Updates on Regional Air Quality Issues in the Great Lakes Region

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Presented at the FET Environment 2018 Conference
Pewaukee, WI

October 24, 2018

LADCO | LAKE MICHIGAN AIR DIRECTORS CONSORTIUM

Isle Royale NP, MI

Boundary Waters Wilderness, MN

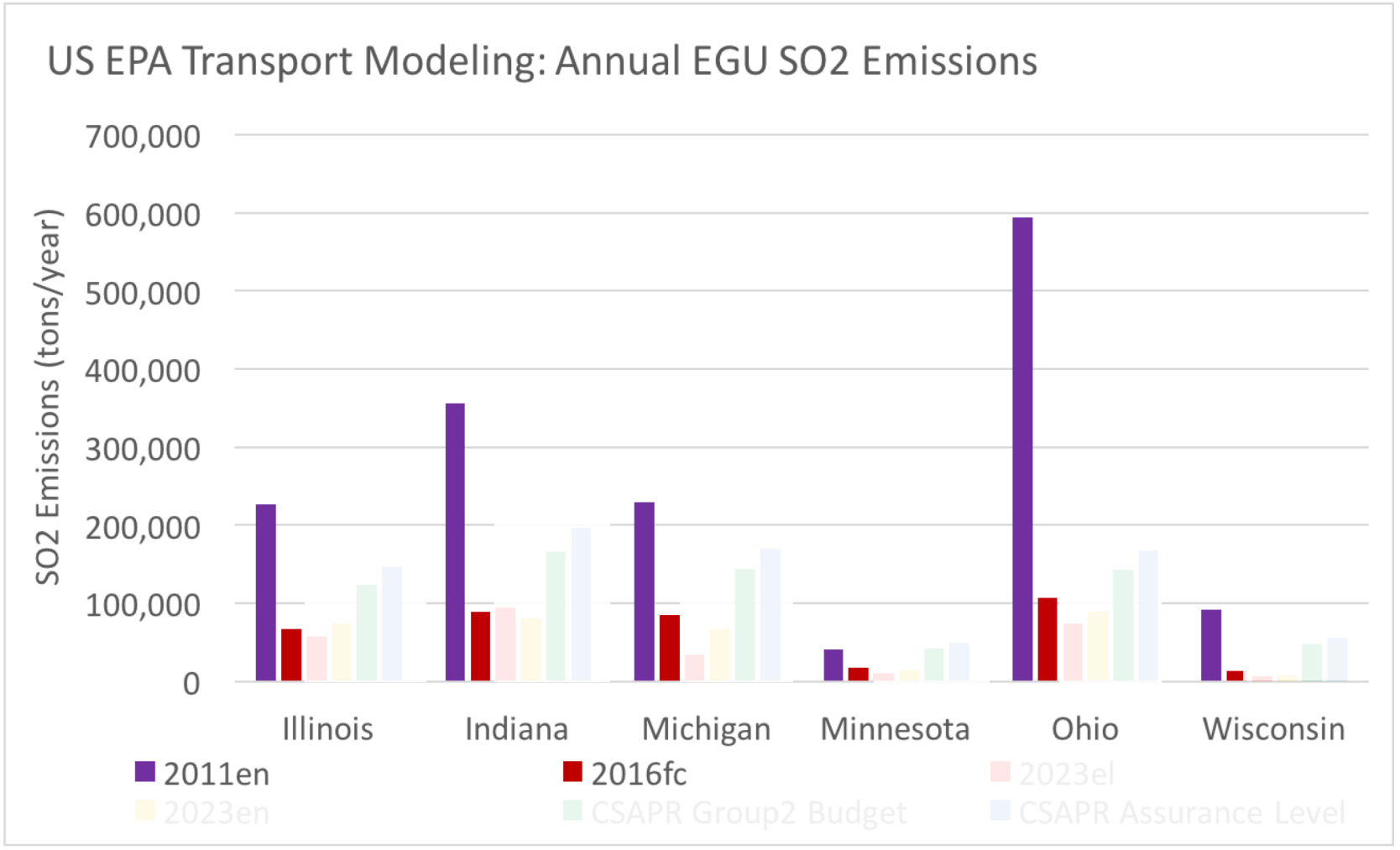
LADCO Background

- Formed in 1989 to bring Michigan, Indiana, Illinois, and Wisconsin together to address high ground level ozone in the region
  - Ohio joined in 2004; Minnesota joined in 2012
- Air pollution science, training, and planning support for the state (and tribal & local) air management agencies in the region
- Provides a forum to discuss regional air pollution issues
- Technical lead in the region for continental to urban-scale atmospheric modeling: meteorology, emissions, and chemistry-transport
- Current Events
  - New leadership as of September 2017
  - New modeling and business staff as of January 2018

Today's Talk

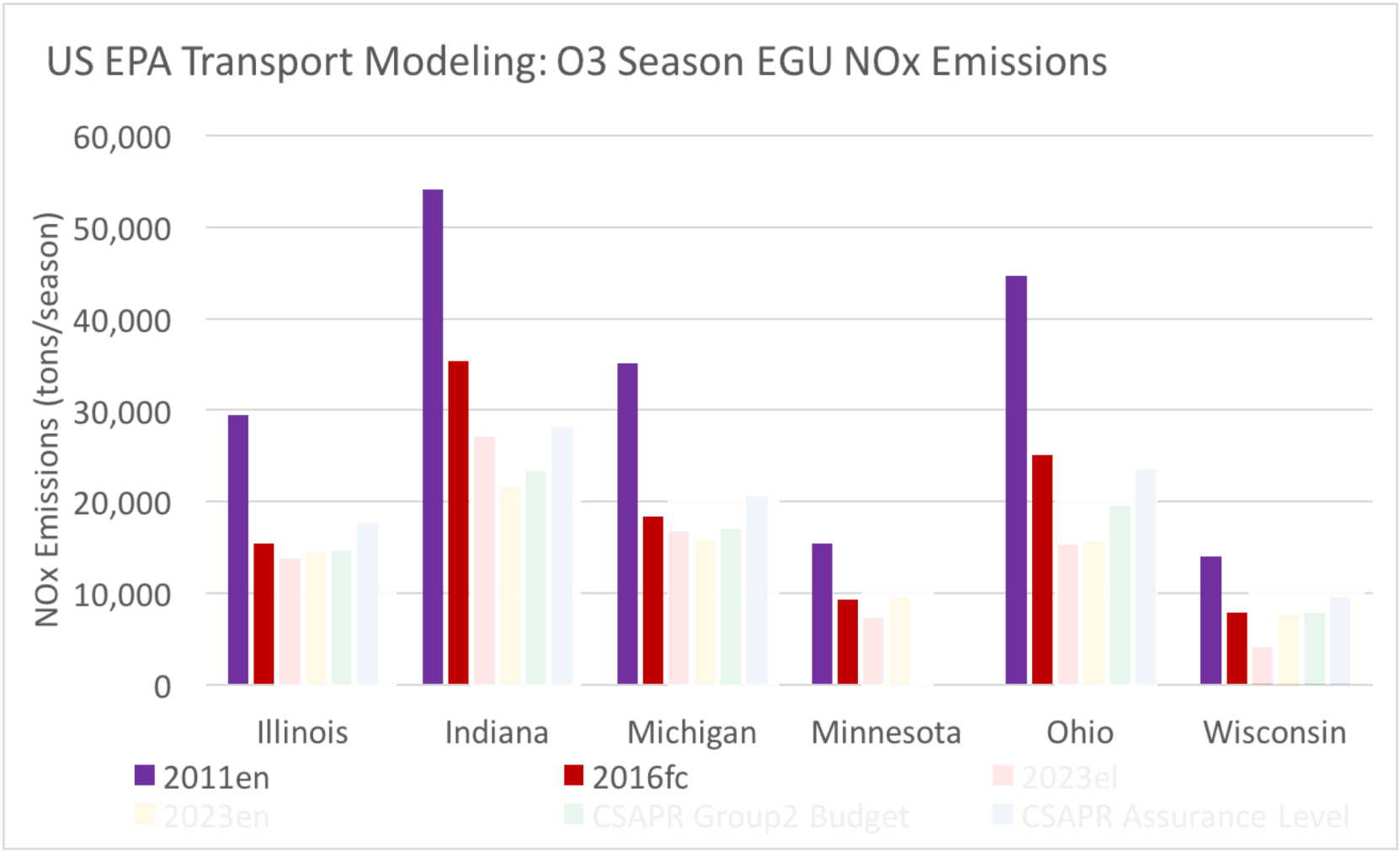
- Overview of recent air quality in the region
- Lake Michigan Ozone Study (LMOS) update
- Ozone transport – "Good Neighbor SIPs" for the 2015 O_3 NAAQS
- Research and planning support activities @LADCO

Energy Sector Changes Impact on Midwest Air Quality

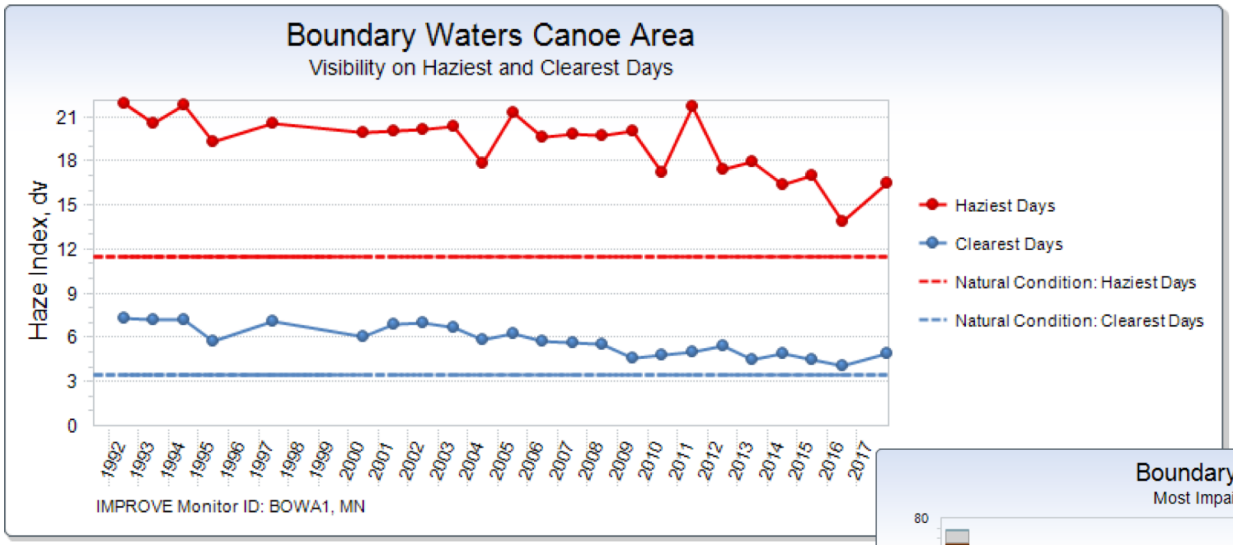


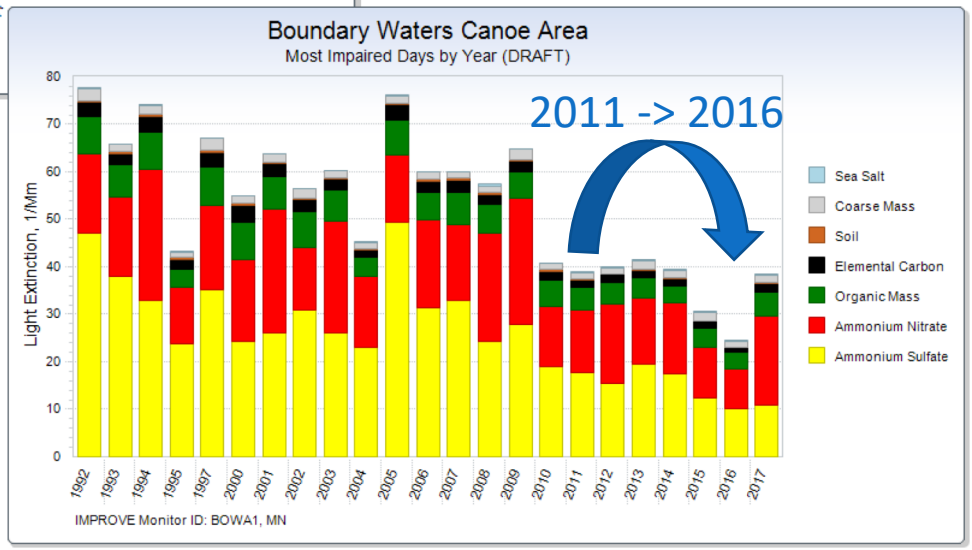
Energy Sector Changes Impact on Midwest Air Quality

LADCO



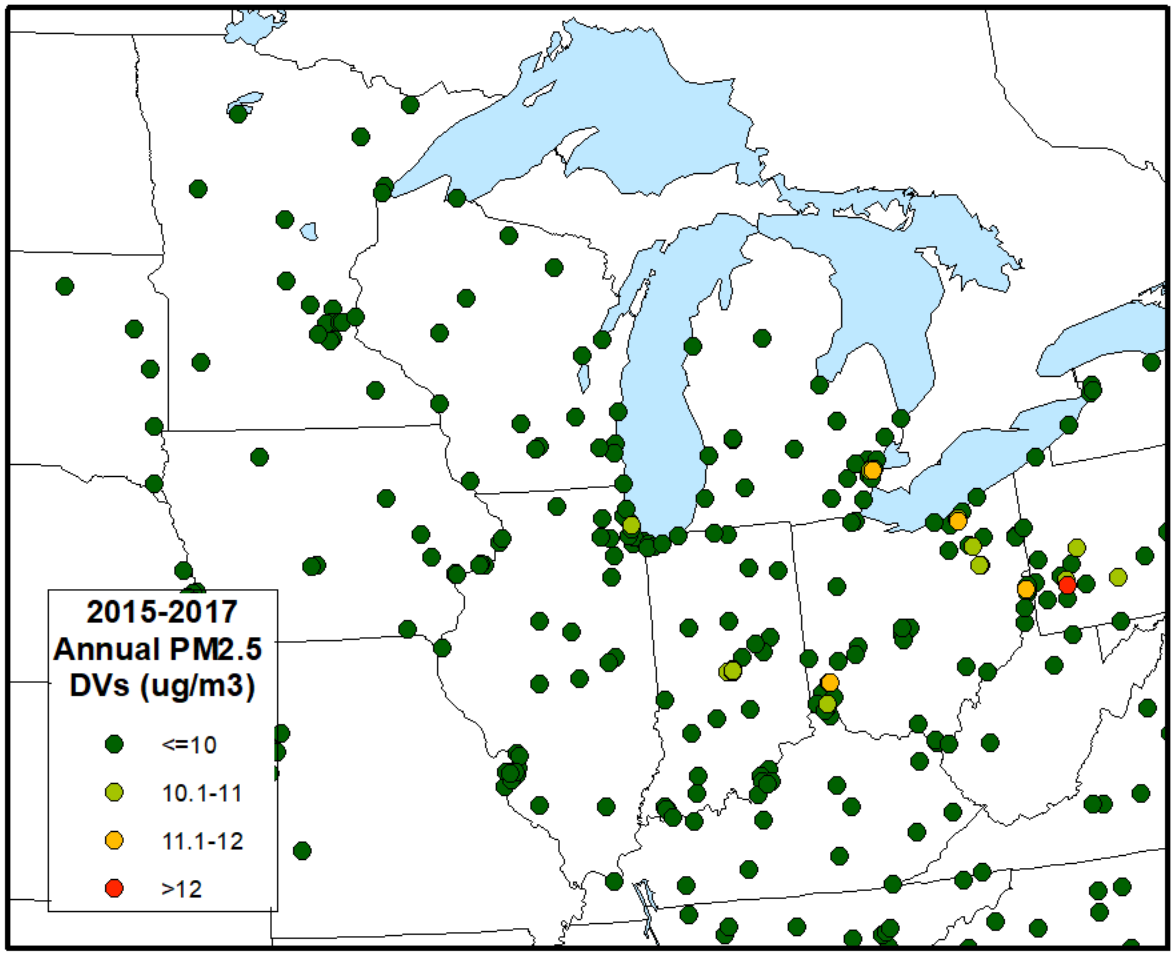
Energy Sector Changes Impact on Midwest Air Quality





- Boundary Waters (MN) shows improvement in Most Impaired Days metric, starting around 2010
- 2011 to 2016 trend follows emissions
- Driven by NO_3 and SO_4

Recent $PM_{2.5}$ Design Values

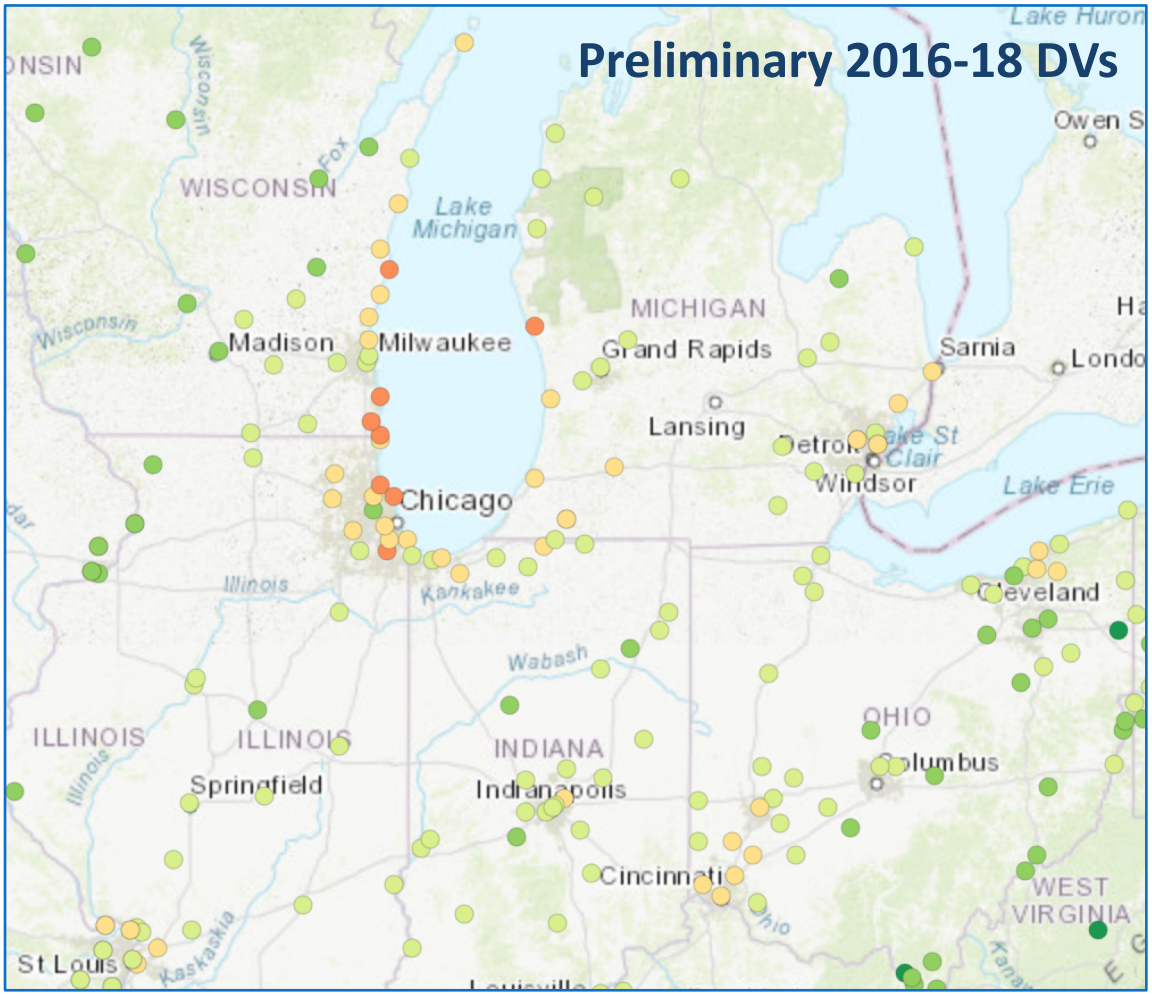


Annual $PM_{2.5}$ DV
3 year average of annual mean $PM_{2.5}$

Recent Ozone Design Values

LADCO

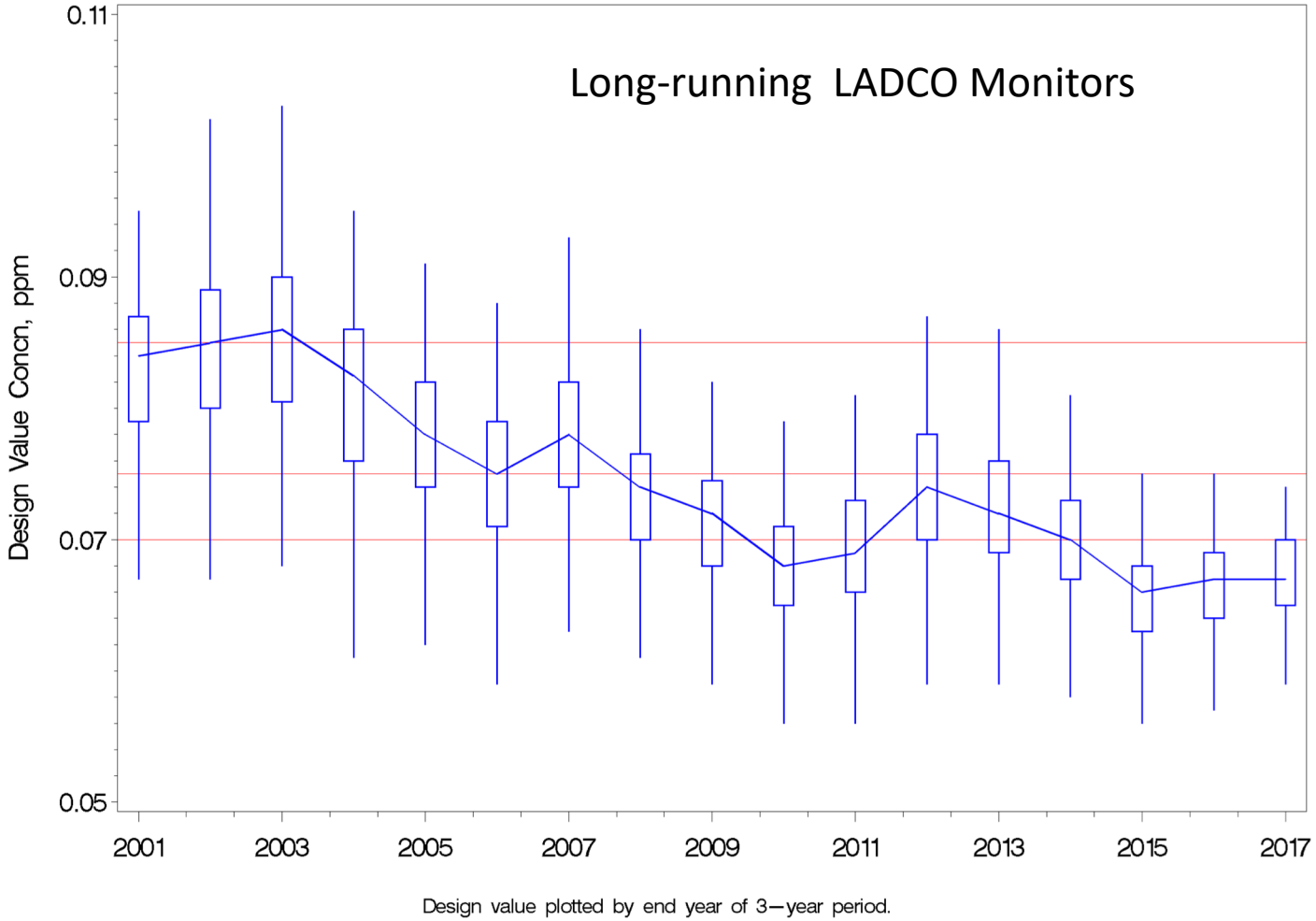
- > 0.08 – 0.088
- > 0.075 – 0.08
- > 0.07 – 0.075
- > 0.065 – 0.07
- > 0.06 – 0.065
- 0.049 – 0.06



O_3 DV

3 year average of annual 4th highest daily maximum 8-hour average O_3

Ozone: 3-Year Design Value Trend



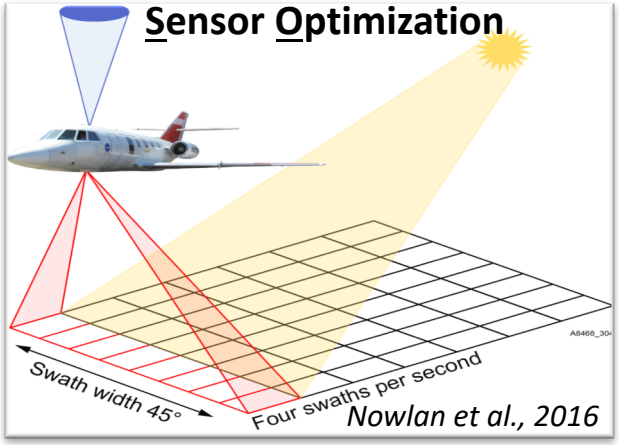
Lake Michigan Ozone Study

May – June 2017
Western Shore of Lake Michigan

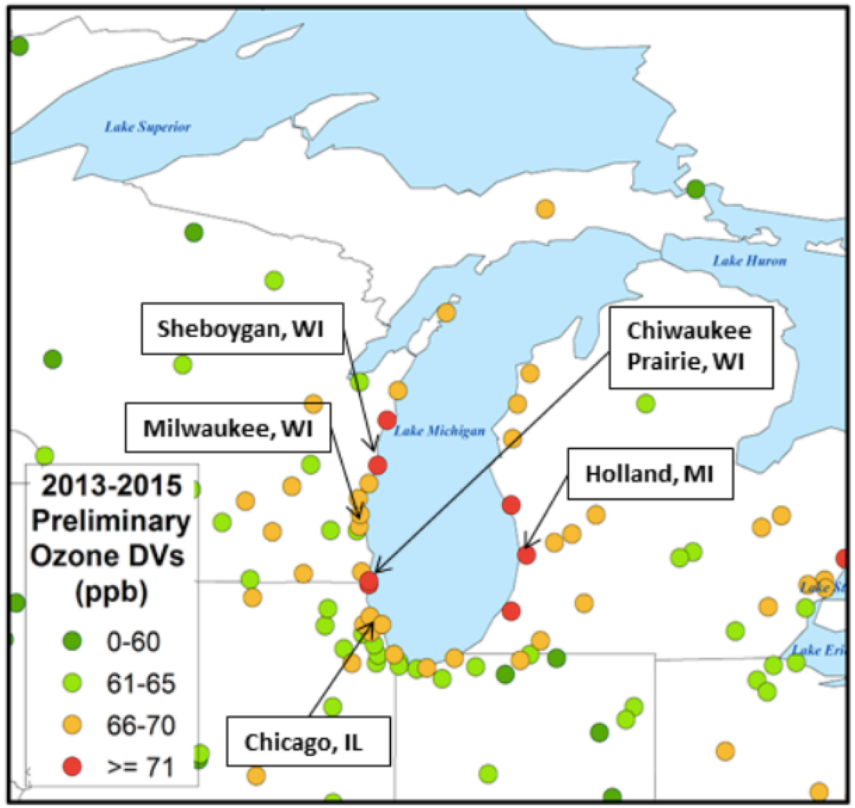
Motivations for LMOS

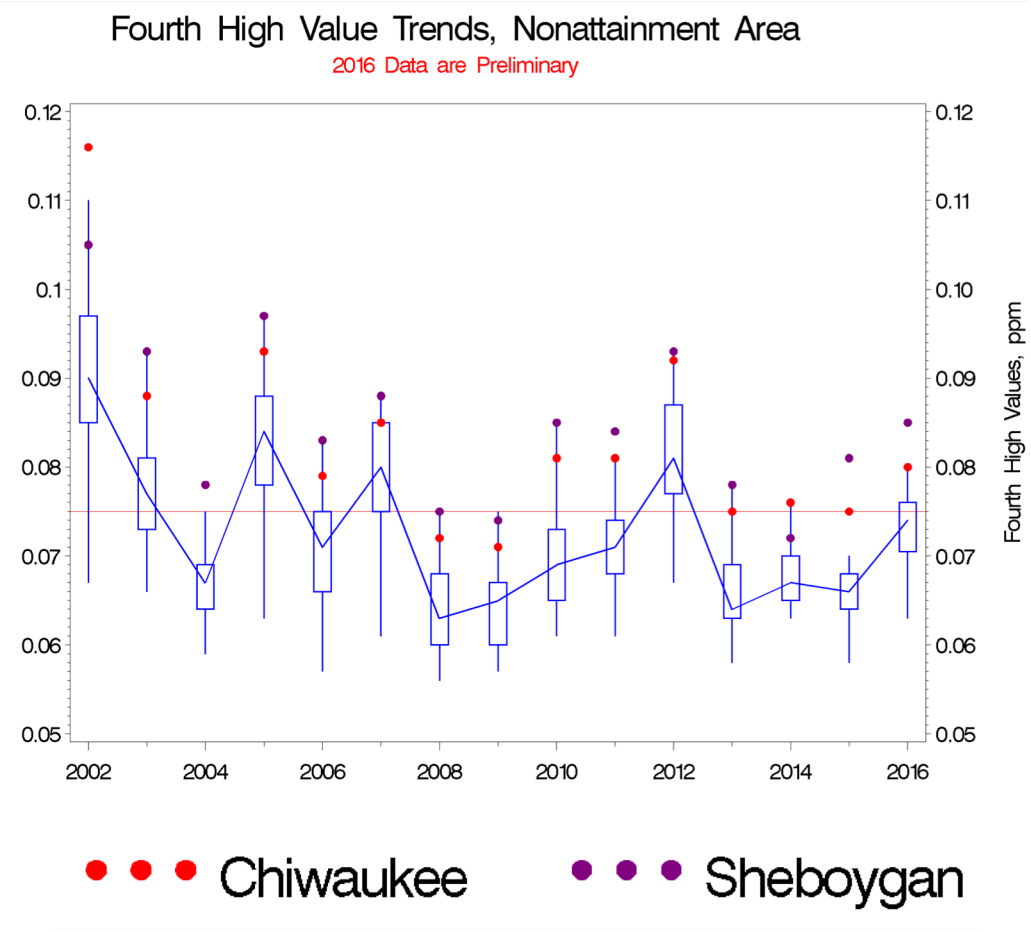
- Persistent high O_3 at some coastal sites
- Planning needs of the LADCO states require further clarity on regional O_3 production
- Last field campaign: summer 1991
- Need for a new study: New instruments/satellites and scarce aloft and over-lake observations

Geostationary Trace gas and Aerosol Sensor Optimization



Persistent High O_3 at Coastal Sites

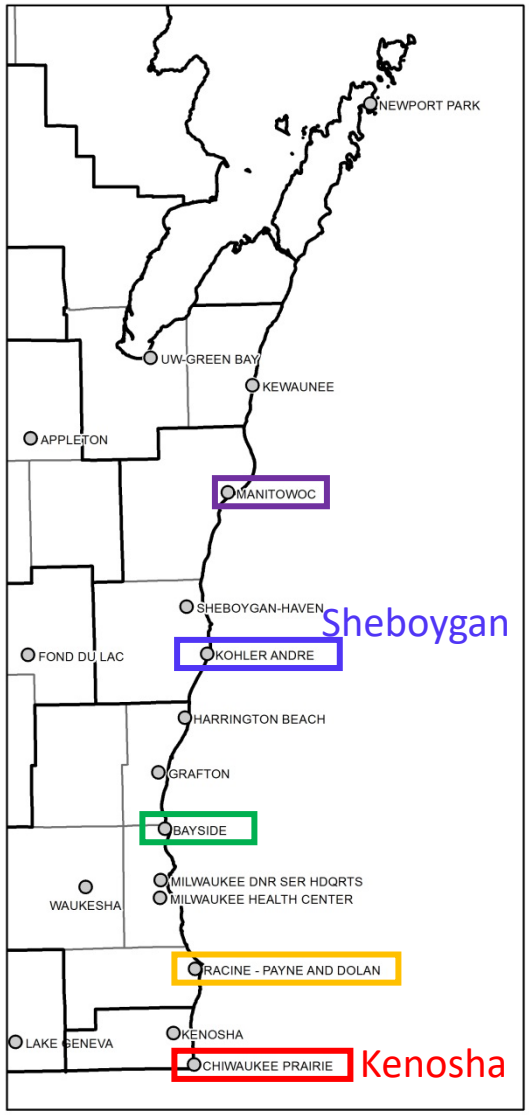


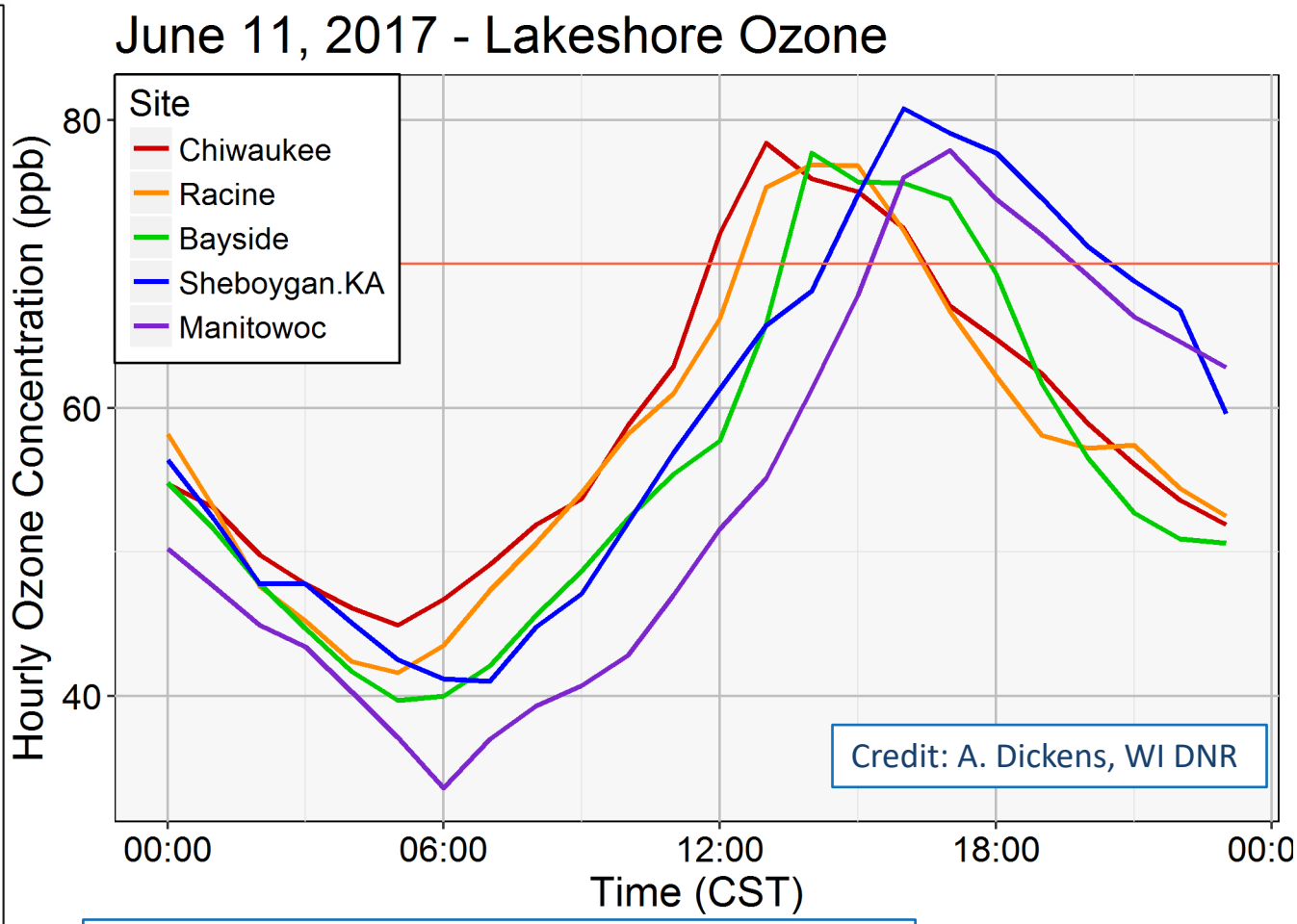


Legend set to 2015 O_3 NAAQS

Typical Regional Ozone Event

LADCO

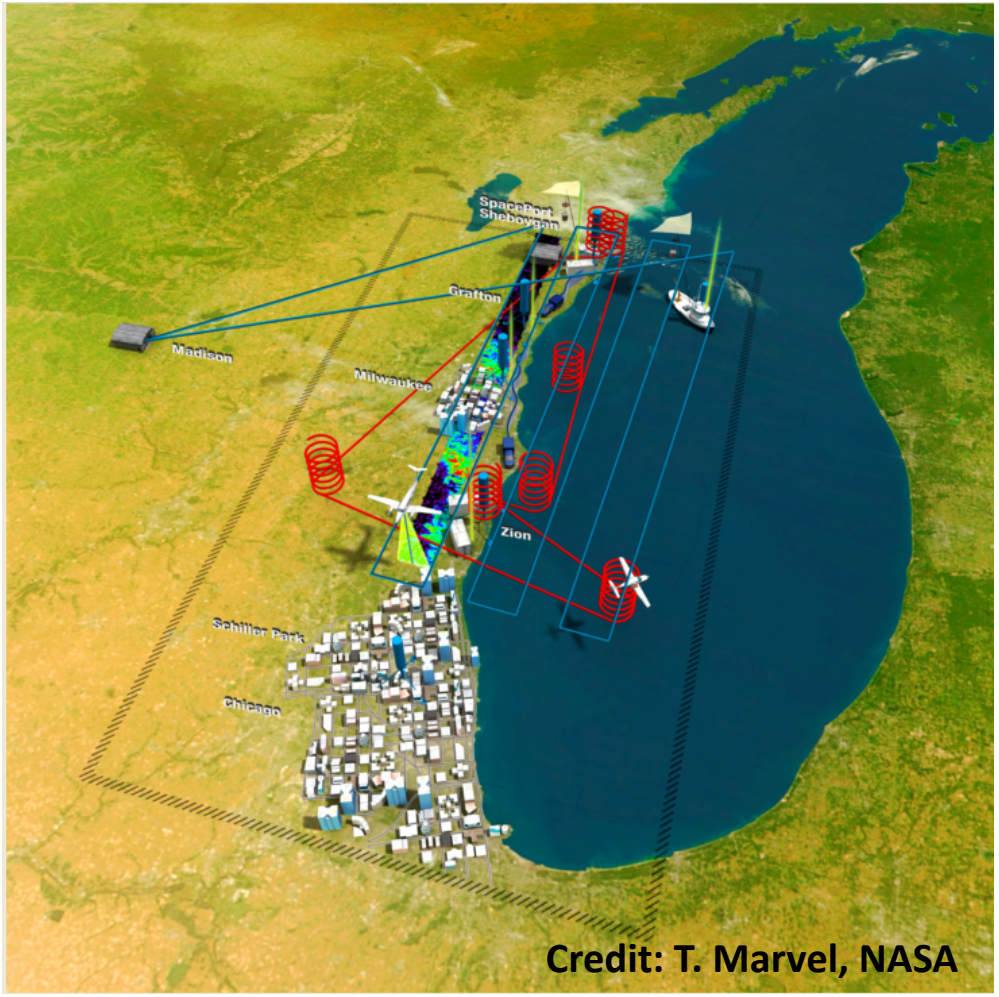




- Ozone peaks first at southern monitors
- Ozone plume moves northward

LMOS Study Design

- Observations
  - Aircraft
  - Ship
  - Mobile on-shore
  - Zion, IL Supersite
  - Sheboygan, WI Ground Site
- Forecasts
  - WI DNR
  - NOAA NESDIS
  - U. Iowa
  - NWS



LMOS Airborne Platforms

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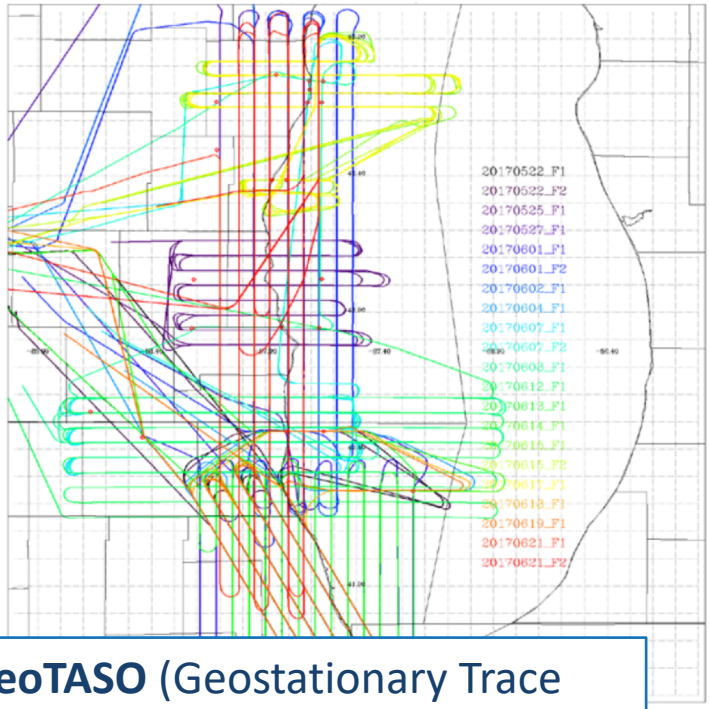
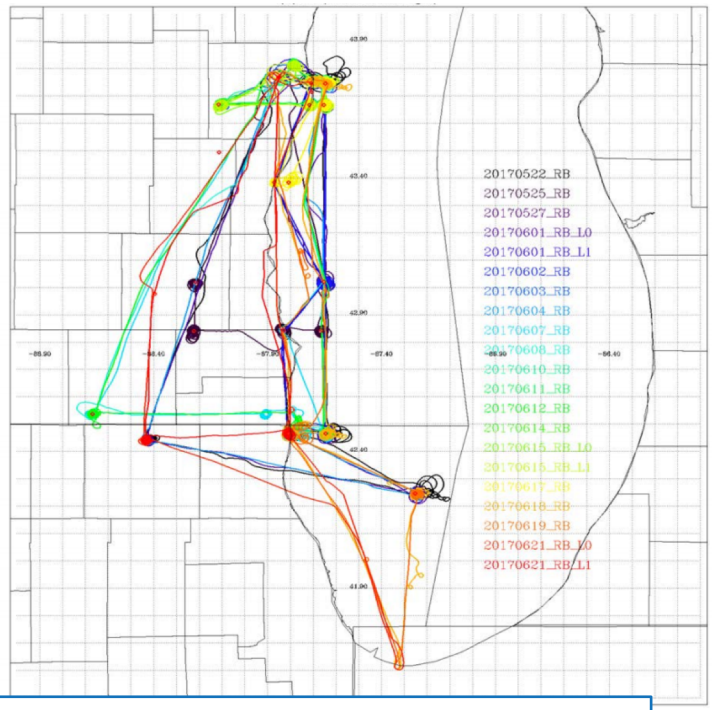
NASA GeoTASO remote sensing Flights



GeoTASO (Geostationary Trace gas and Aerosol Sensor Optimization) is an airborne NO_2 instrument that is being used as a testbed for future geostationary remote sensing platforms

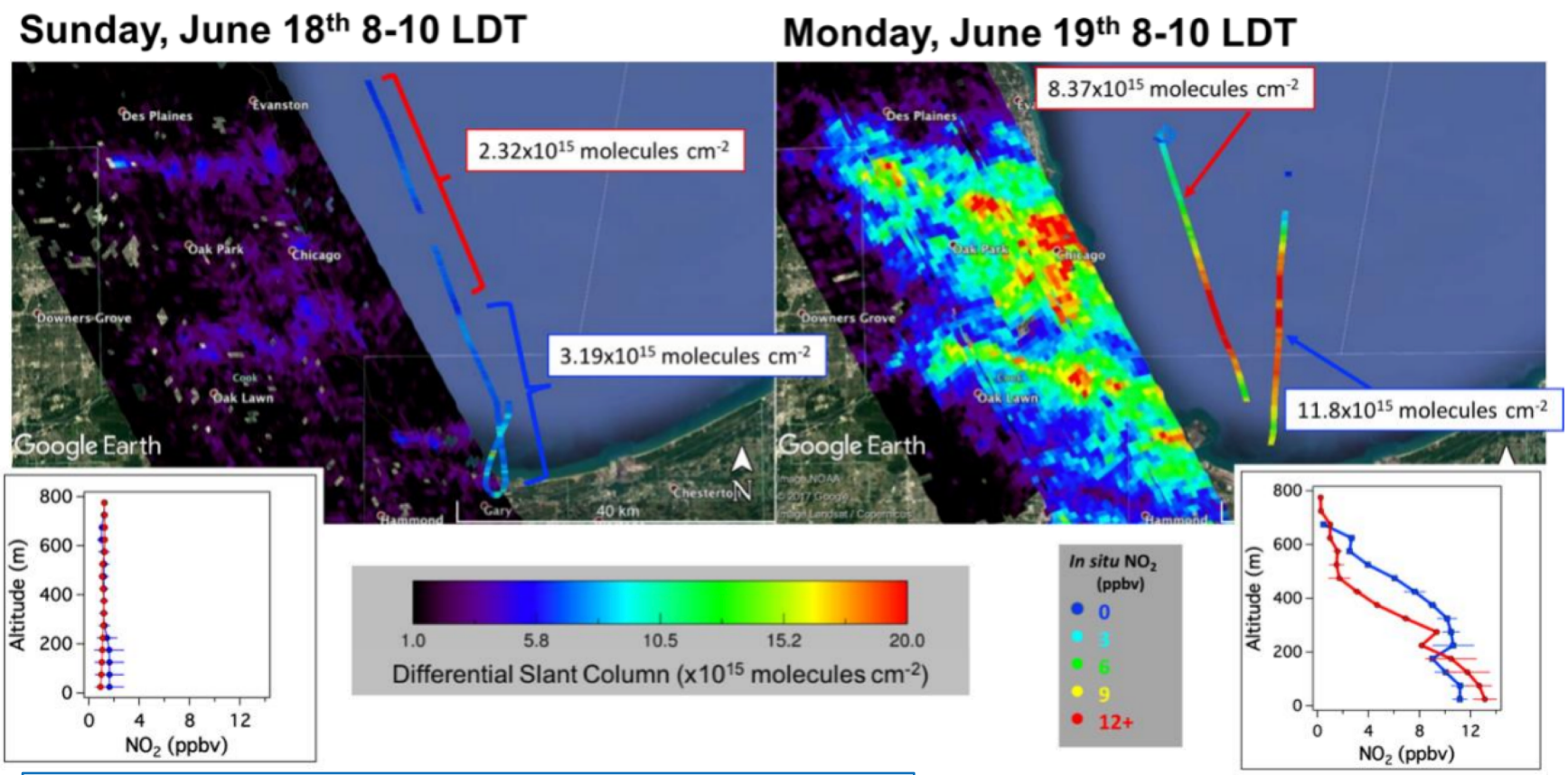
Scientific Aviation insitu sampling Flights



Scientific Aviation Flights during LMOS provided vertical profiles of O_3, NO_2, CO_2, CH_4, altitude, T, RH, winds, and pressure.

NASA GeoTASO LMOS NO_2 Retrievals

LADCO

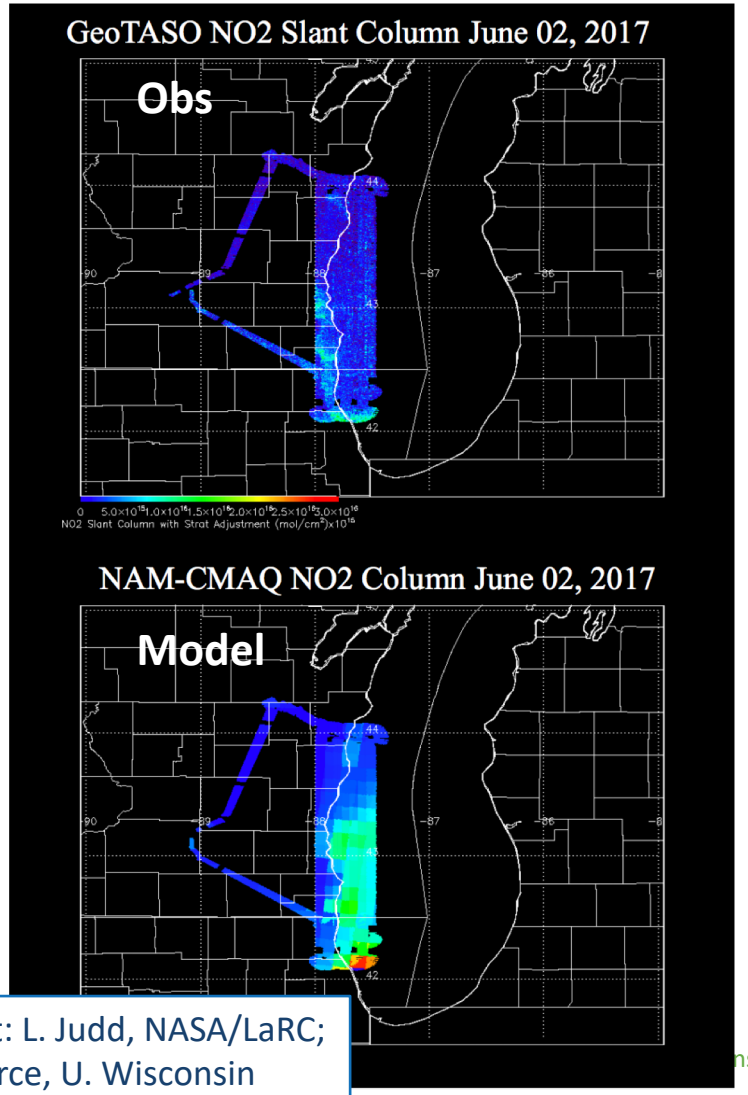


Weekday/weekend NO_2 column differences in Chicago as seen by GeoTASO

Credit: L. Judd, NASA/LaRC

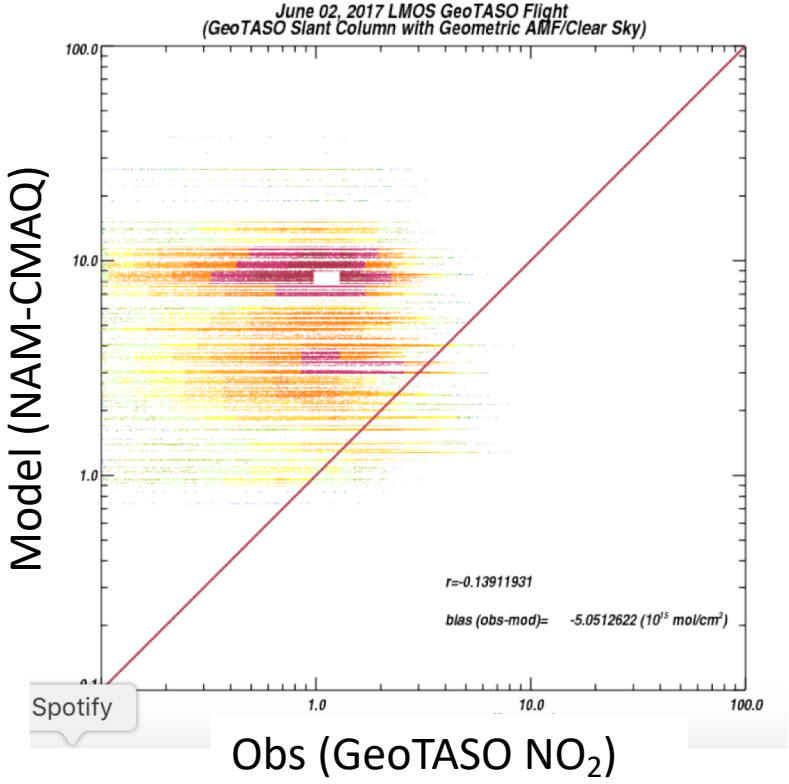
Air Quality Model Evaluation

LADCO



Credit: L. Judd, NASA/LaRC; B. Pierce, U. Wisconsin

Preliminary analysis indicates that the regional air quality models estimate too much NOx.



Preliminary LMOS Results

- Significant O_3 events occurred during LMOS 2017, with exceedances of the 70 ppb 8-hr ozone threshold on June 2, June 11-12, and June 14-16.
  - The LMOS 2017 aircraft observed polluted layers with rapid O_3 formation occurring in a shallow layer near the Lake Michigan surface.
- An experimental network of lower cost O_3 monitors (2B-POM monitors) was deployed over a 6 km area of Sheboygan to measure differences in concentrations with respect to distance from the lake.
  - Inland O_3 values were found to be 5-6% lower than the lakeshore site. However, intermittent data capture from these devices limits the drawing of detailed conclusions regarding spatial gradients.

Preliminary LMOS Results

- Modeling and observations during LMOS showed that the polluted layer over the lake is an important factor in coastal O_3 exceedance events
- Meteorological and photochemical model skill in forecasting these events needs improvement.
  - Models of the LMOS period underestimated peak O_3 concentrations and overestimated NO_2 concentrations
  - Model sensitivity studies show that reductions in anthropogenic NOx emissions and increases in biogenic volatile organic compounds (VOCs) emissions are necessary to reproduce the observed surface O_3

LMOS Next Steps

- Meteorology and air quality model optimization for the Lake Michigan area
  - Integration of remote sensing and in-situ observations into simulations
- Mining the observational data for emissions signals
  - What can we learn about simulated emissions from the LMOS observations?
- Synthesis report for the field campaign available @ **ladco.org**
- LMOS data are now publicly available

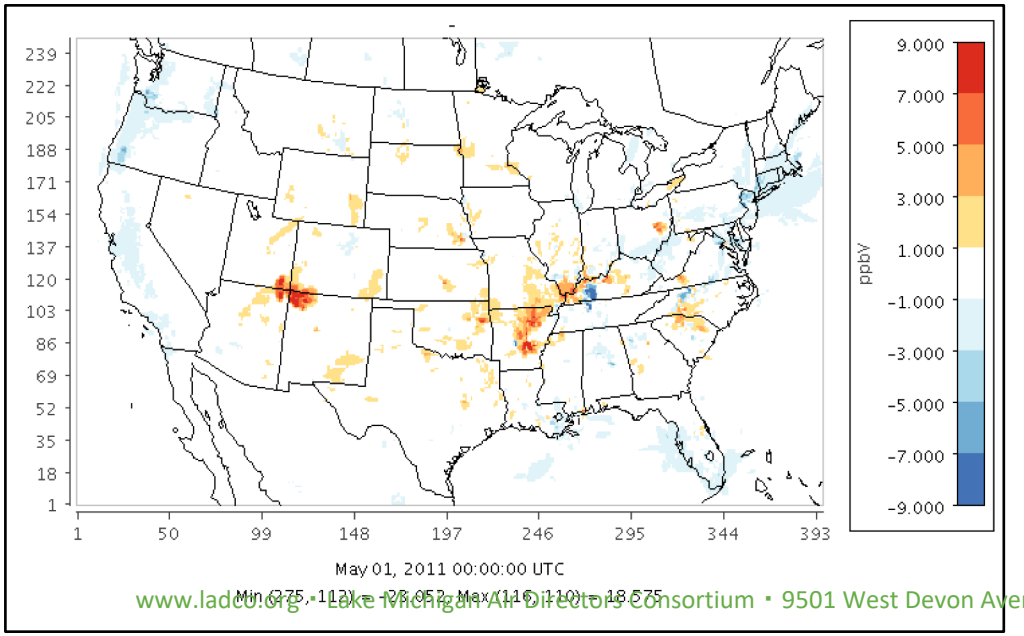
https://www-air.larc.nasa.gov/missions/lmos

Regulatory Issues @ LADCO

- 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 (SIP) not required for marginal
  - Marginal attainment by August 2021
- 2008 O_3 NAAQS
  - Chicago and Sheboygan reclassification from moderate to serious status in January 2019
- Regional Haze
  - Round 2 SIPs due July 2021

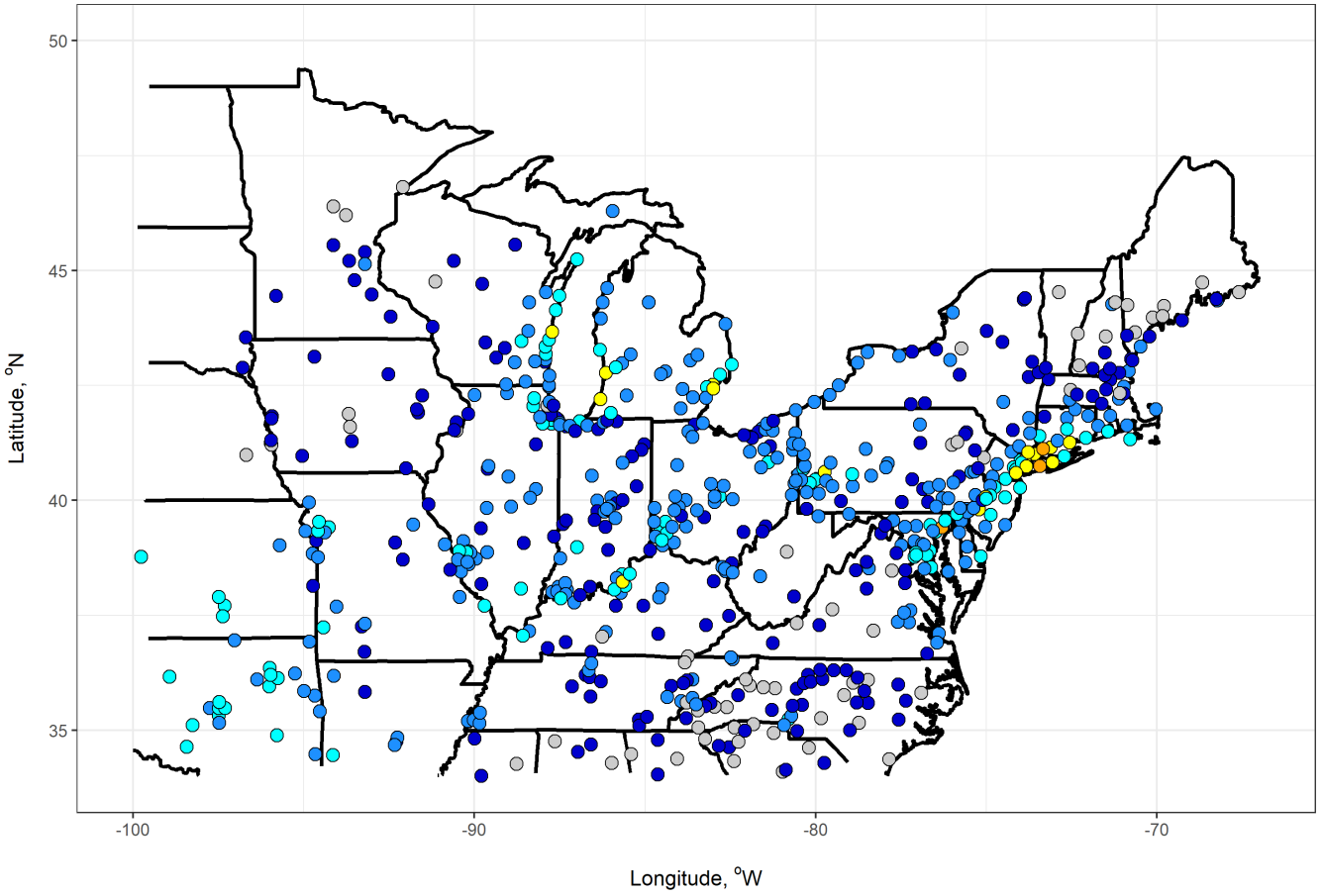
2015 O3 NAAQS Transport Modeling

- LADCO reproduced EPA 2011 and 2023 CAMx regional modeling ("EN Platform") as the basis of a transport modeling Technical Support Document (TSD) for our member states
- LADCO replaced the EPA electricity sector 2023 forecasts with ERTAC-EGU model projections; everything else the same with EPA
- CAMx used to tag sector and state contributions to 2023 ozone



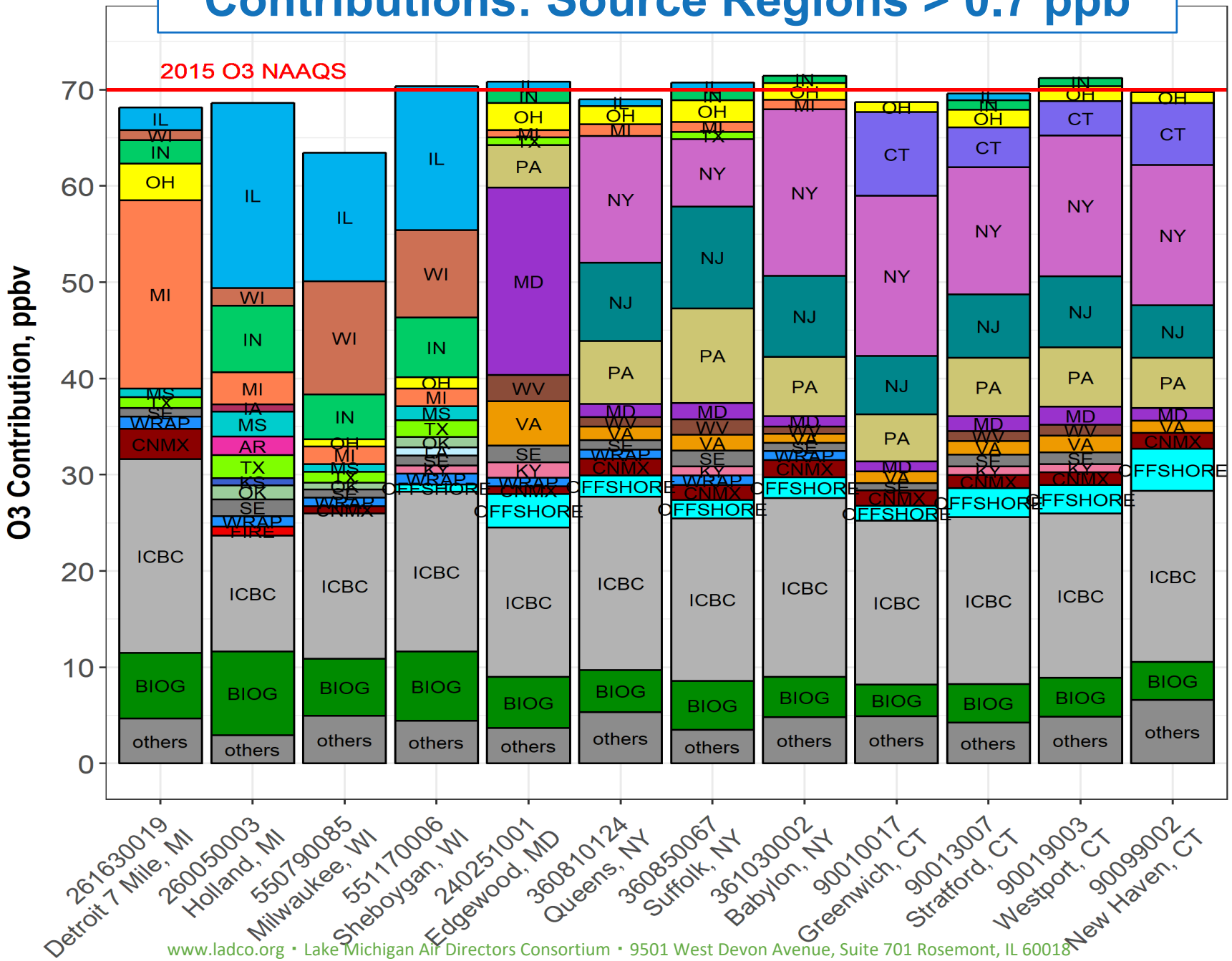
EPA – LADCO differences in 2023 daily maximum MDA8 O3.

LADCO 2023 Ozone Design Values

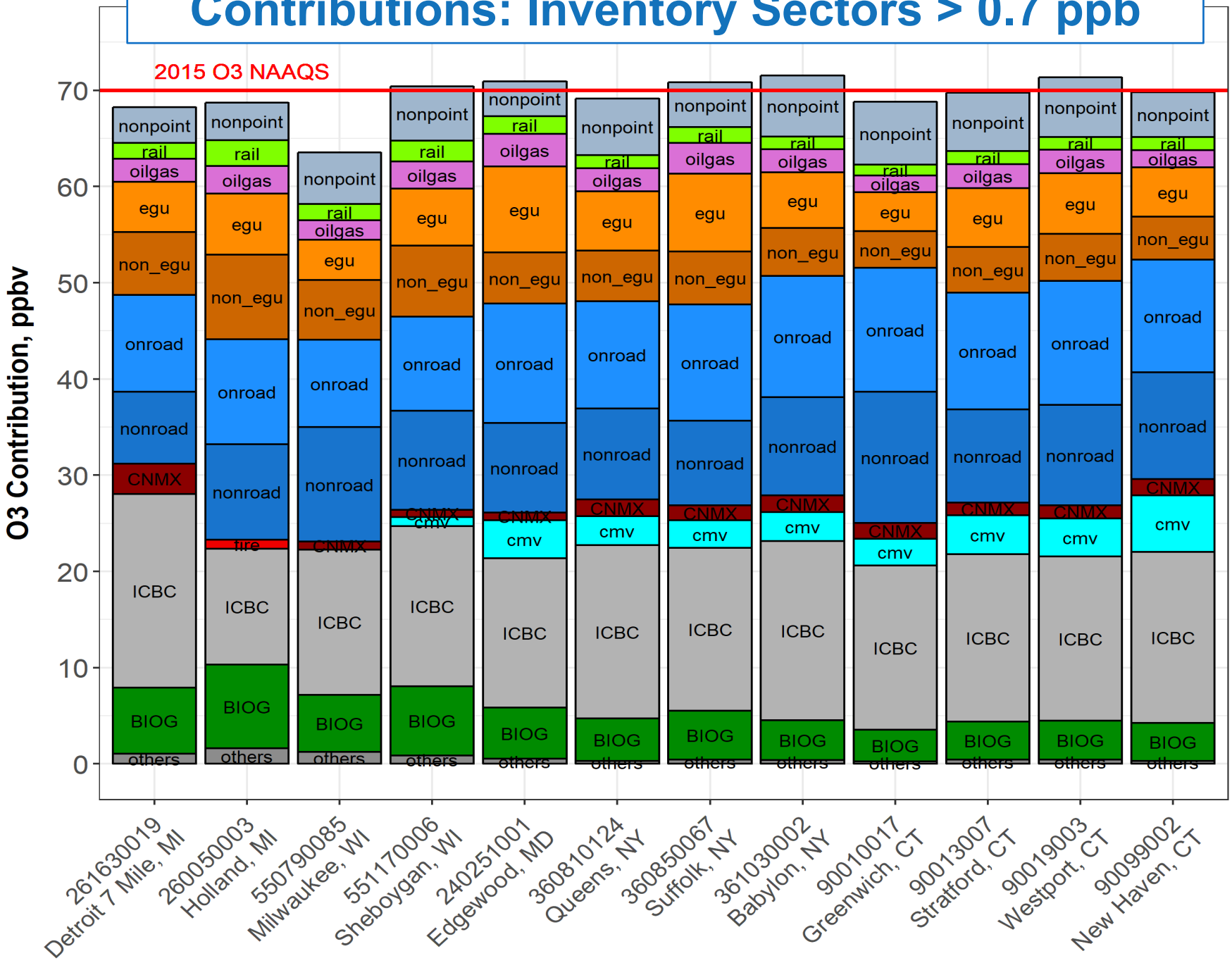


LADCO forecast 4 monitors in the Northeast to be nonattainment of the 2015 O_3 NAAQS by 2023

Contributions: Source Regions > 0.7 ppb



Contributions: Inventory Sectors > 0.7 ppb

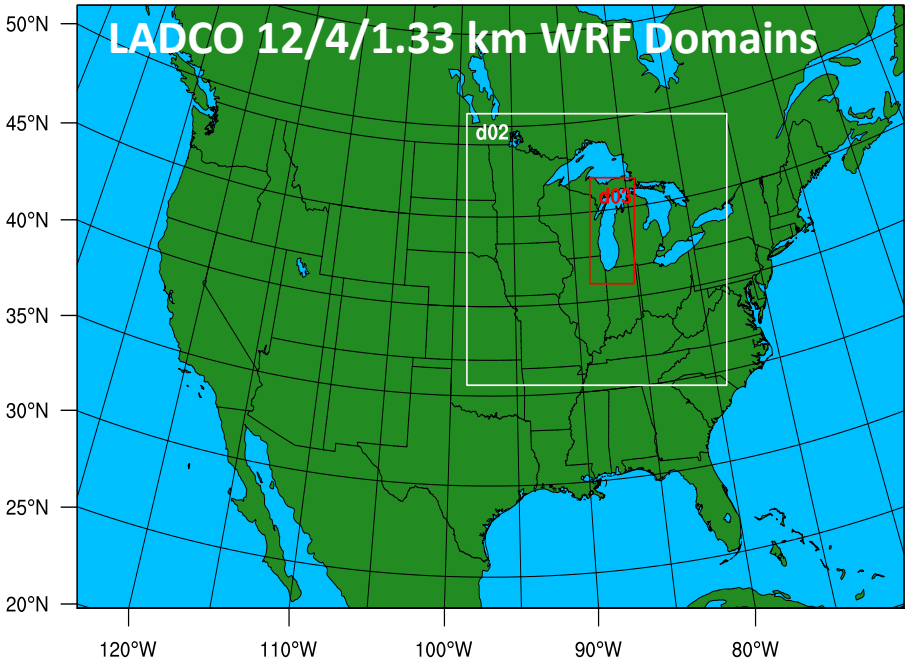


O_3 Transport Modeling Summary

- Recent modeling studies (LADCO, EPA, MOG, TCEQ) forecast that most of the US will be in attainment of the 2015 O_3 NAAQS by 2023
- EPA Flexibility Memo (March 2018) laid out analysis alternatives for states to use for quantifying transport, source-receptor linkages, and maintenance
- First attainment deadline for 2015 O_3 NAAQS will use DVs for 2018-2020, to demonstrate attainment by 2021
- How will we get the forecasted levels of attainment?
  - The next three O_3 season (including 2018) temps are normal or cooler than avg
  - Emissions trends continue to decline along the slope that started in 2011
  - Lower than normal wildfire seasons
  - Long-range transport from outside U.S. flattens or declines

Technical Analyses @ LADCO

- Regional Photochemical Modeling
  - 2016 WRF/CAMx/CMAQ 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



Questions and Contact

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