they move over Lake Michigan and their impact on surface ozone.

Currently drafting white paper for NASA review.

[1]Requesting NASA facility airborne remote sensing instruments

Analytical Approaches:

	Satellites	Airborne platforms	Ground-based
Type of measurement:	Remote sensing only	In situ & remote sensing	In situ & remote sensing
Spatial Coverage:	Excellent	Good	Limited
Temporal Coverage:	Limited	Good	Excellent



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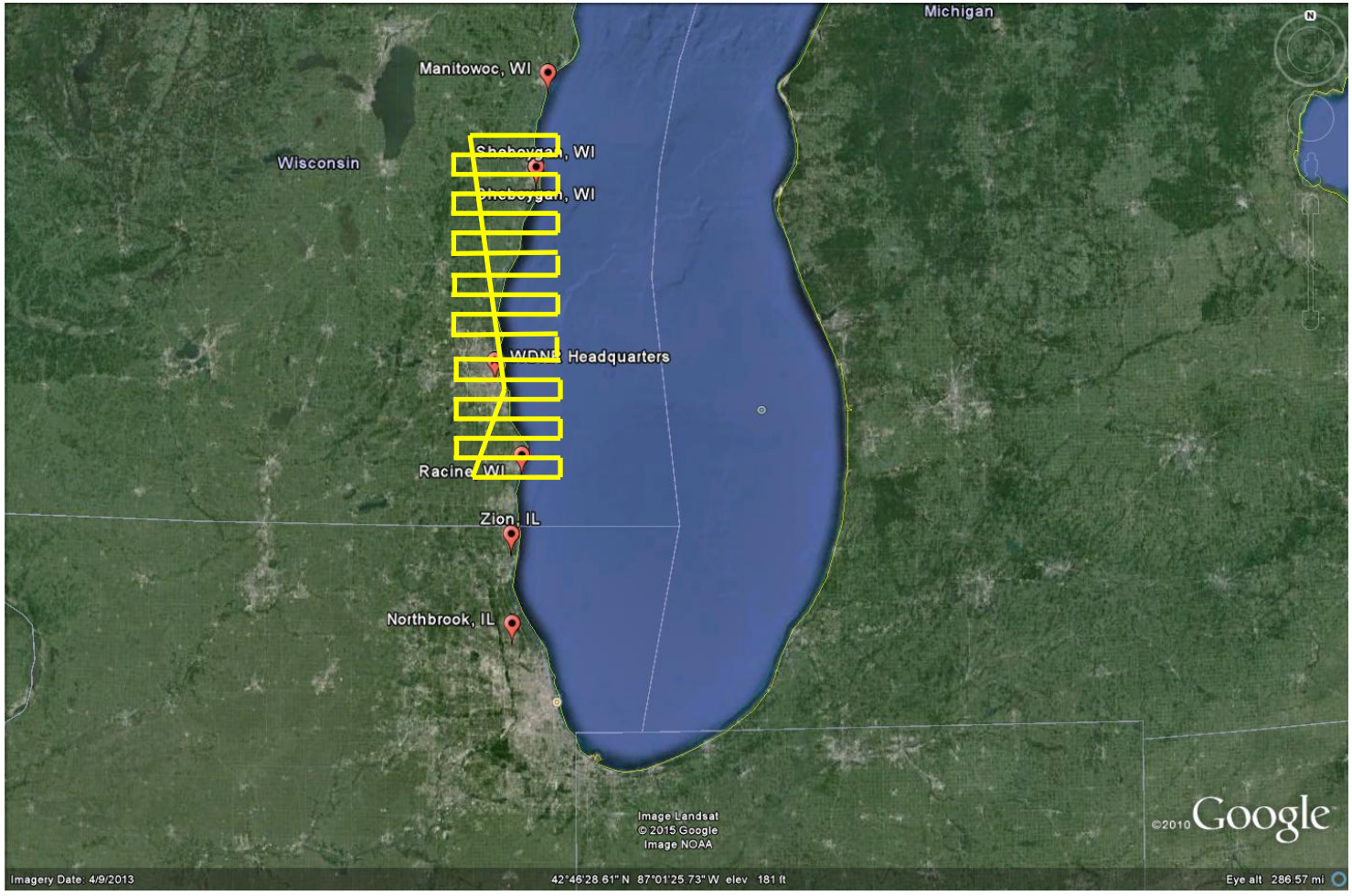

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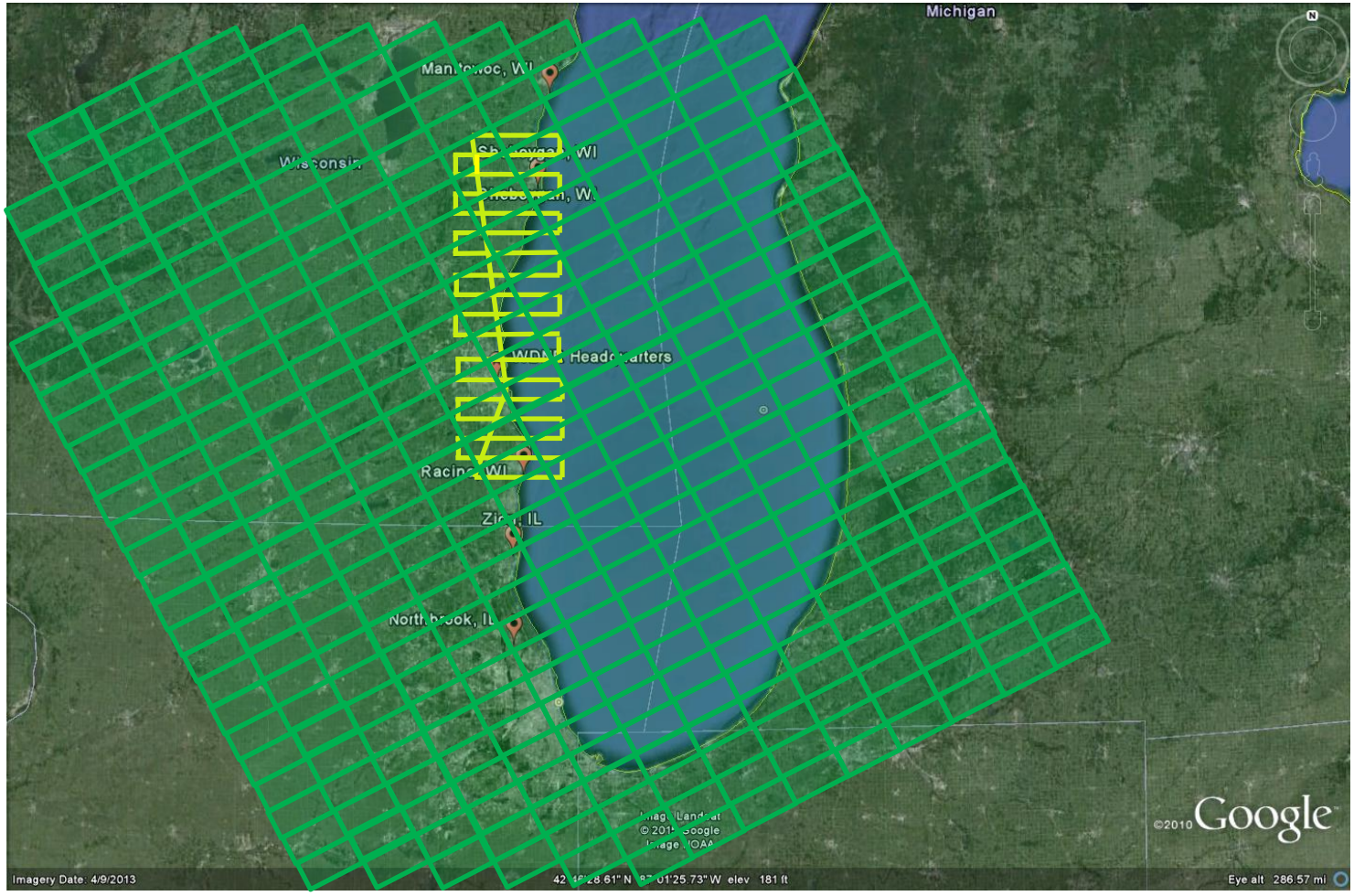

Questions?

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