LADCO and Air Quality Planning in the Great Lakes Region

Zac Adelman

LADCO Executive Director

Environmental Law & Policy Center Brown Bag
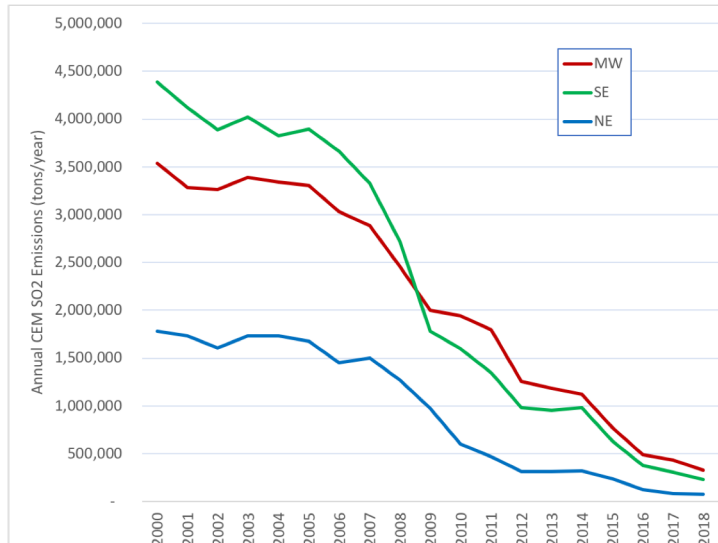April 15, 2019

LADCO | LAKE MICHIGAN
AIR DIRECTORS CONSORTIUM

Isle Royale NP, MI
Credit: Ray Dumas

Boundary Waters Wilderness, MN
Credit: Mike Sweet

Regional Changes in CEM* Emissions: 2000-2018

SO₂ Emissions

NOₓ Emissions
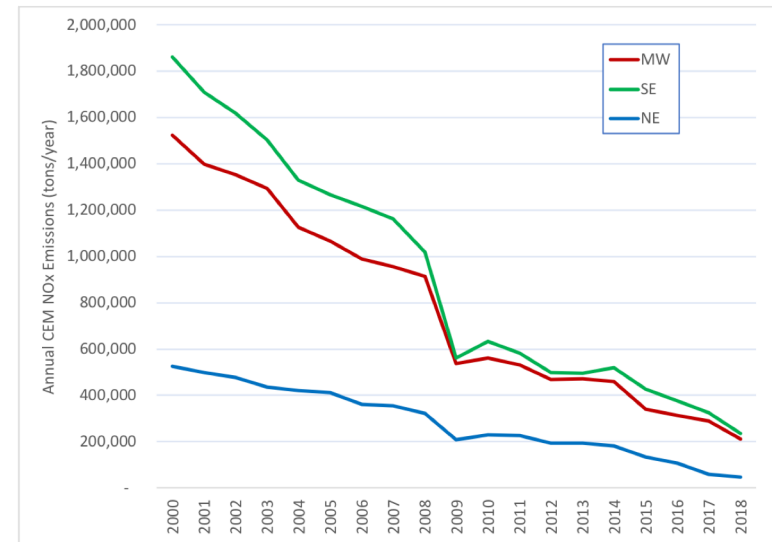
Annual Total

dE/dT (2018-2000)
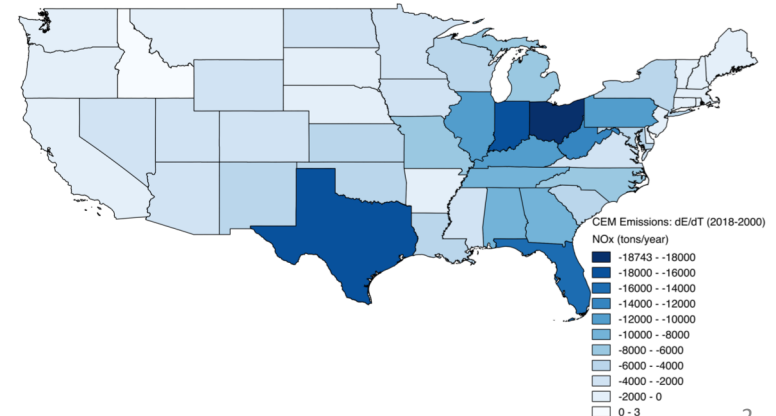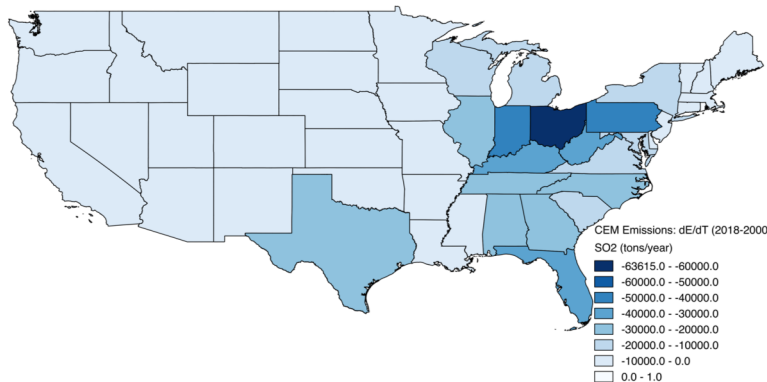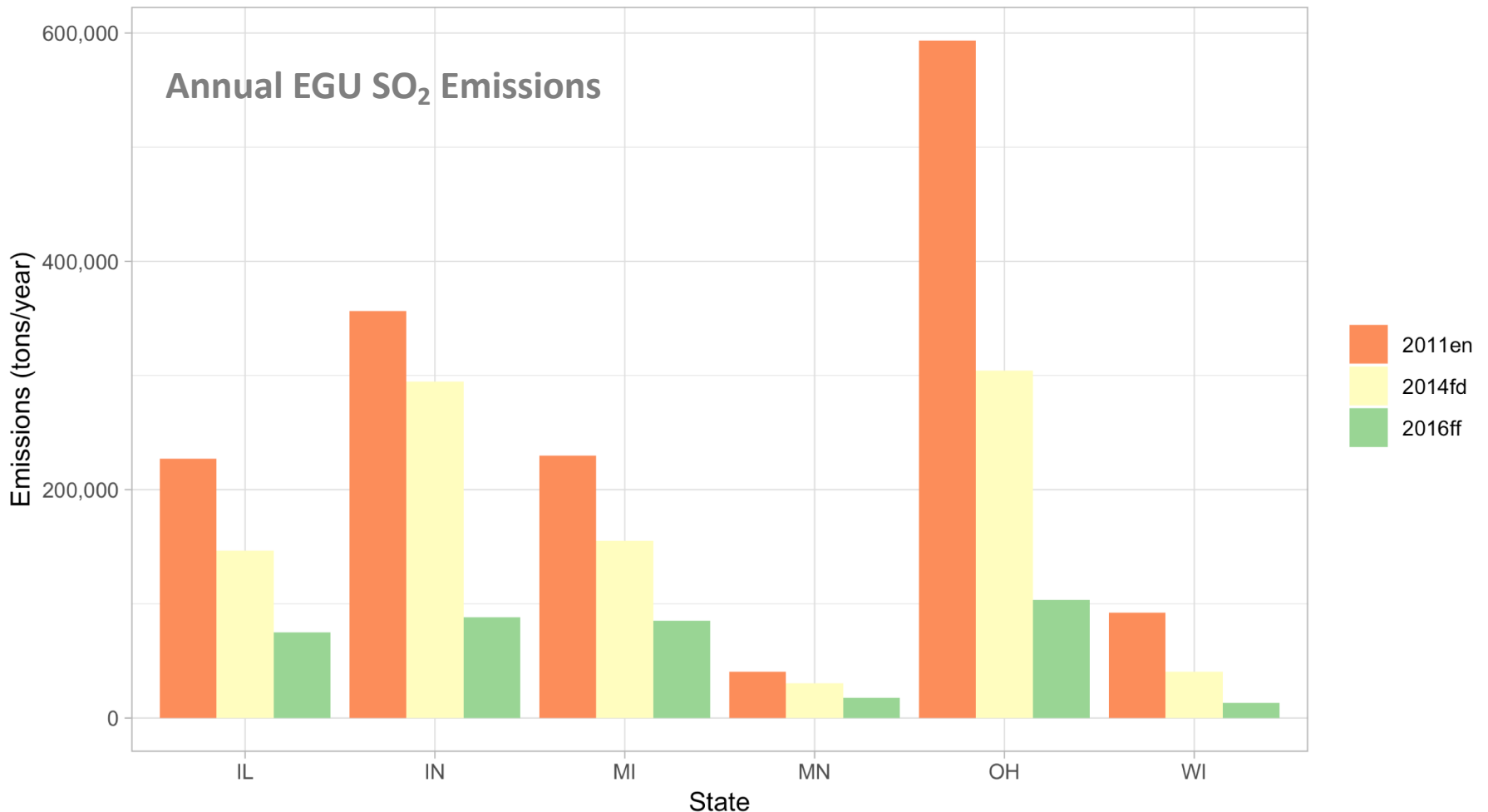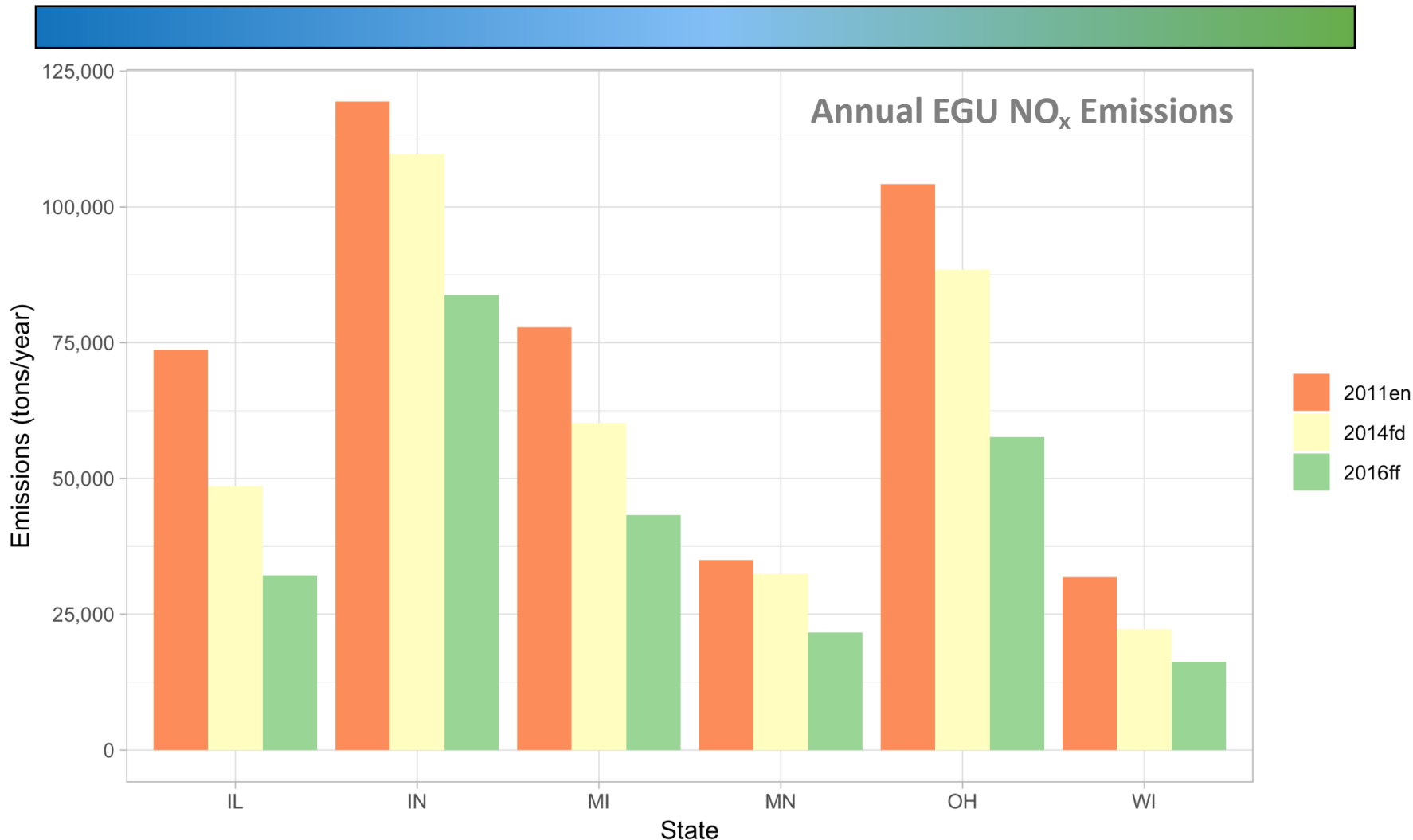
* CEM = Continuous Emissions Monitor = large industrial stationary sources

2

Energy Sector Changes Impact on Midwest Air Quality

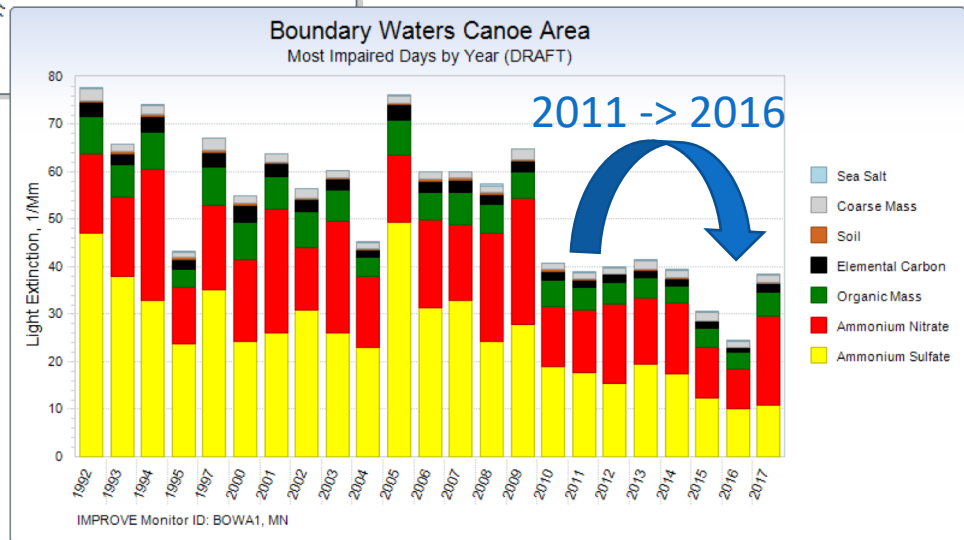Annual EGU SO$_2$ Emissions

Energy Sector Changes Impact on Midwest Air Quality

Annual EGU NO$_x$ Emissions

Energy Sector Changes Impact on Midwest Haze

Boundary Waters Canoe Area
Visibility on Haziest and Clearest Days

- Haziest Days
- Clearest Days
- Natural Condition: Haziest Days
- Natural Condition: Clearest Days

IMPROVE Monitor ID: BOWA1, MN
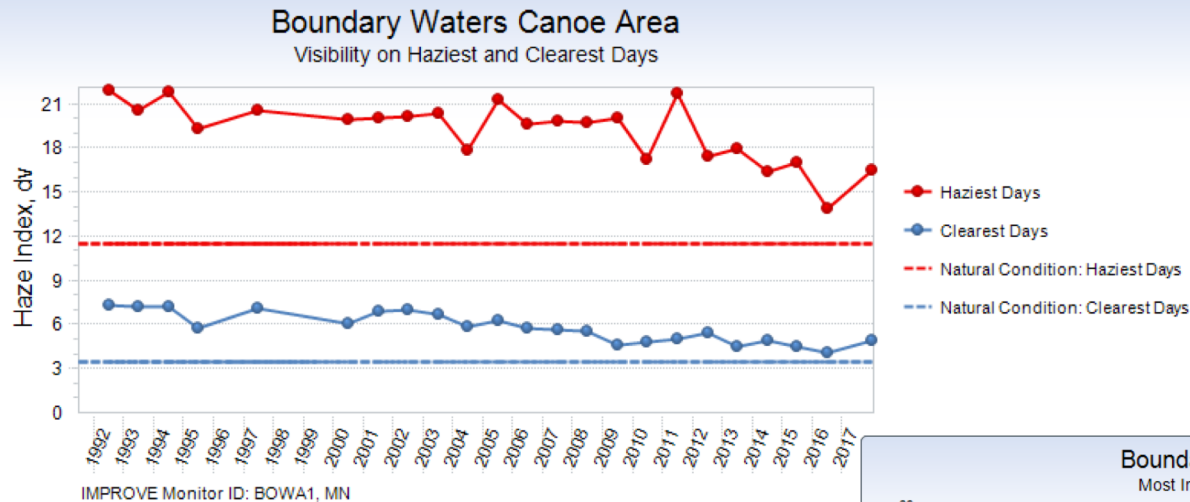

- Boundary Waters (MN) shows improvement in Most Impaired Days metric, starting around 2010
- 2011 to 2017 trend follows EGU SO_2 emissions
- Driven by NO_3 and SO_4


Boundary Waters Canoe Area
Most Impaired Days by Year (DRAFT)

2011 -> 2016

- Sea Salt
- Coarse Mass
- Soil
- Elemental Carbon
- Organic Mass
- Ammonium Nitrate
- Ammonium Sulfate

IMPROVE Monitor ID: BOWA1, MN

Energy Sector Changes Impact on Northeast Haze

Brigantine NWR
Visibility on Haziest and Clearest Days

- Haziest Days
- Clearest Days
- Natural Condition: Haziest Days
- Natural Condition: Clearest Days

IMPROVE Monitor ID: BRIG1, NJ

Brigantine NWR
Most Impaired Days by Year (DRAFT)

2011 -> 2016

- Sea Salt
- Coarse Mass
- Soil
- Elemental Carbon
- Organic Mass
- Ammonium Nitrate
- Ammonium Sulfate

IMPROVE Monitor ID: BRIG1, NJ
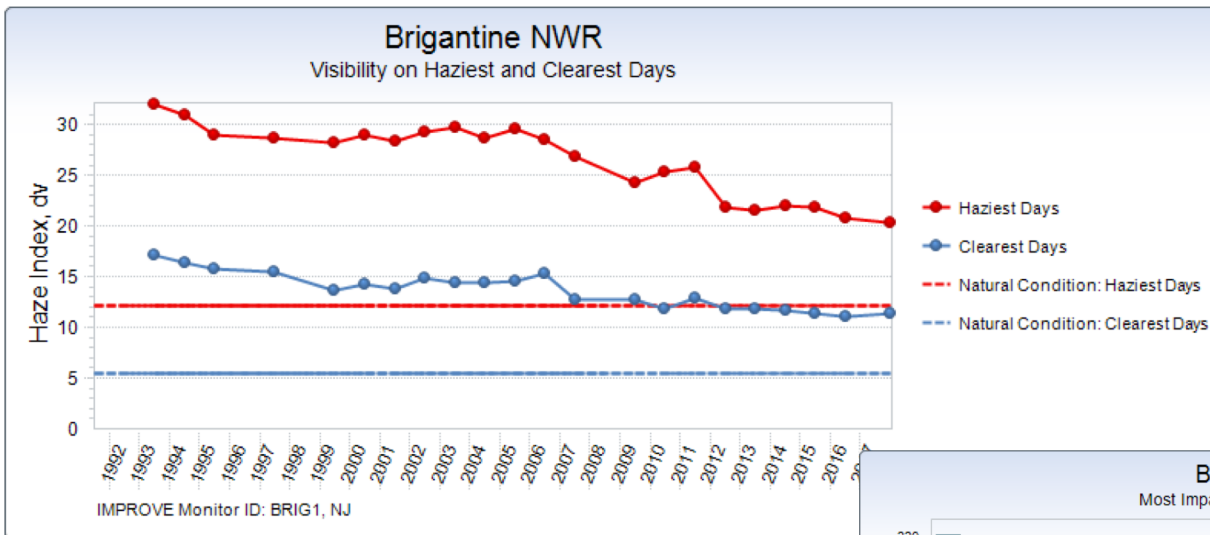
- Brigantine (NJ) 2017 measurements follow the continued improvements in haze since mid-2000's
- Driven by NO_3 and SO_4
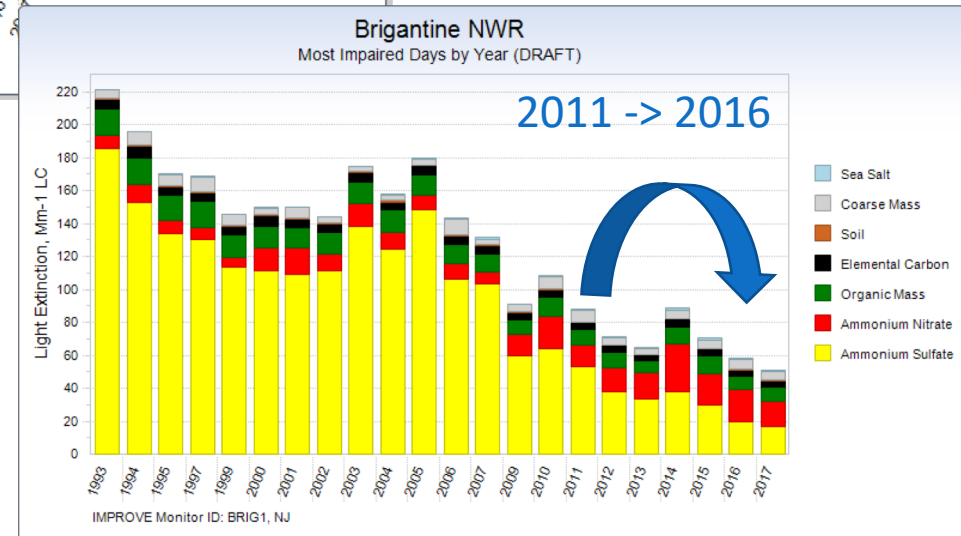
U.S. Total Anthropogenic Emissions Trends: NEI Annual SO$_2$
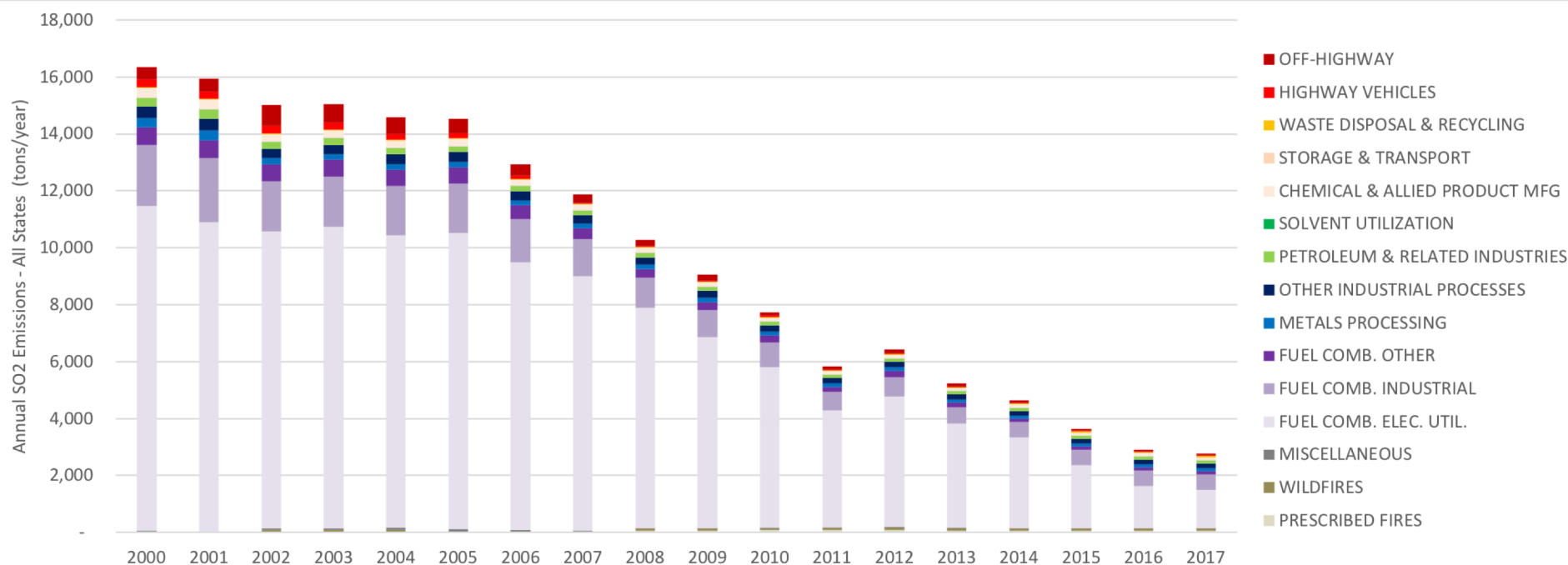
Annual Emissions Totals for the Lower 48 States: 2000-2017
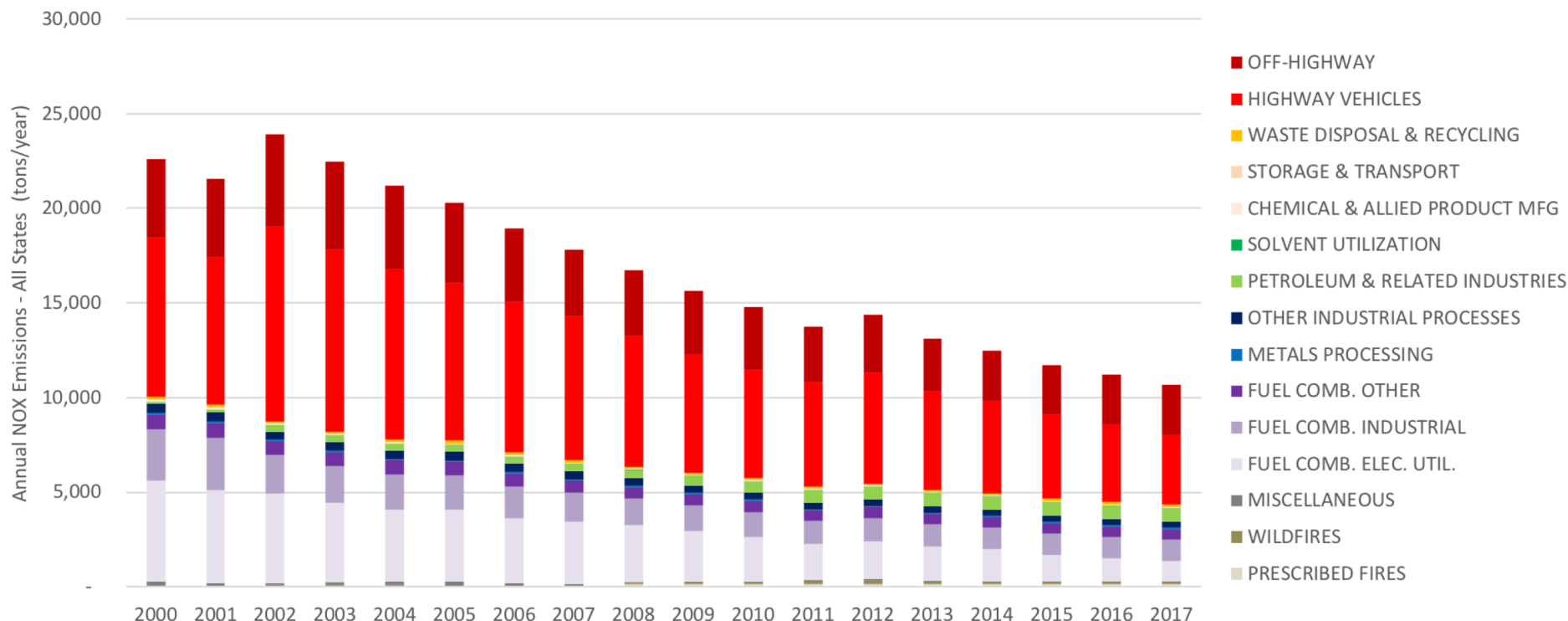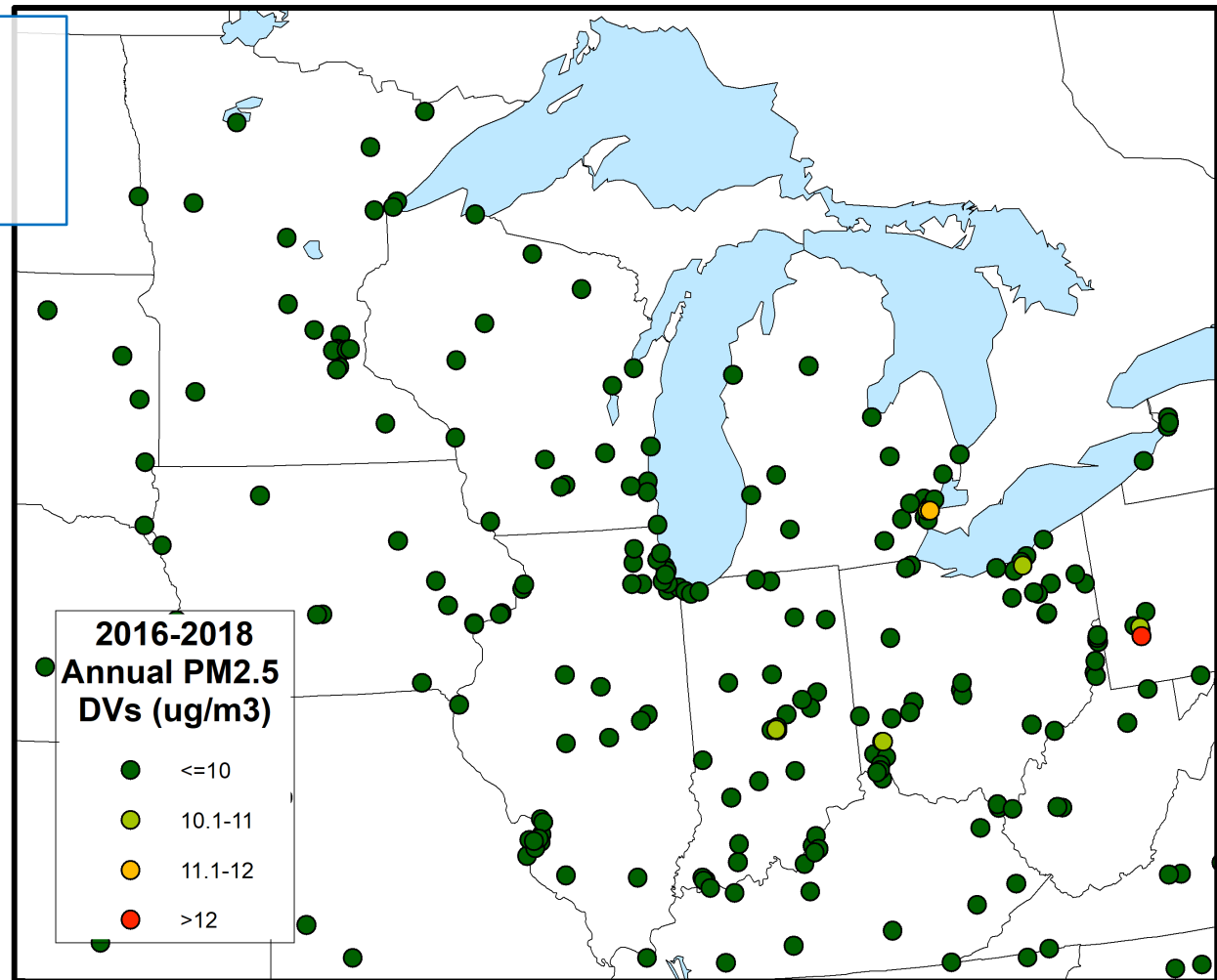US EPA Air Pollution Emissions Trends

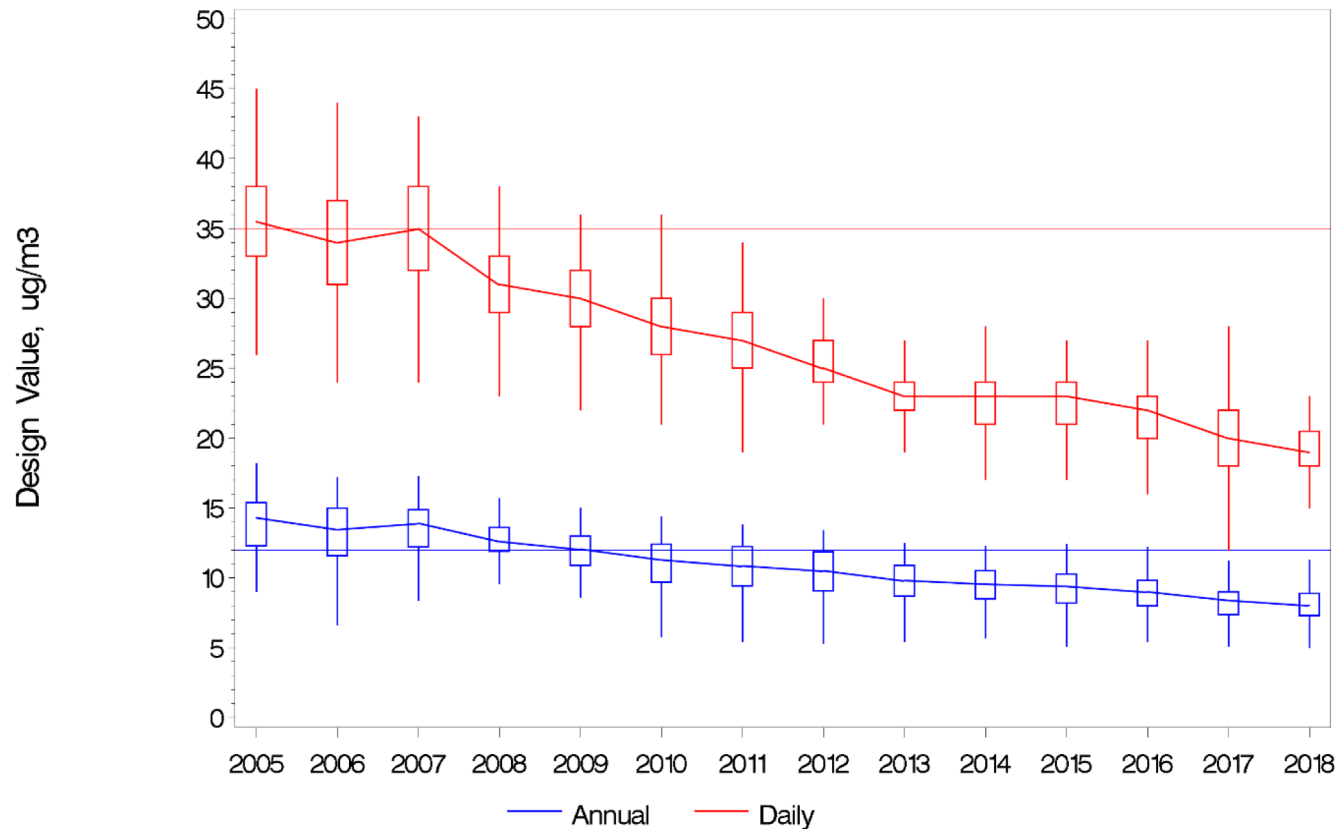# U.S. Total Anthropogenic Emissions Trends: NEI Annual NOx

Annual Emissions Totals for the Lower 48 States: 2000-2017
US EPA Air Pollution Emissions Trends

Recent PM$_{2.5}$ Design Values

Annual PM$_{2.5}$ DV
3 year average of
annual mean PM$_{2.5}$

2016-2018
Annual PM2.5
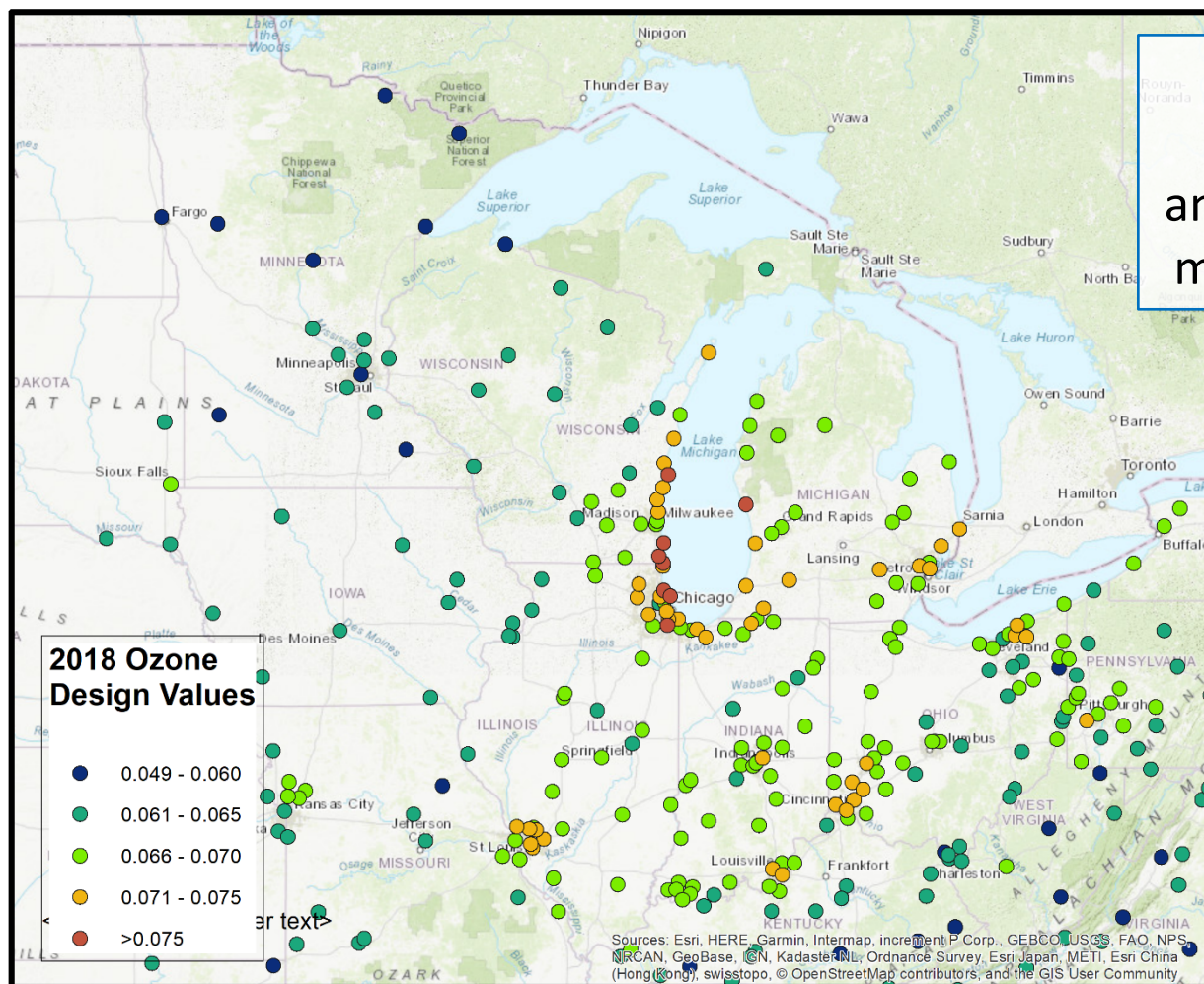DVs (ug/m3)

- <=10
- 10.1-11
- 11.1-12
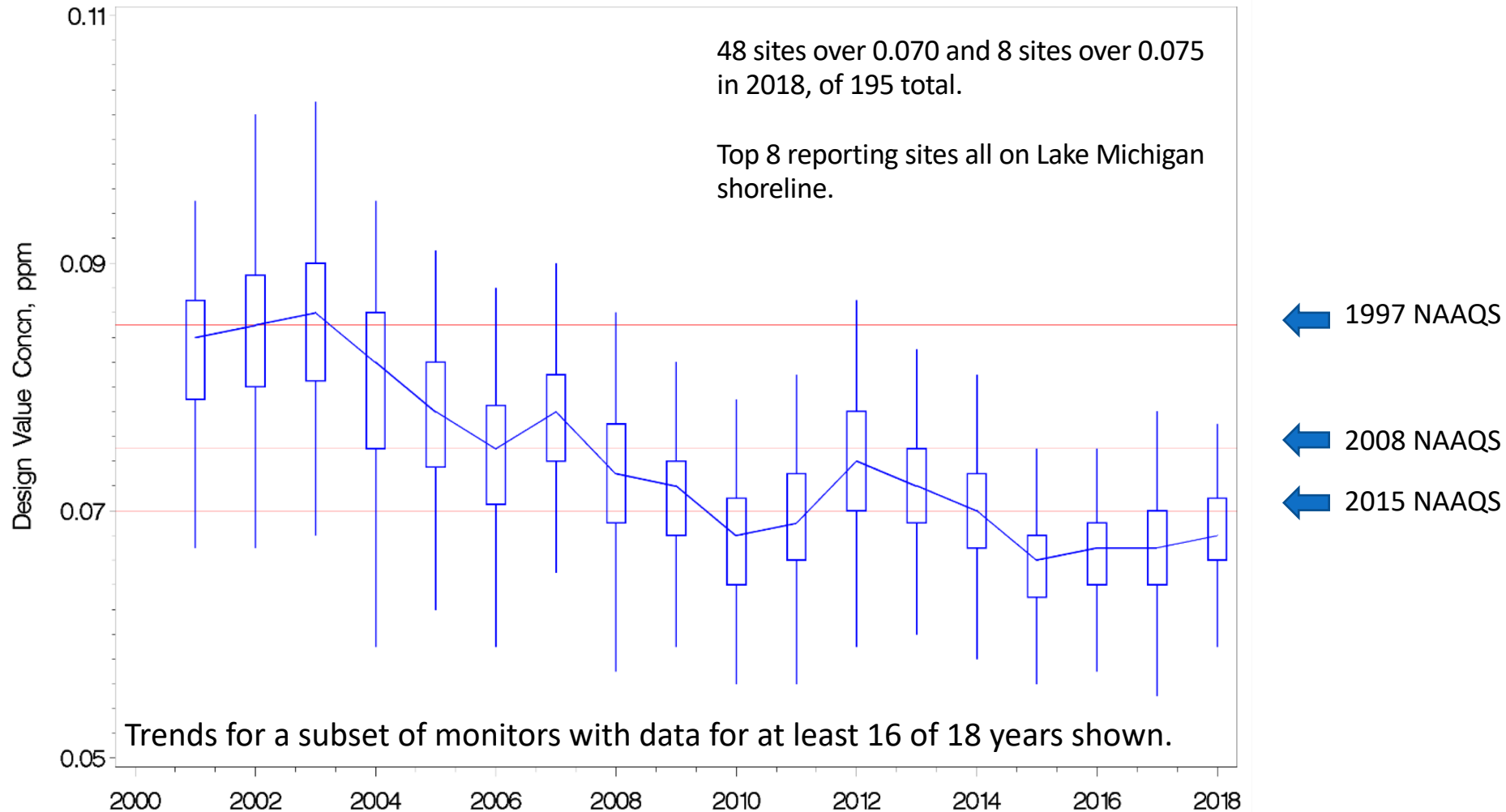- >12

PM$_{2.5}$: Region-wide DV Trends

Only monitors with 11 or more years of complete data, not including IL
Design value plotted by end year of 3-year period.

Ozone: 2018 Design Values

Ozone DV
3 year average of annual 4th highest, daily max 8-hour average O$_3$

2018 Ozone Design Values

- ● 0.049 - 0.060
- ● 0.061 - 0.065
- ● 0.066 - 0.070
- ● 0.071 - 0.075
- ● >0.075

Ozone: Region-wide Design Value Trends

48 sites over 0.070 and 8 sites over 0.075 in 2018, of 195 total.

Top 8 reporting sites all on Lake Michigan shoreline.

← 1997 NAAQS

← 2008 NAAQS

← 2015 NAAQS

Trends for a subset of monitors with data for at least 16 of 18 years shown.

Multi-Jurisdictional Organizations
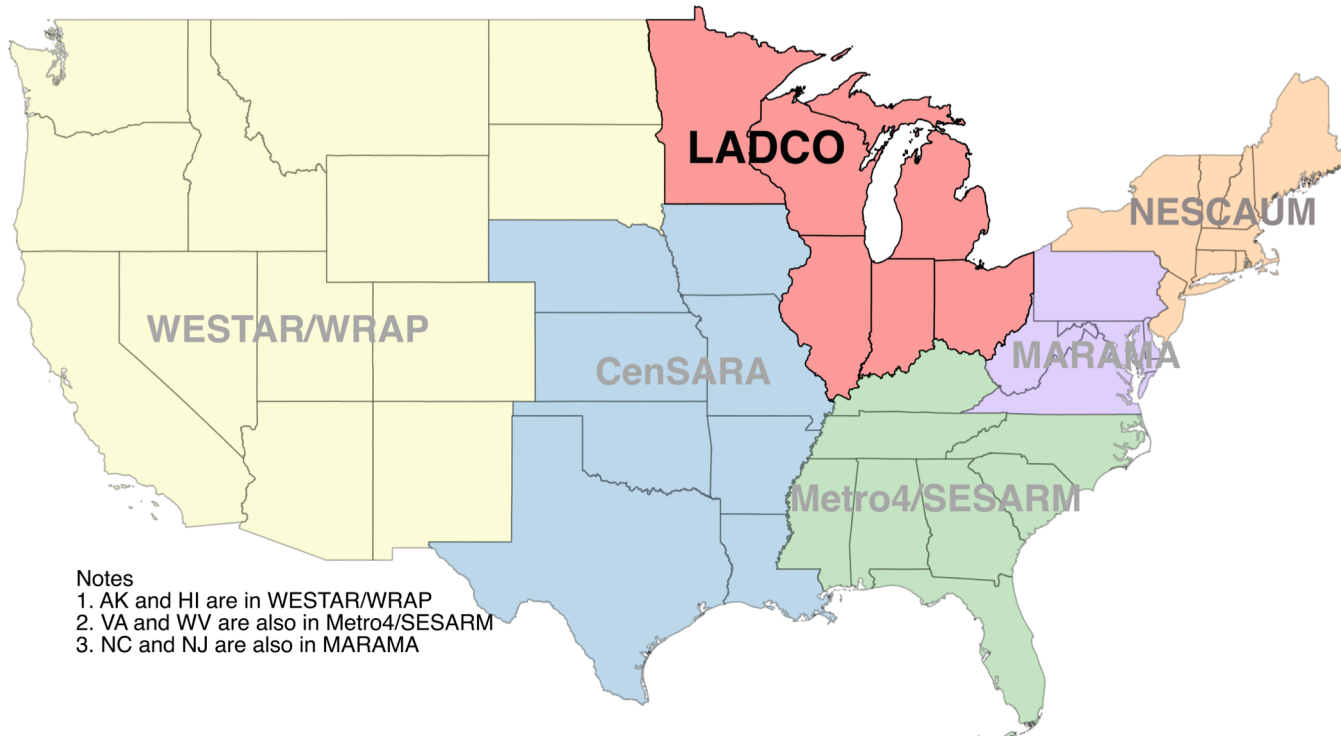
Notes
1. AK and HI are in WESTAR/WRAP
2. VA and WV are also in Metro4/SESARM
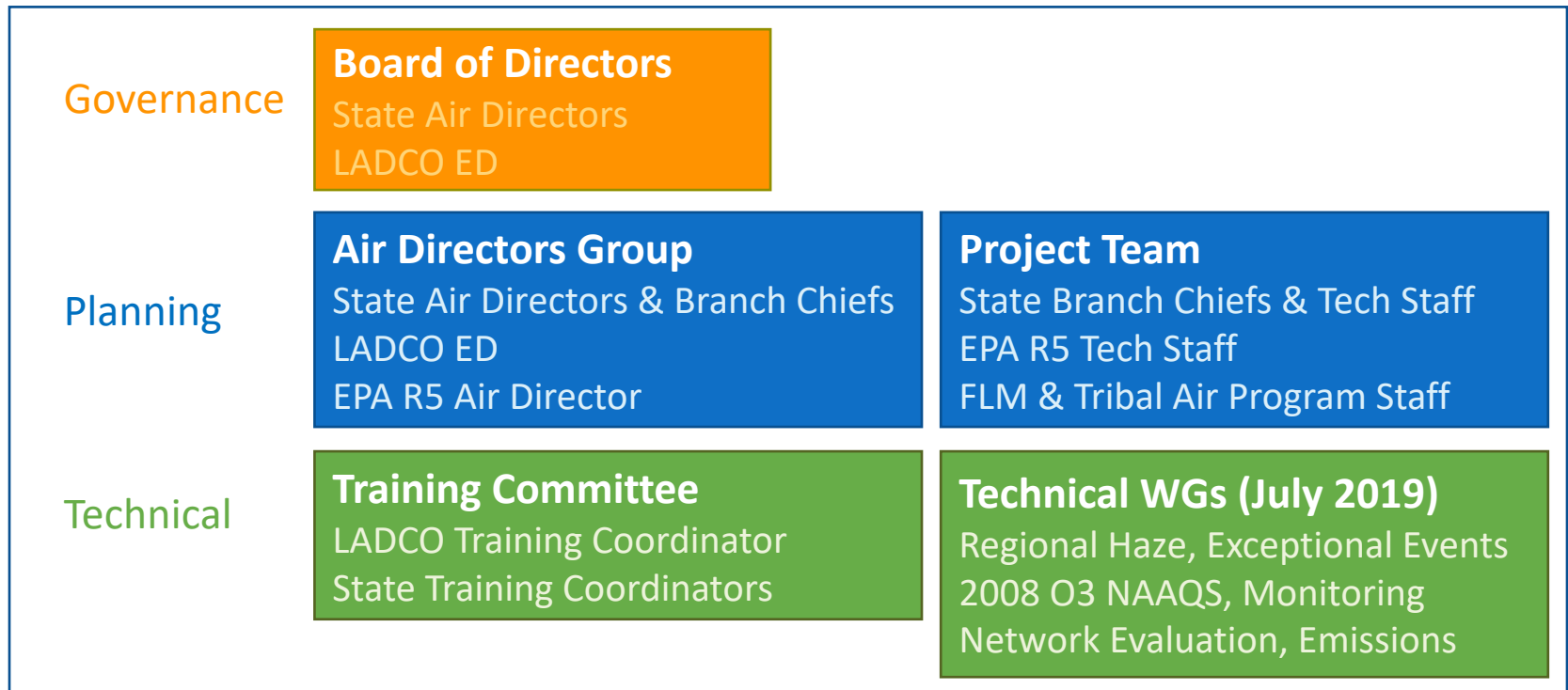3. NC and NJ are also in MARAMA

LADCO and the MJOs are funded primarily by U.S. EPA grants to the states under Section 105 of the Clean Air Act.

LADCO Background and Scope

- Formed in 1989 to bring Michigan, Indiana, Illinois, and Wisconsin together to address ozone pollution
  - Ohio joined in 2004; Minnesota joined in 2012
- Technical lead in the region for continental to urban-scale atmospheric modeling: meteorology, emissions, and chemistry-transport
  - LADCO produces decision support information via modeling and monitoring data analyses that our states use for air quality manag
  - ement plans (SIPs)
- LADCO does not provide policy guidance to our membership, only technical guidance and support

LADCO Organization

Governance	**Board of Directors** State Air Directors LADCO ED	
Planning	**Air Directors Group** State Air Directors & Branch Chiefs LADCO ED EPA R5 Air Director	**Project Team** State Branch Chiefs & Tech Staff EPA R5 Tech Staff FLM & Tribal Air Program Staff
Technical	**Training Committee** LADCO Training Coordinator State Training Coordinators	**Technical WGs (July 2019)** Regional Haze, Exceptional Events 2008 O3 NAAQS, Monitoring Network Evaluation, Emissions

What Does LADCO Actually Do?

- Air Quality Modeling
- Air Monitoring
- Data Science
- Air Quality Research
- Training Coordination
- Intra-region Communication Platform
- Contract Management
- Outreach and Advocacy

LADCO Executive Office Staff

Zac Adelman Executive Director

Donna Kenski, PhD Data Scientist

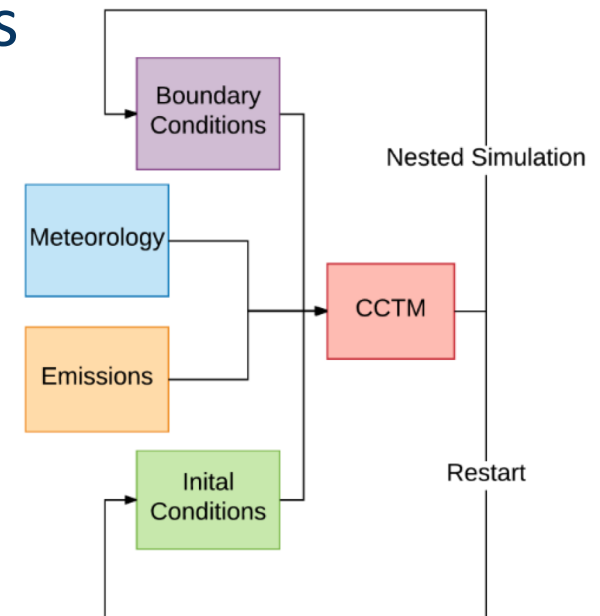**Mark Janssen** Emissions Director

Tsengel Nergui, PhD Modeler

Catherine Heath Office Manager

What Does LADCO Produce?

- Decision Support Systems and Data
- Modeling Protocols
- Technical Support Documents (TSDs)
- Knowledge in our Member States

Modeling Platform
Software and data package of all elements that went into a modeling project

# Purpose of Regional Air Quality Modeling

- Air quality models integrate our understanding of individual processes into a coherent system
- Air pollution systems are non-linear
  - Need to establish links between emissions sources and ambient concentrations
- Measurements are sparse
  - Models provide a continuous spatial and temporal view of air quality
- Decision support
  - Platforms for testing the effectiveness and impacts of pollution mitigation policies
- Experimental
  - Identify knowledge gaps, quantify drivers, source-receptor relationships
- Deterministic
  - Randomness/noise is not considered in the solution: consistently reproducible
  - Bottom Up: Link processes together to a solution

Air Monitoring & Data Science

- LADCO staff are experts with ambient monitoring data, and air quality modeling data

- LADCO supports our states through transferring data, analysis products, and modeling capabilities

GIS & Mapping
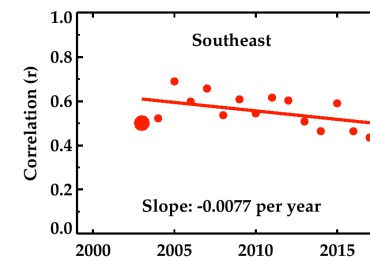
Data Visualization
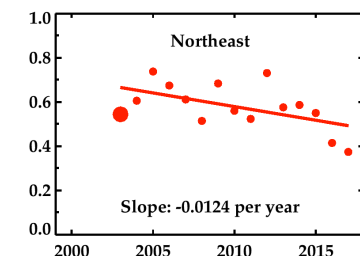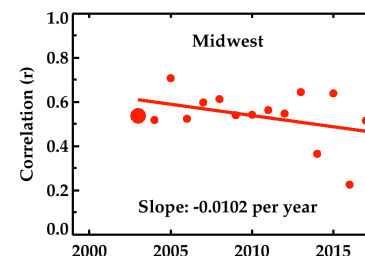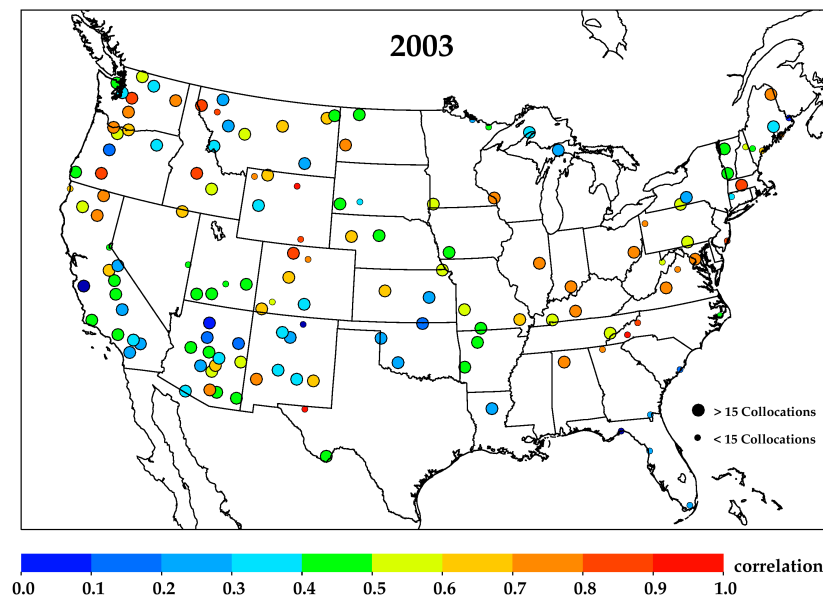
Model Evaluation
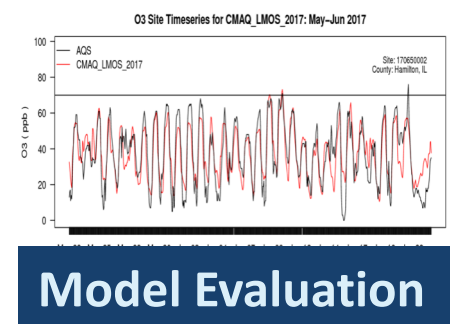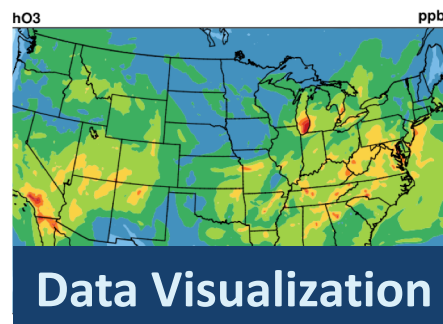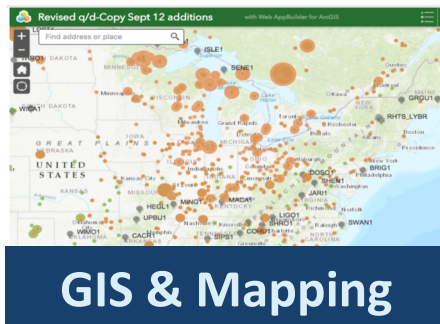
Statistical Analyses

Cloud Computing

Big Data

Air Quality Research

LADCO technical staff serve as collaborators, technical advisors, and air planning agency stakeholders

**Remote Sensing Aerosol Optical Depth vs. Surface Visibility Correlation Warm Season (Apr – Sept) Trends**

Current Technical Analyses

- Observational Trends
  - Surface network review and enhancement
  - Updating regional & urban O_3 conceptual models

- Regional Photochemical Modeling
  - 2016 met and chemistry modeling for O_3 and Regional Haze

- Emissions Modeling
  - Inventory Collaborative
  - Analysis/improvement of mobile sources: onroad, offroad, rail, marine

- Meteorology Modeling
  - WRF optimization for high ozone conditions

- Exceptional Events
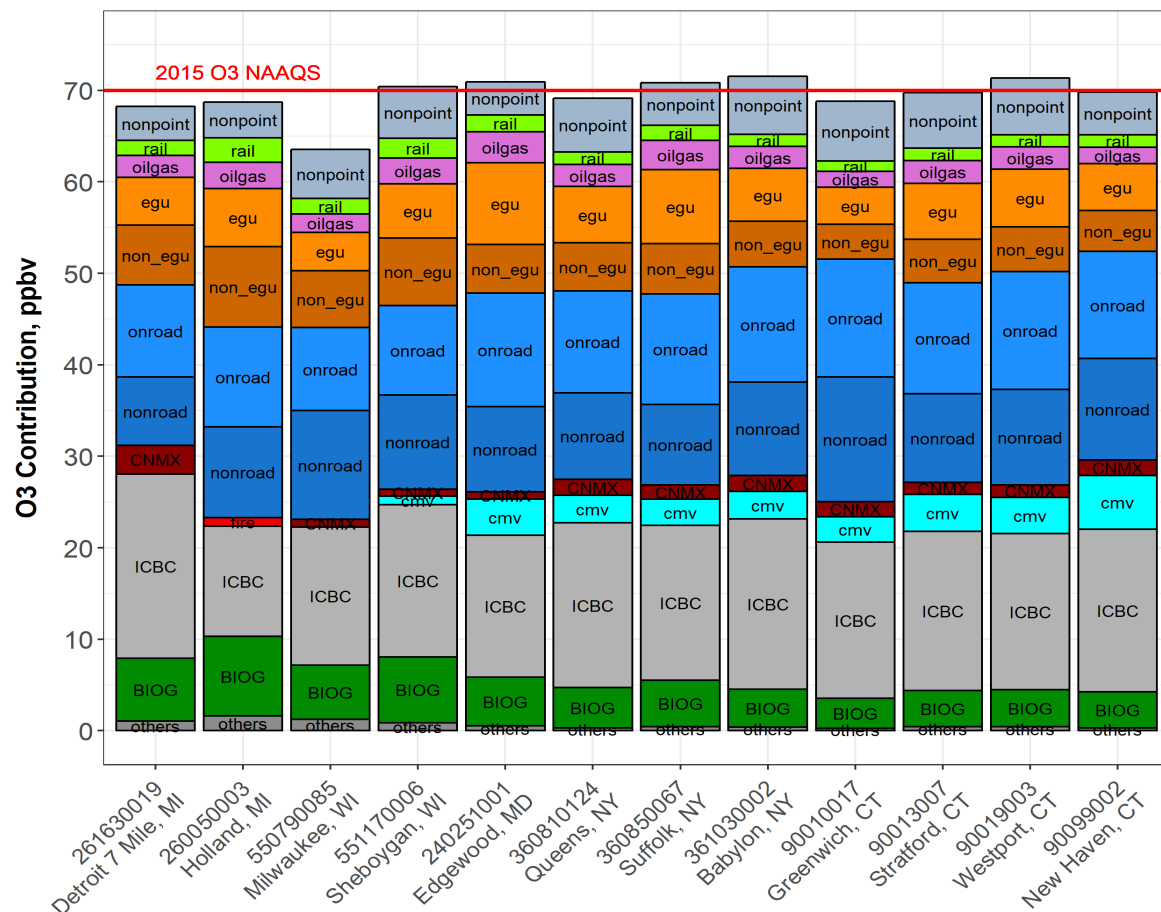 - Studying smoke impacts on air quality in the region

LADCO 12/4/1.33 km WRF Domains
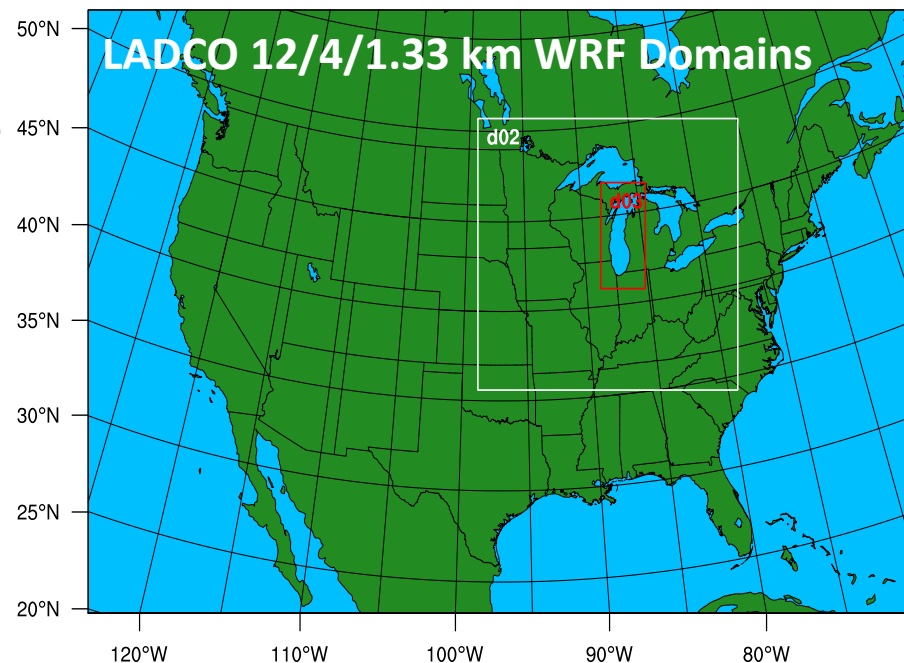
Current Regulatory Focus

- 2015 O_3 NAAQS
  - EPA designations finalized in August 2018
  - Marginal status for all violating LADCO monitors
  - iSIPs (including "Good Neighbor" SIPs) due October 2018
  - Attainment demonstration (NAA SIP) not required for marginal
  - Marginal attainment date August 3, 2021 $\leftarrow$ 2020 O_3 Season

- 2008 O_3 NAAQS
  - Chicago and Sheboygan reclassification from moderate to serious status due to be finalized summer 2019
  - NAA SIPs due from IL, IN, WI in Spring 2020
  - Serious attainment date July 21, 2021 $\leftarrow$ 2020 O_3 Season

- Regional Haze
  - Round 2 SIPs due July 2021

Source Apportionment

- Tag emissions sources (by sector and/or source region)

- Follow the tracers through the model to quantify source-receptor relationships

- Chart shows the inventory sectors contributing to ozone at particular surface monitors

MDA8 O_3 (ppbV) (with WATER) inventory sector contributions to DVs$_{2023}$ at key monitors in the LADCO 2023 simulation

2008 O$_3$ NAAQS Attainment Modeling

- Chicago and Sheboygan O$_3$ NAAs reclassified to serious

- Attainment modeling will be done by LADCO to demonstrate how to reach attainment by July 21, 2021 (actually by the 2020 O$_3$ season)

- Modeling approach
  - WRF 2016 simulation, configuration based on LMOS and NASA research projects
  - 2016 emissions projected to 2020 using EPA MOVES (mobile) and ERTAC EGU (power sector) emissions
  - On-the-books emissions controls and source apportionment modeling to identify inventory sector/source regions that contribute to regional ozone

- LADCO technical support products (modeling results) to states by Fall 2019

Regional Haze: Visibility Differences

Voyageurs National Park

Source: http://vista.cira.colostate.edu/Datawarehouse/IMPROVE/Data/Photos/VOYA/html/IMG0015.htm
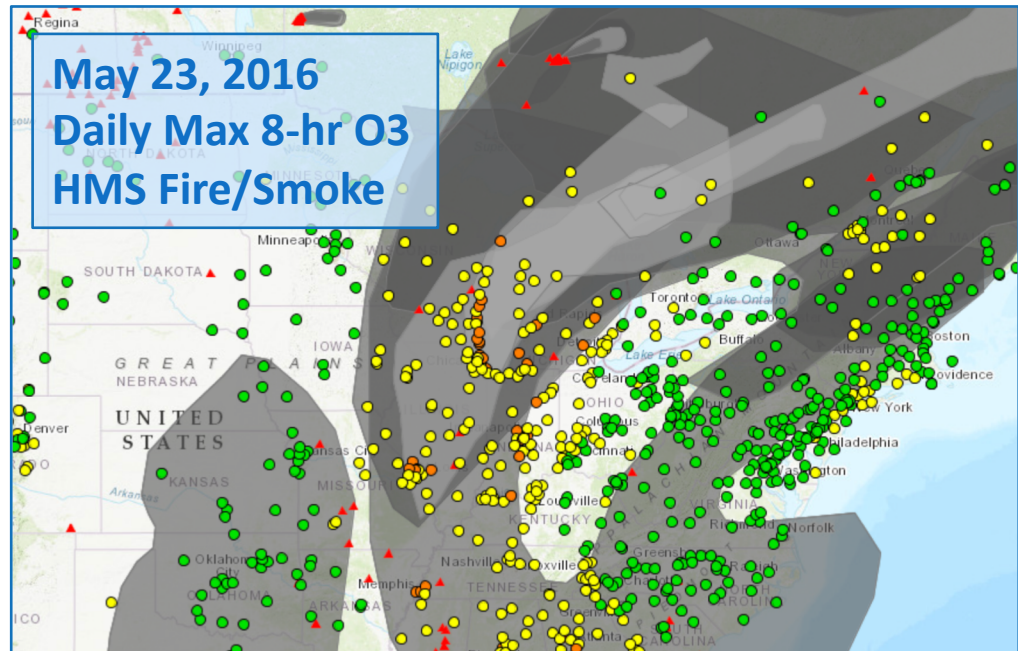
What causes haze?

- Particles in the atmosphere scatter light.

- Natural and anthropogenic sources: wildfires, agriculture, coal combustion contribute to light extinction and visibility impairment.

- Like ozone and $PM_{2.5}$, meteorology plays a role.

Round II Regional Haze Planning

- Regional Haze committee was reconvened in January 2018

- Members from LADCO states, FLMs, R5, EPA-HQ, tribes

- **Goal:** develop documentation, analyses, modeling, and inventories to assist states in meeting the July 2021 RH SIP submittal target

Exceptional Events

- States can get regulatory relief from air pollution caused by unusual or naturally occurring air pollution events

- LADCO works with our states to survey ozone season observations for possible exceptional events (EE)

May 23, 2016
Daily Max 8-hr O3
HMS Fire/Smoke

Credit: Airow Tech

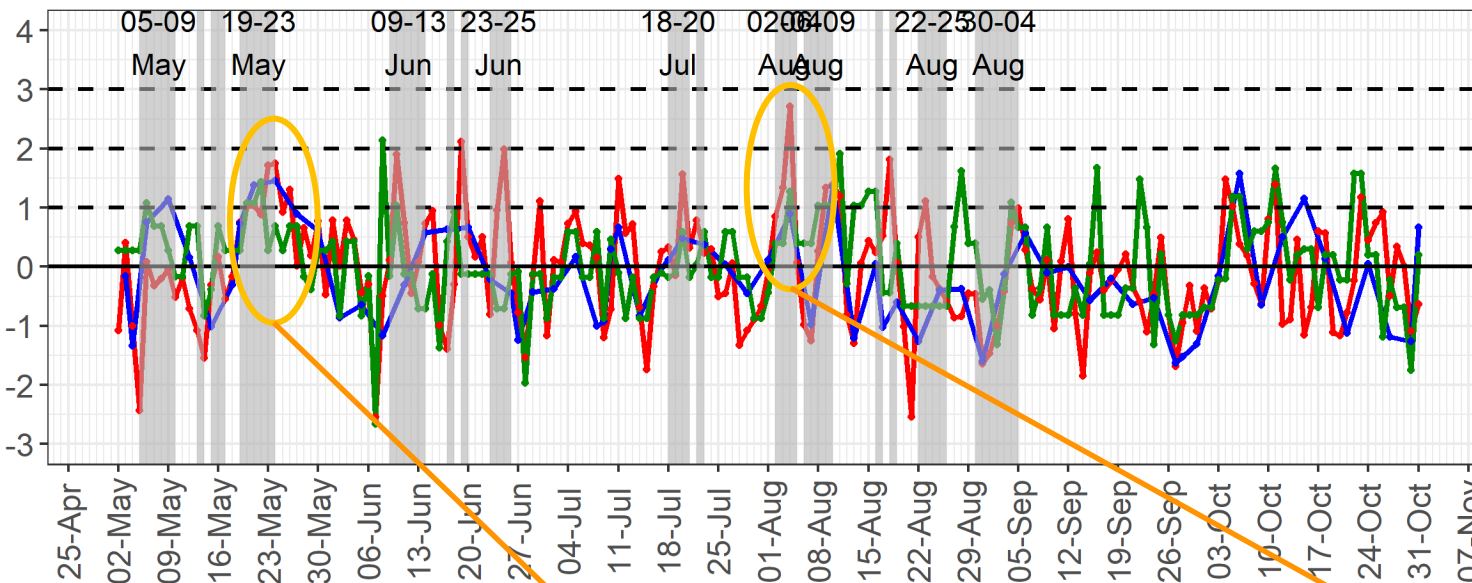- LADCO EE Workgroup: monthly triage analysis reviews daily surface observations and smoke columns from previous month

Sheboygan, WI NAA 2016 EE Screening

NAA: Wisconsin Shoreline, WI; FIPS in c(55089, 55117, 55071, 55079, 55027)
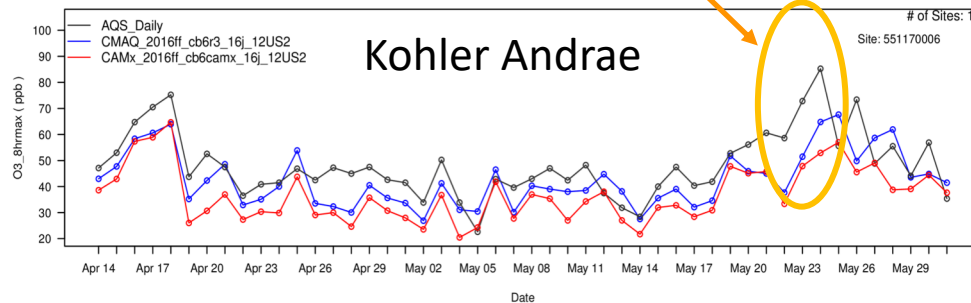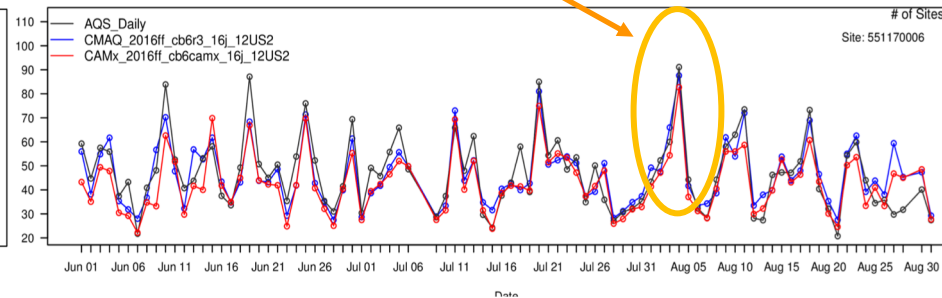
Ft. McMurray Fire (~May 20-24)
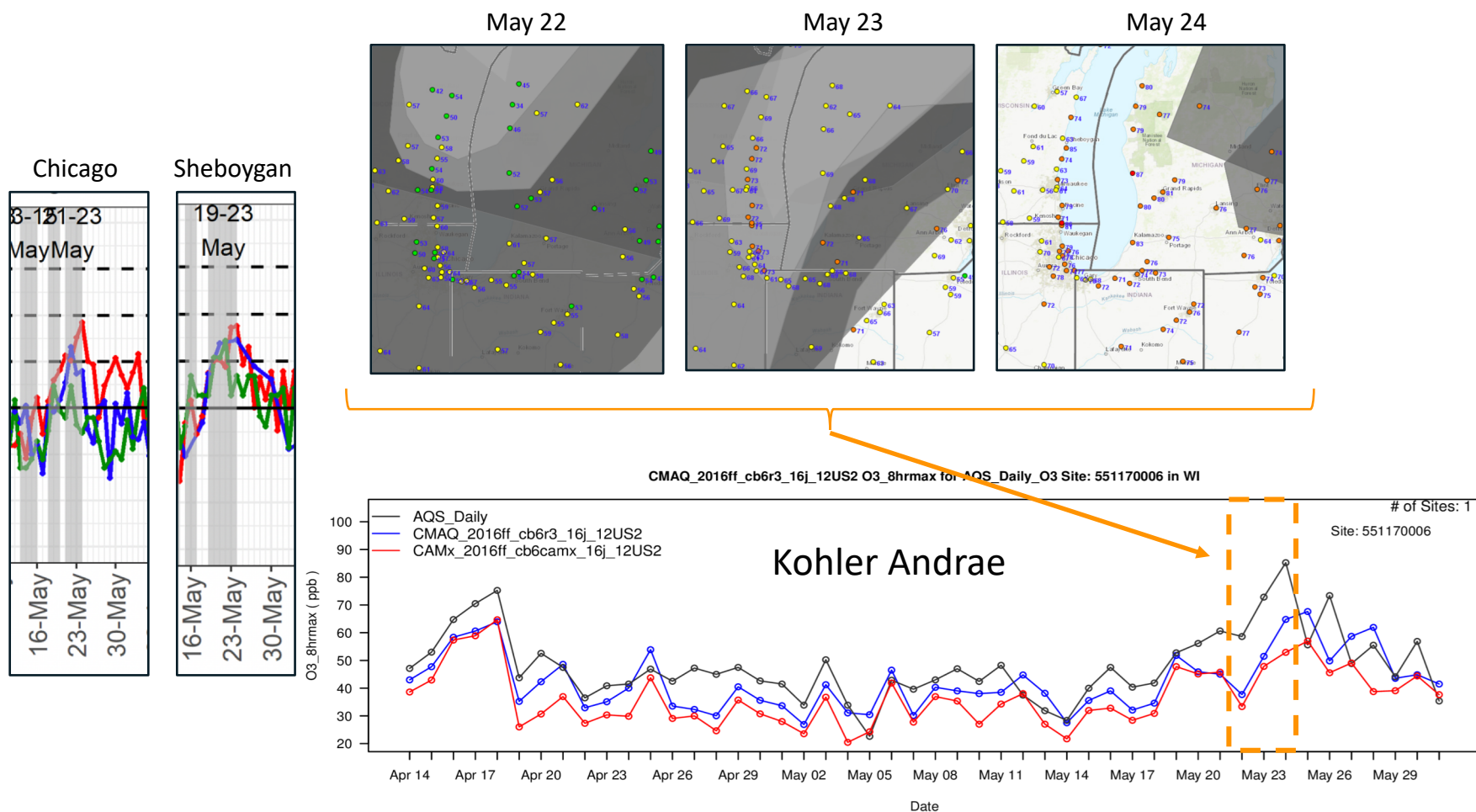
Ft. McMurray Fire

May 23, 2016 @ 2:30 am Central

Aerosols near the surface
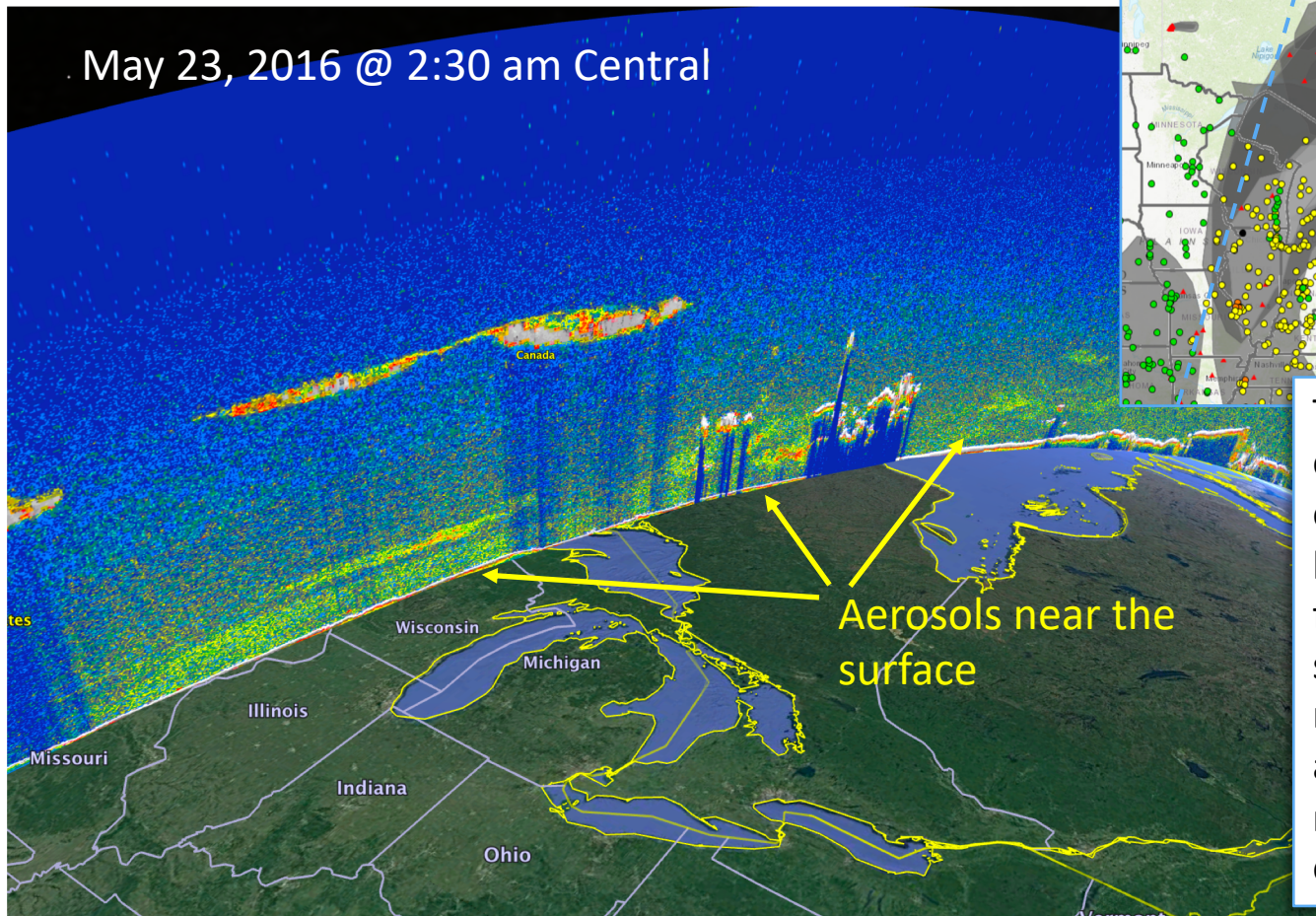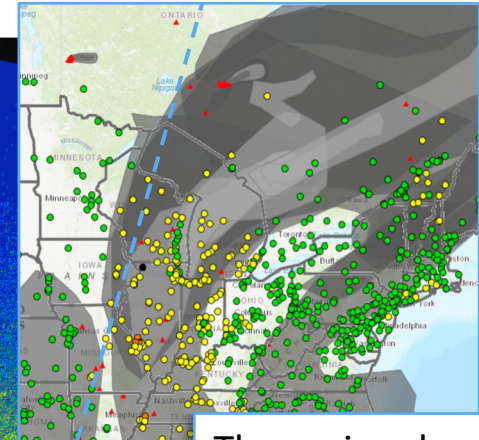
The regional ozone episode enhanced/created by the Ft. McMurray fire smoke isn't simulated by the regional models, and will likely not respond to modeled emissions changes

LADCO's 1-2 Year Plan

- Continue to service our member state air quality planning needs
  - Build collaborations around the region to enhance our capabilities and services

- Modernize our decision support and data systems
  - Cloud-based computing
  - Interactive web-based analysis resources @ www.ladco.org
  - Driving applied research with remote sensing data and cutting-edge modeling technologies

- Enhance the National Air Pollution Training Program

- Continued advocacy for LADCO region on national initiatives

Questions and Contact

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www.ladco.org

Sleeping Bear Dunes, MI
Credit: NPS

Garden of the Gods, IL
Credit: Daniel Schwen