LADCO Winter 2018 Update

Zac Adelman
LADCO Executive Director

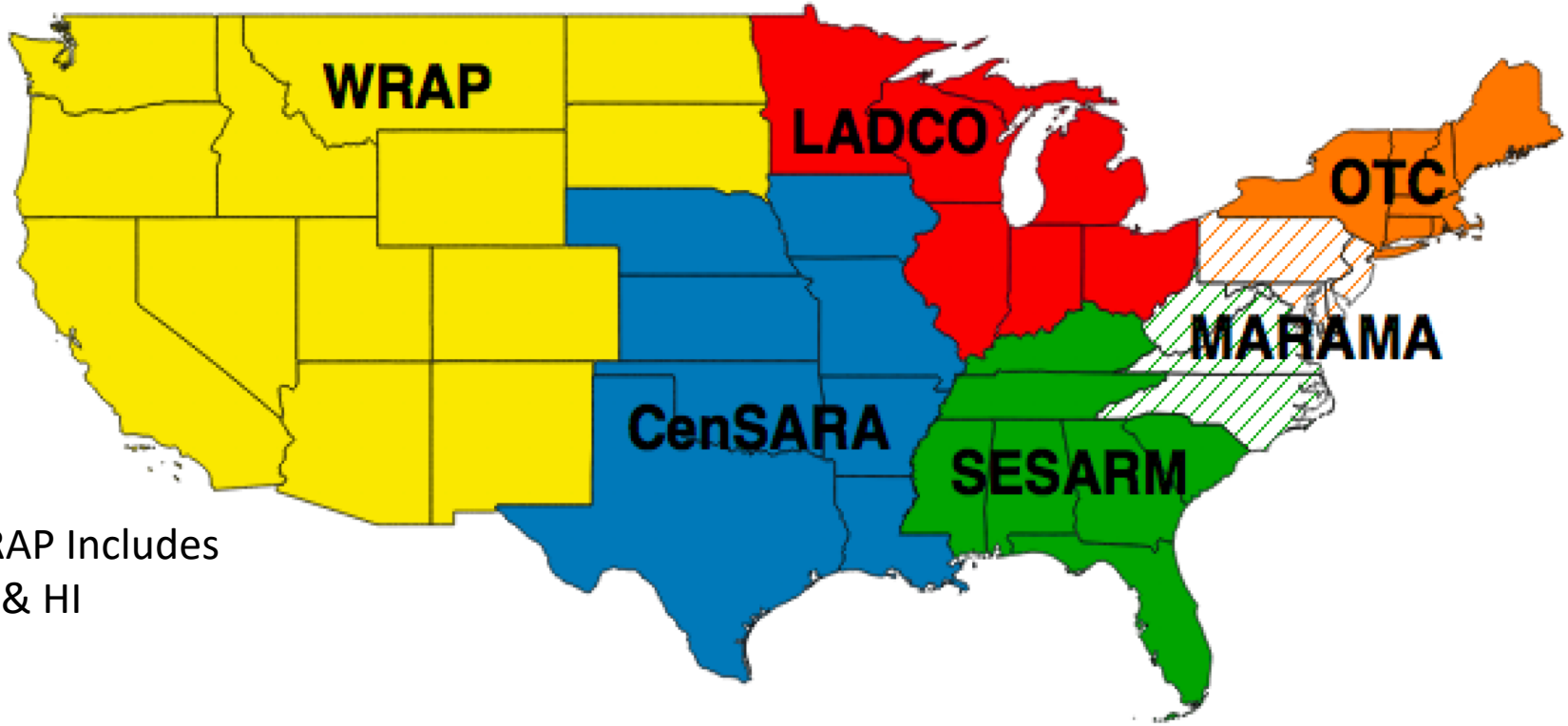
Presented at the Lake Michigan Section of the Air & Waste Management Association Breakfast Program

February 20, 2018


Isle Royale NP, MI


Boundary Waters Wilderness, MN

MJOs in 2018

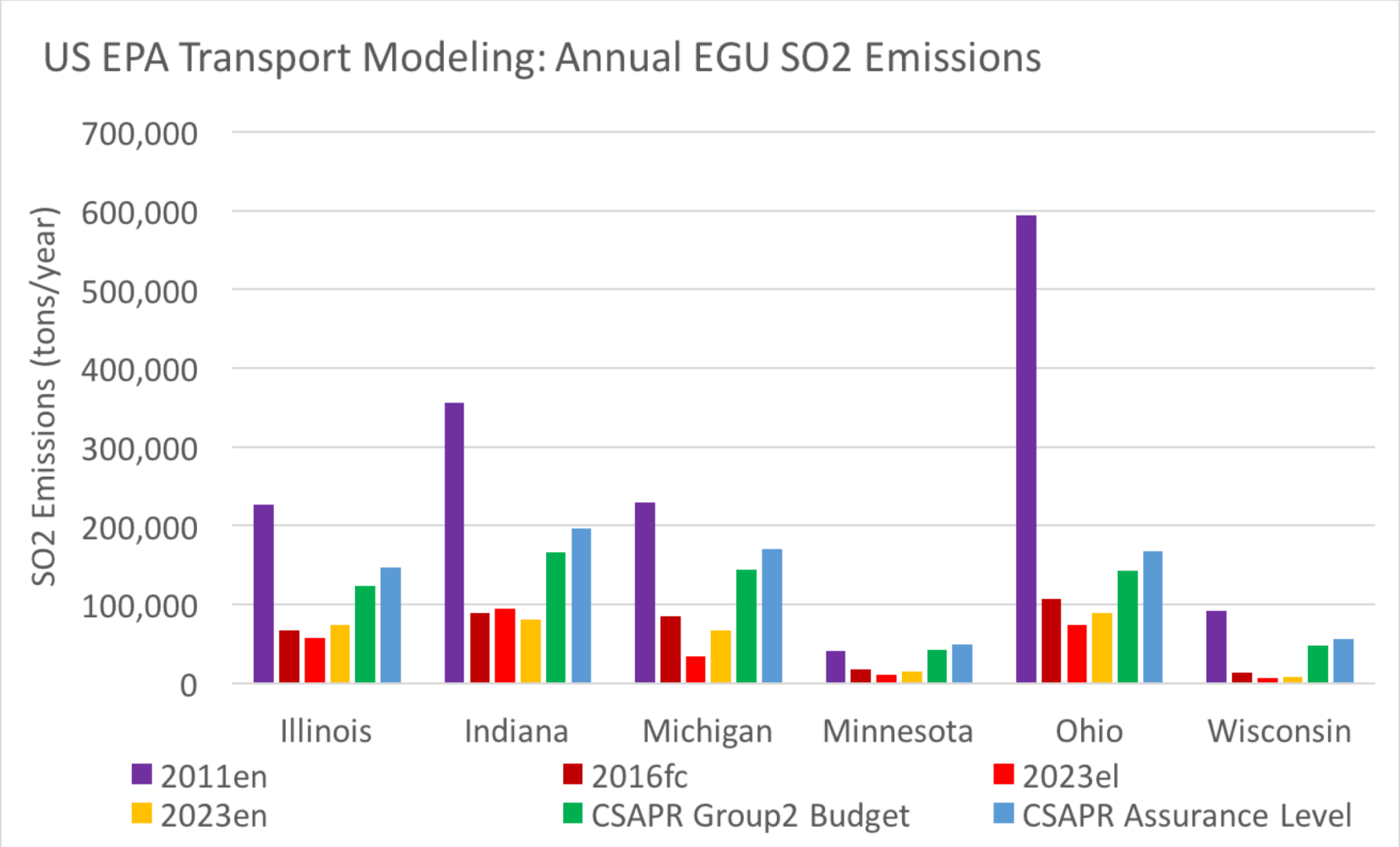


WRAP Includes
AK & HI

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

How Have Energy Sector Changes Impacted LADCO Class I Areas?



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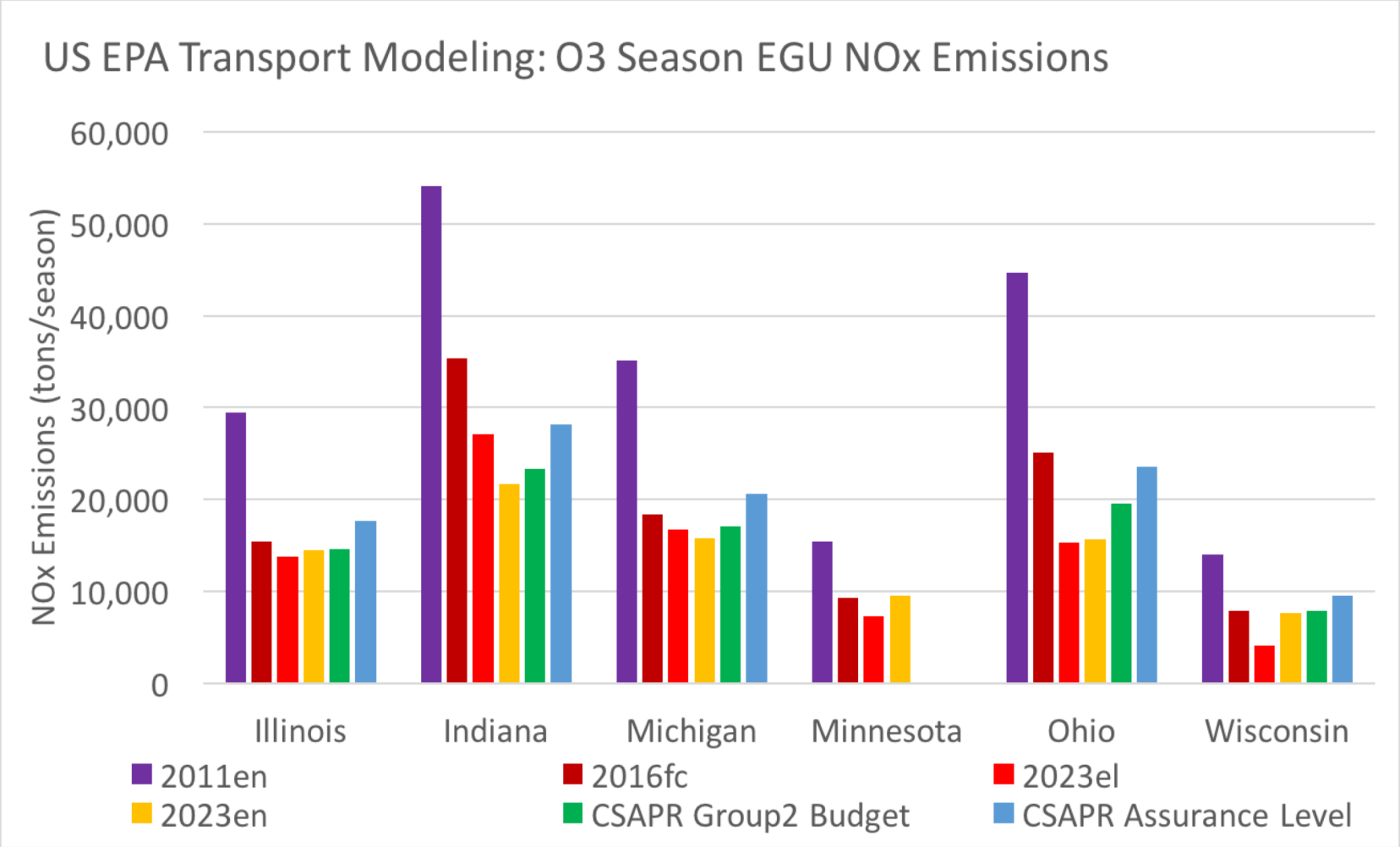

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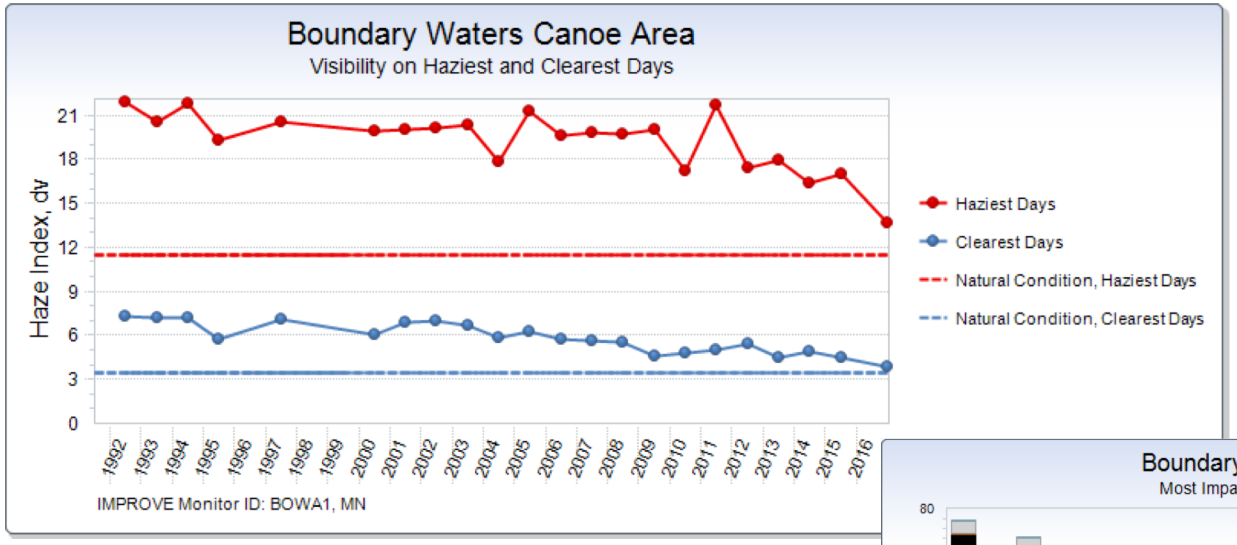

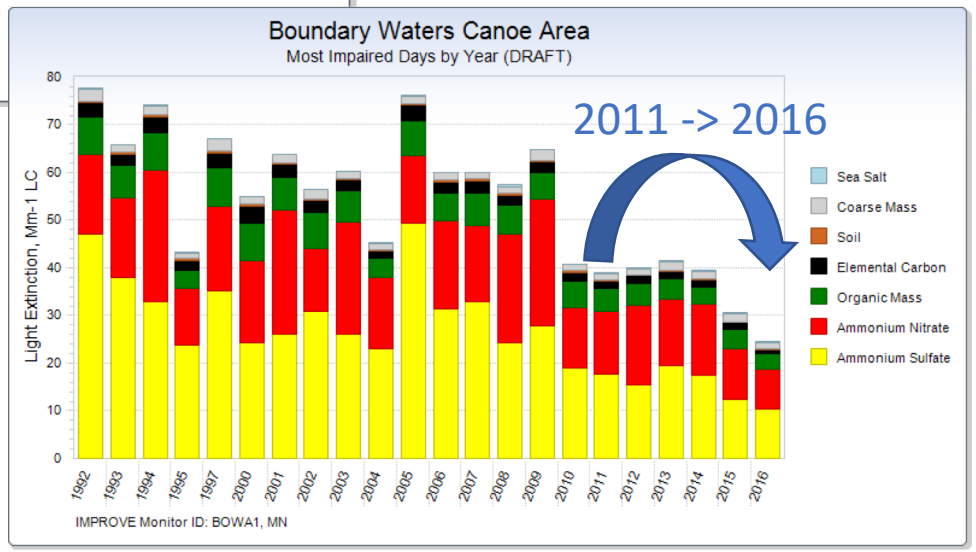

- Boundary Waters (MN) shows improvement in Most Impaired Days metric, starting around 2010
- 2011 to 2016 trend follows emissions
- Driven by NO_3 and SO_4

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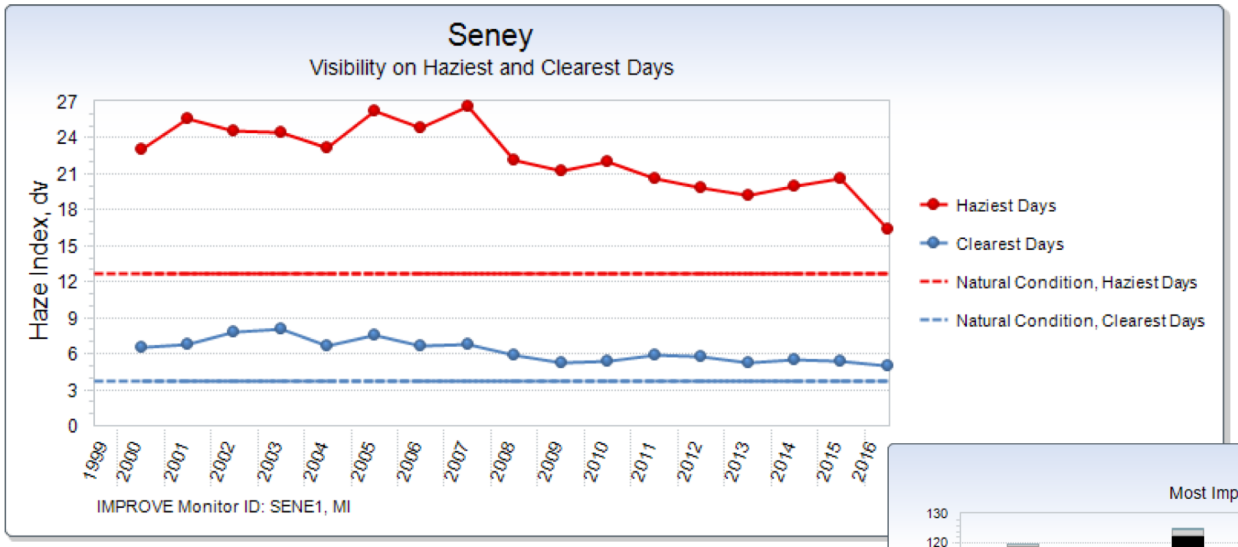
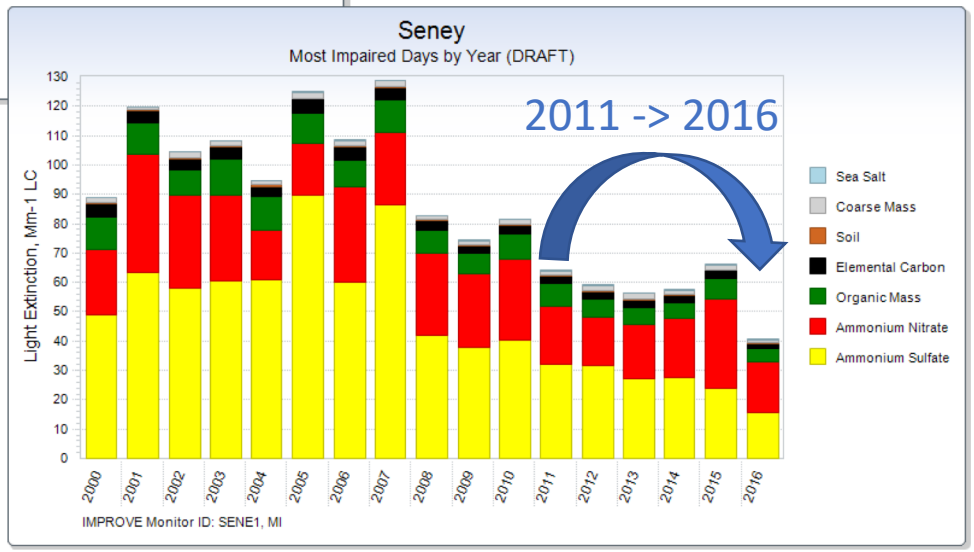
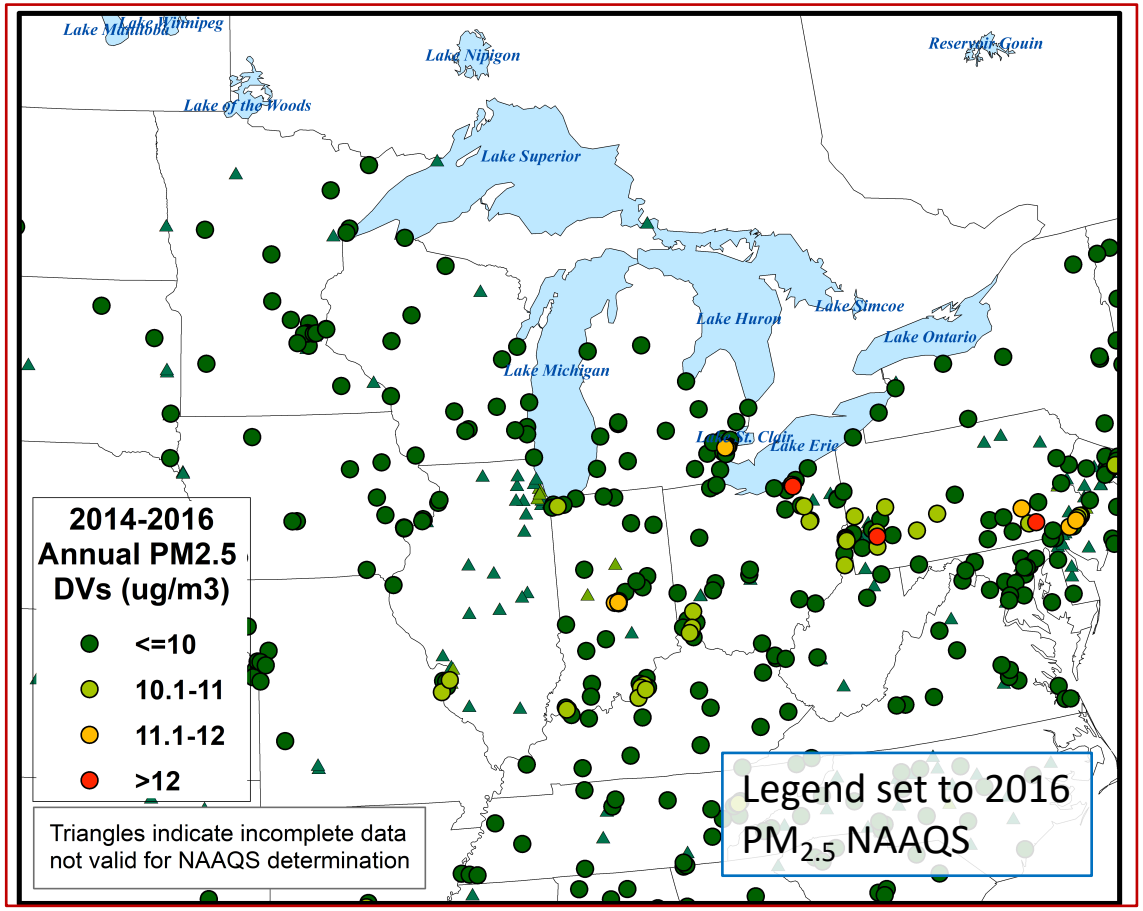




- Seney (MI) shows improvement in Most Impaired Days metric, starting around 2008
- 2011 to 2016 trend follows emissions
- Driven by SO_4

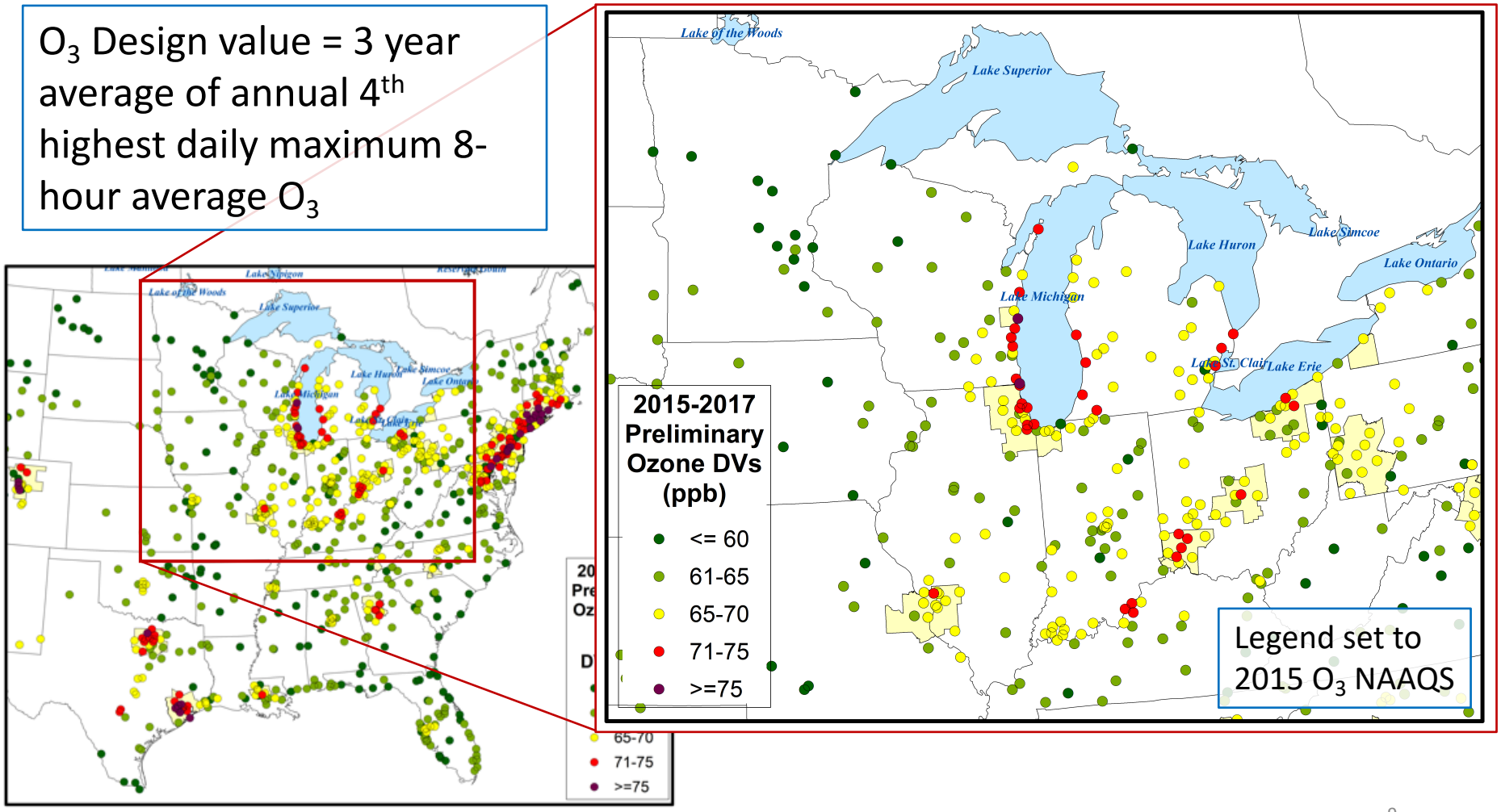
Recent $PM_{2.5}$ Design Values

Annual $PM_{2.5}$ Design value
= 3 year average of annual mean $PM_{2.5}$



Recent Ozone Design Values

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



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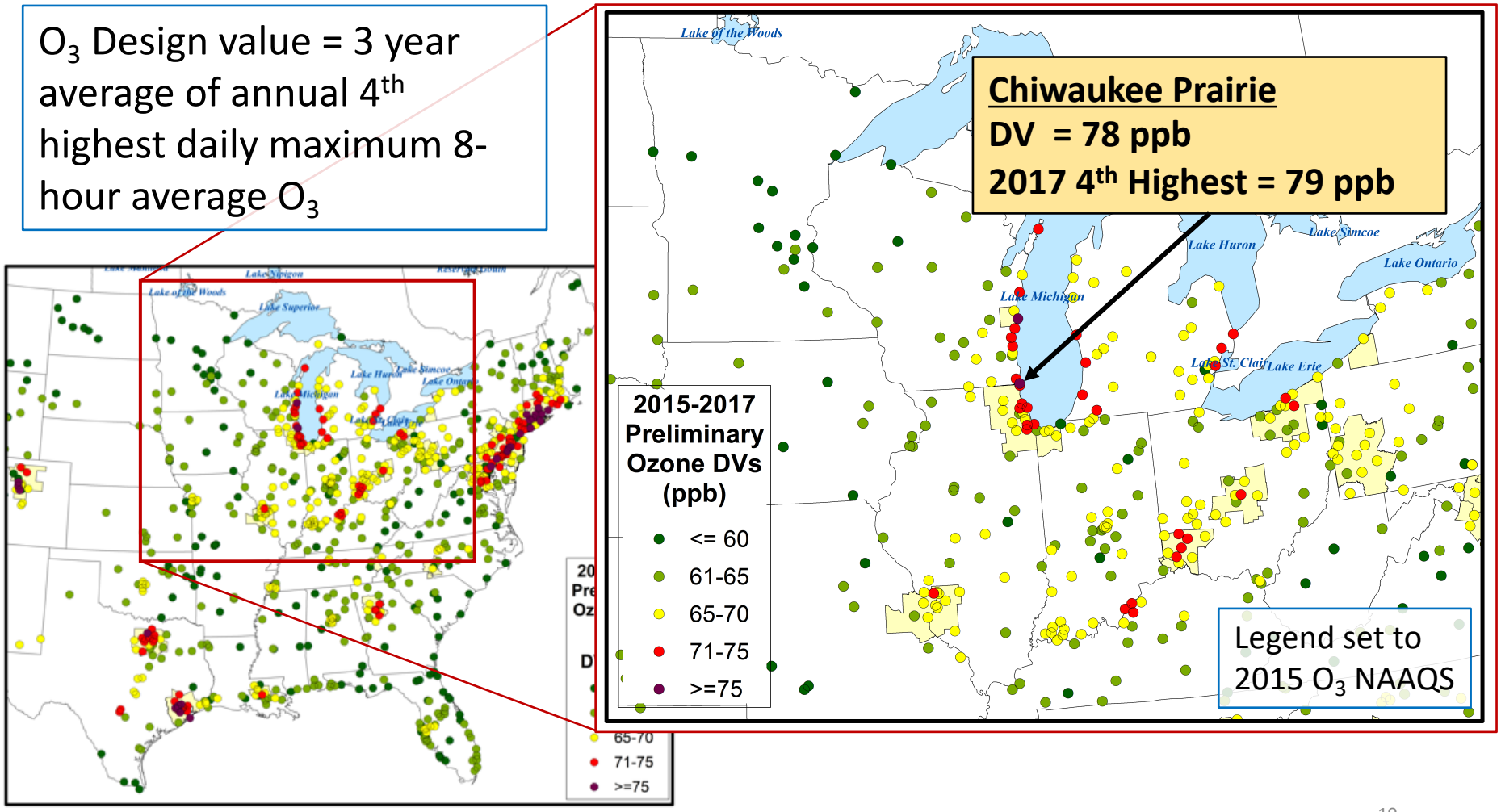
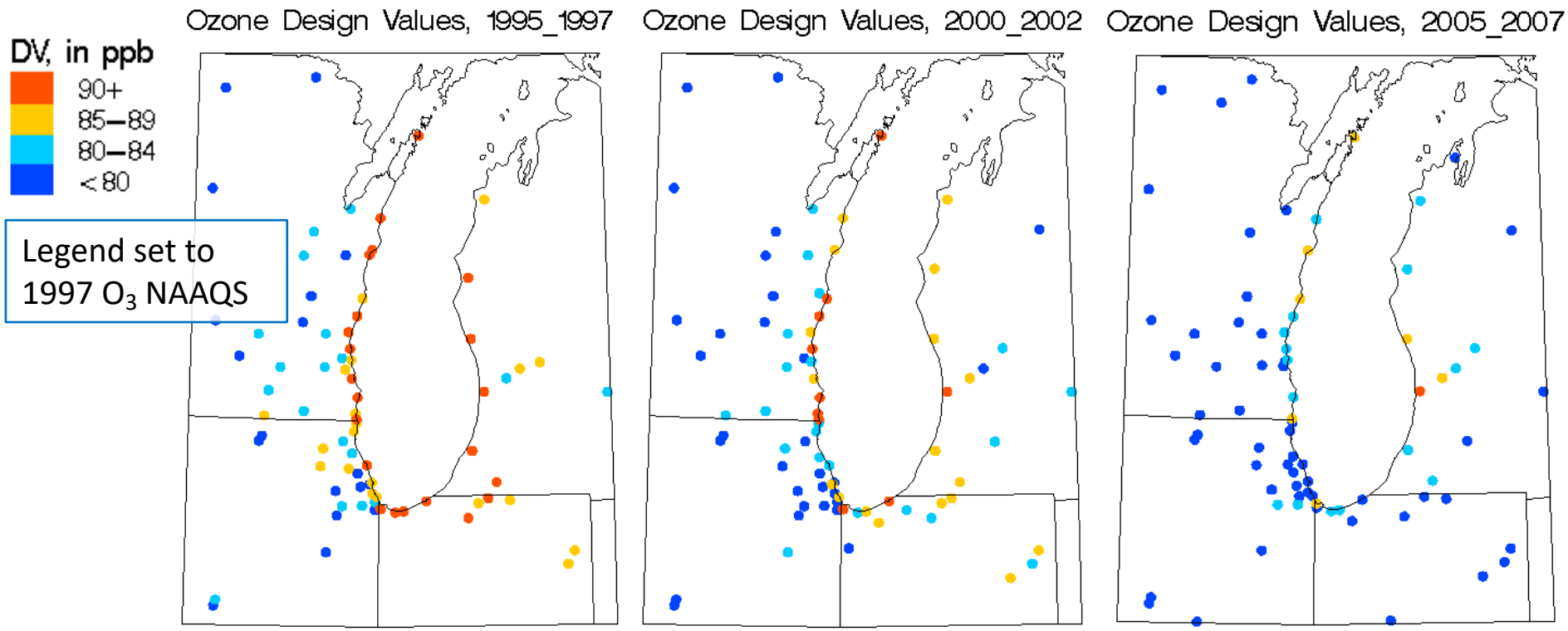


Lake Michigan Ozone Study

May – June 2017
Western Shore of Lake Michigan

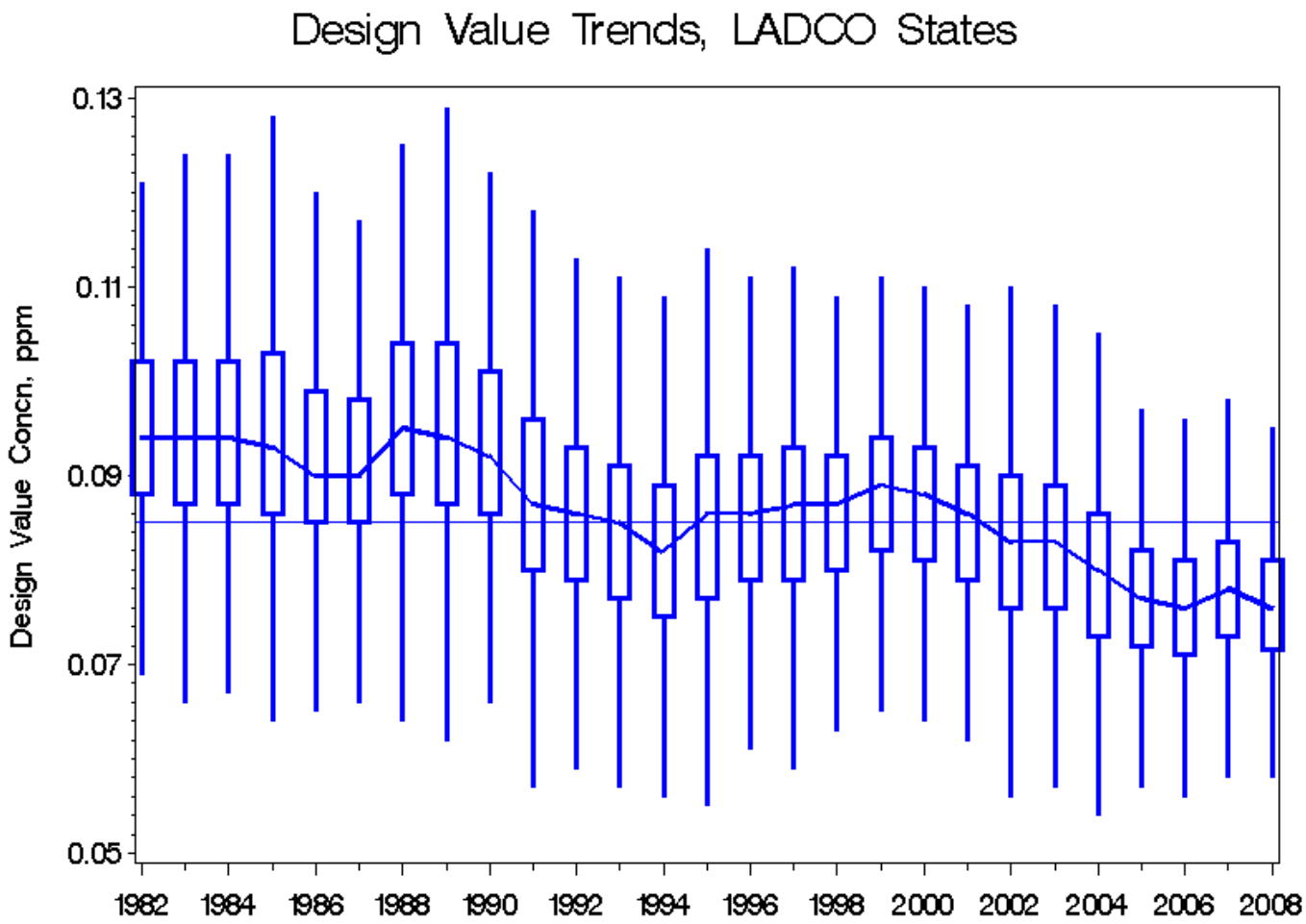
Background on LMOS



Legend set to 1997 O_3 NAAQS

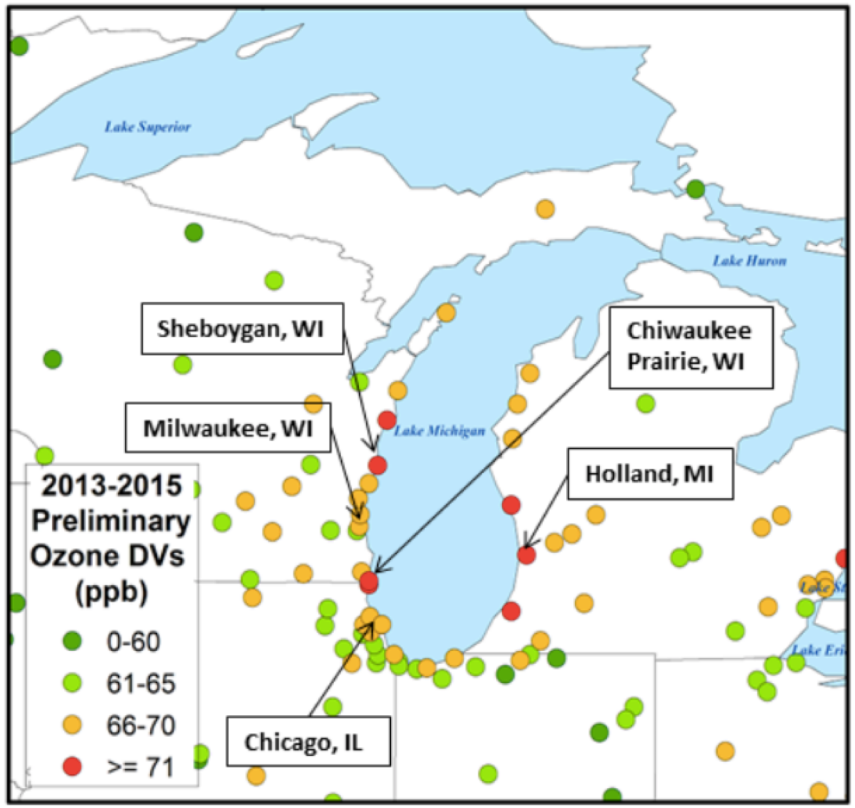
Ground level ozone concentrations in the region have improved significantly since the mid-90s.

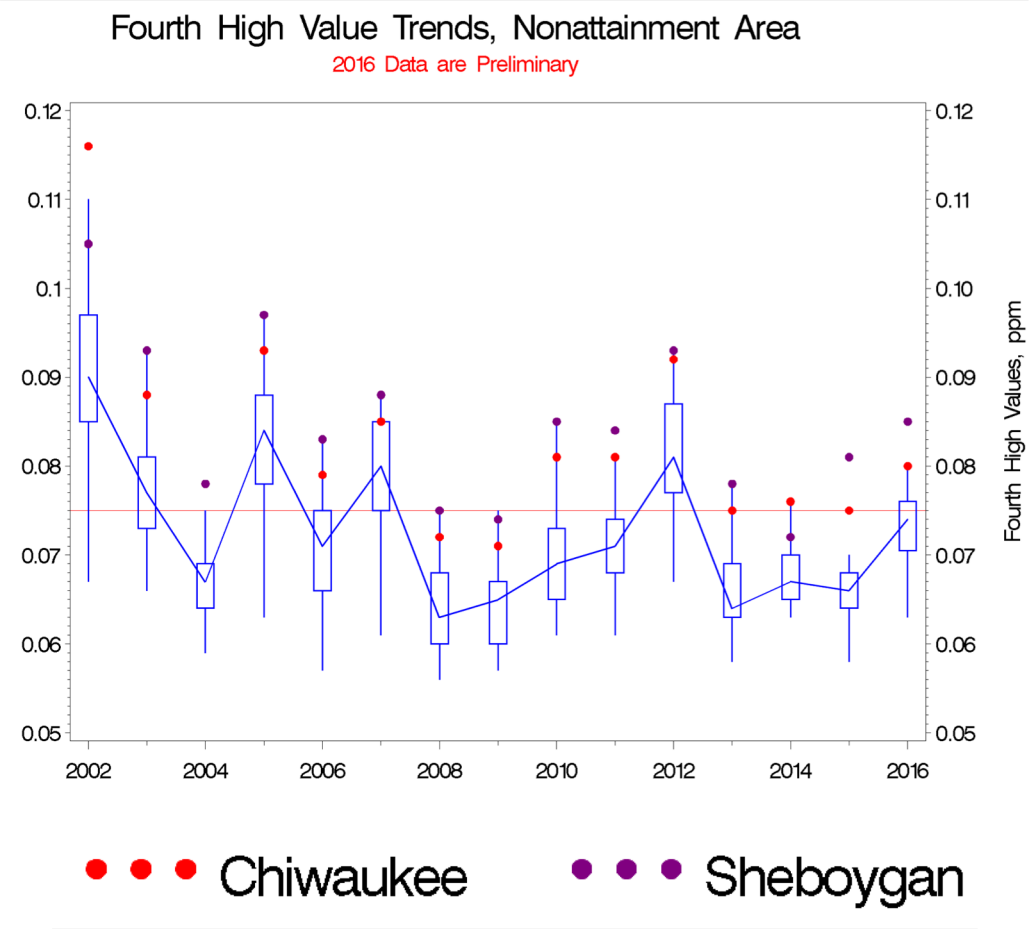
Background on LMOS



Design value plotted by end year of 3—year period. 2008 data are preliminary.

Persistent High O_3 at Coastal Sites





Legend set to 2015 O_3 NAAQS

We Know…

- NO_x + VOCS + sunlight → O_3

Credit: T. Holloway, U. Wisconsin

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- NO_x + VOCS + sunlight → O_3

But not the ratio of NOx to VOCs across the region → key to policy design

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- NO_x + VOCS + sunlight → O_3
- Ozone precursors from IL, IN, MI, WI (& more!) "cook up" over Lake Michigan

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- NO_x + VOCS + sunlight → O_3
- Ozone precursors from IL, IN, MI, WI (& more!) "cook up" over Lake Michigan

But we don't know how much is attributable to each state under changing conditions

Credit: T. Holloway, U. Wisconsin

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- Ozone values at the monitors

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- NO_x + VOCS + sunlight → O_3
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But not over water bodies, or away from the monitors on land

Credit: T. Holloway, U. Wisconsin

We Know…

- NO_x + VOCS + sunlight → O_3
- Ozone precursors from IL, IN, MI, WI (& more!) "cook up" over Lake Michigan
- Ozone values at the monitors
- What the models tell us about lake breeze & chemistry

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- Ozone precursors from IL, IN, MI, WI (& more!) "cook up" over Lake Michigan
- Ozone values at the monitors
- What the models tell us about lake breeze & chemistry

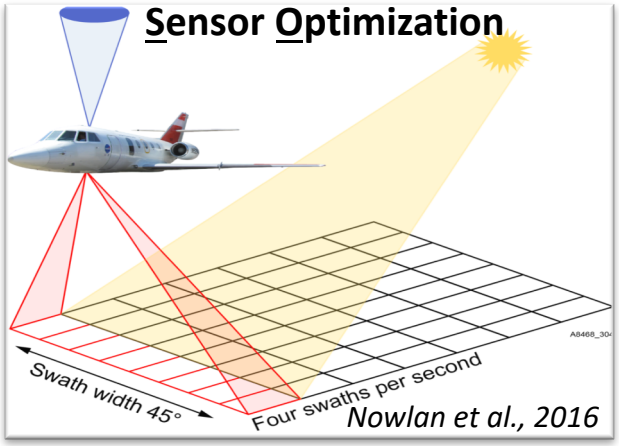
But the models may not resolve, include, or correctly capture key processes

Credit: T. Holloway, U. Wisconsin

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

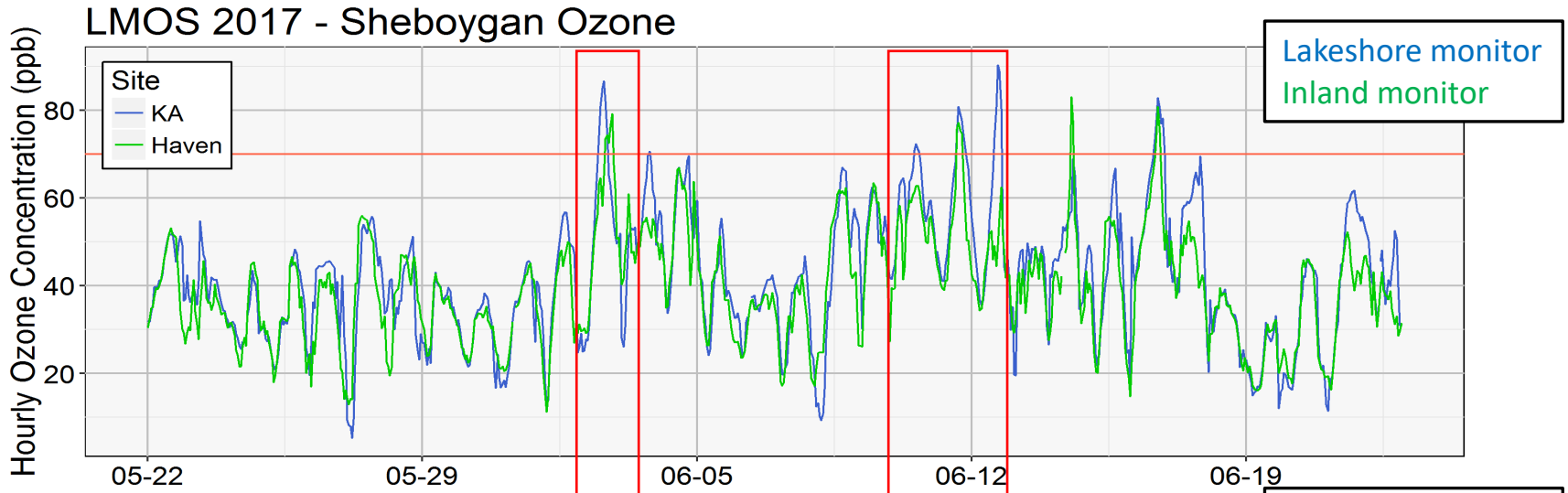


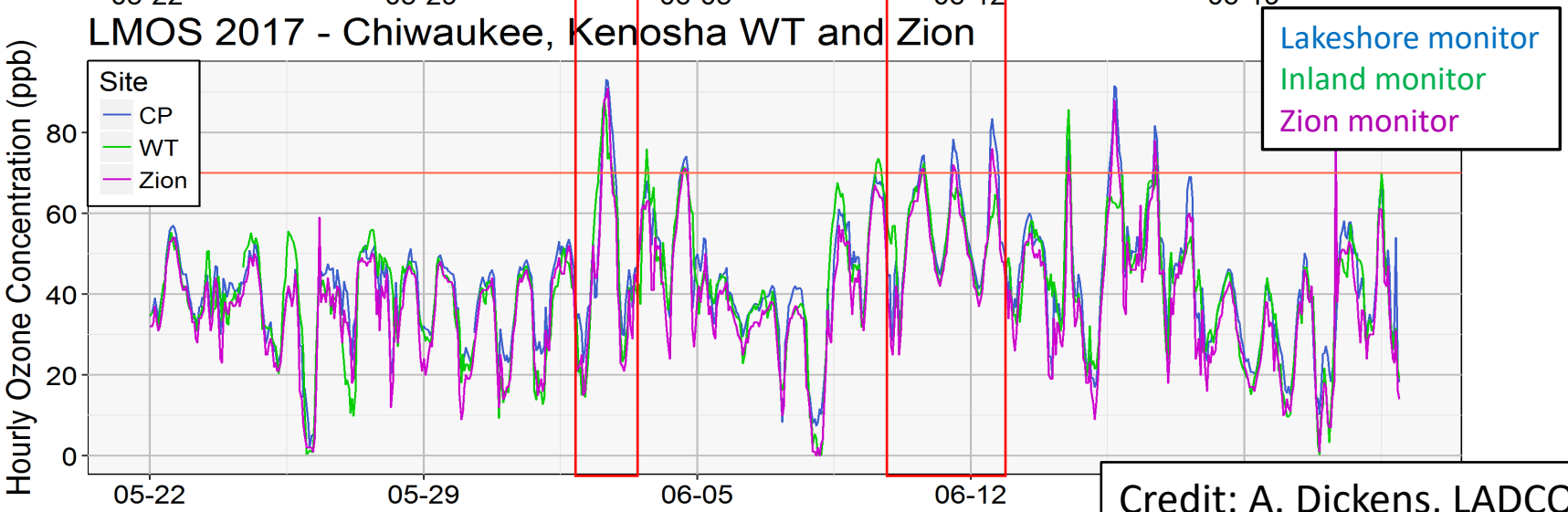
Nowlan et al., 2016

LMOS Objectives

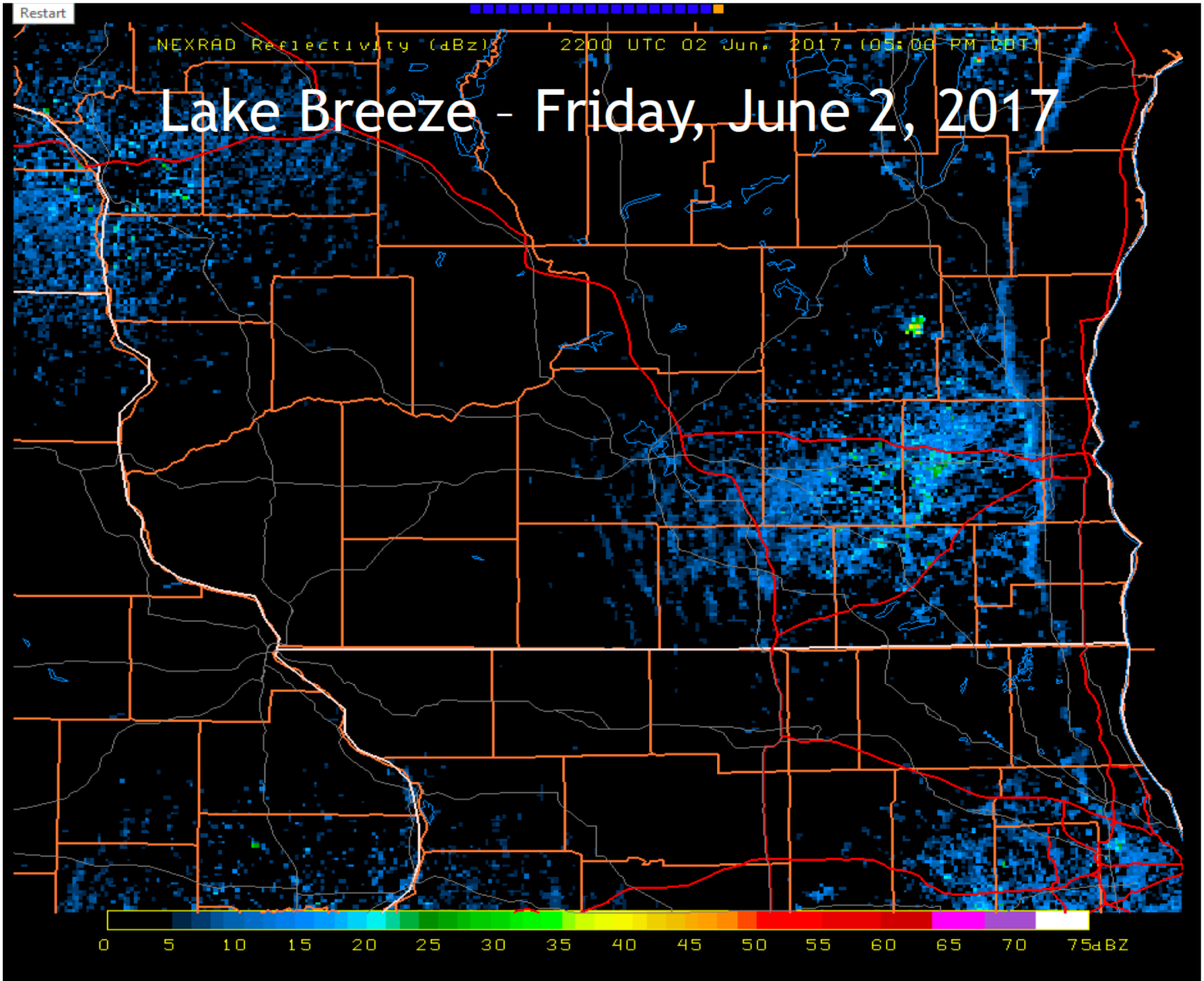
- Measure the concentrations of O_3-relevant compounds
- Quantify the relative contribution of inter- and intra-state NO_x and VOC emissions and emissions sources on O_3 production rates along Lake Michigan
- Evaluate and improve meteorological and chemical transport model skill
- Study link between lake breeze circulations and O_3
- Analyze the causes of concentration differences between coastal and inland sites with observations and model data
- Develop best practices for O_3 planning modeling

1st Law of Measurement Campaigns?

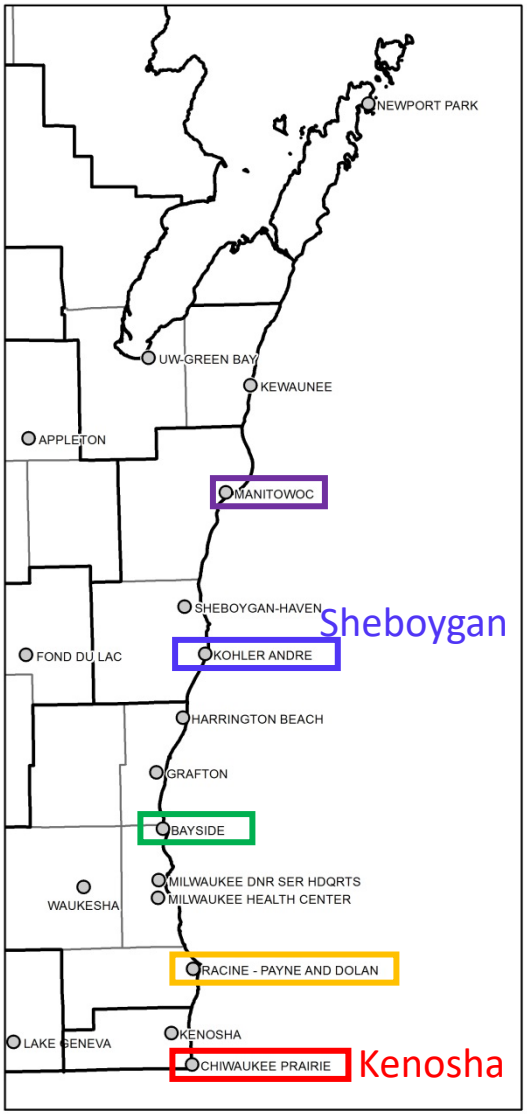


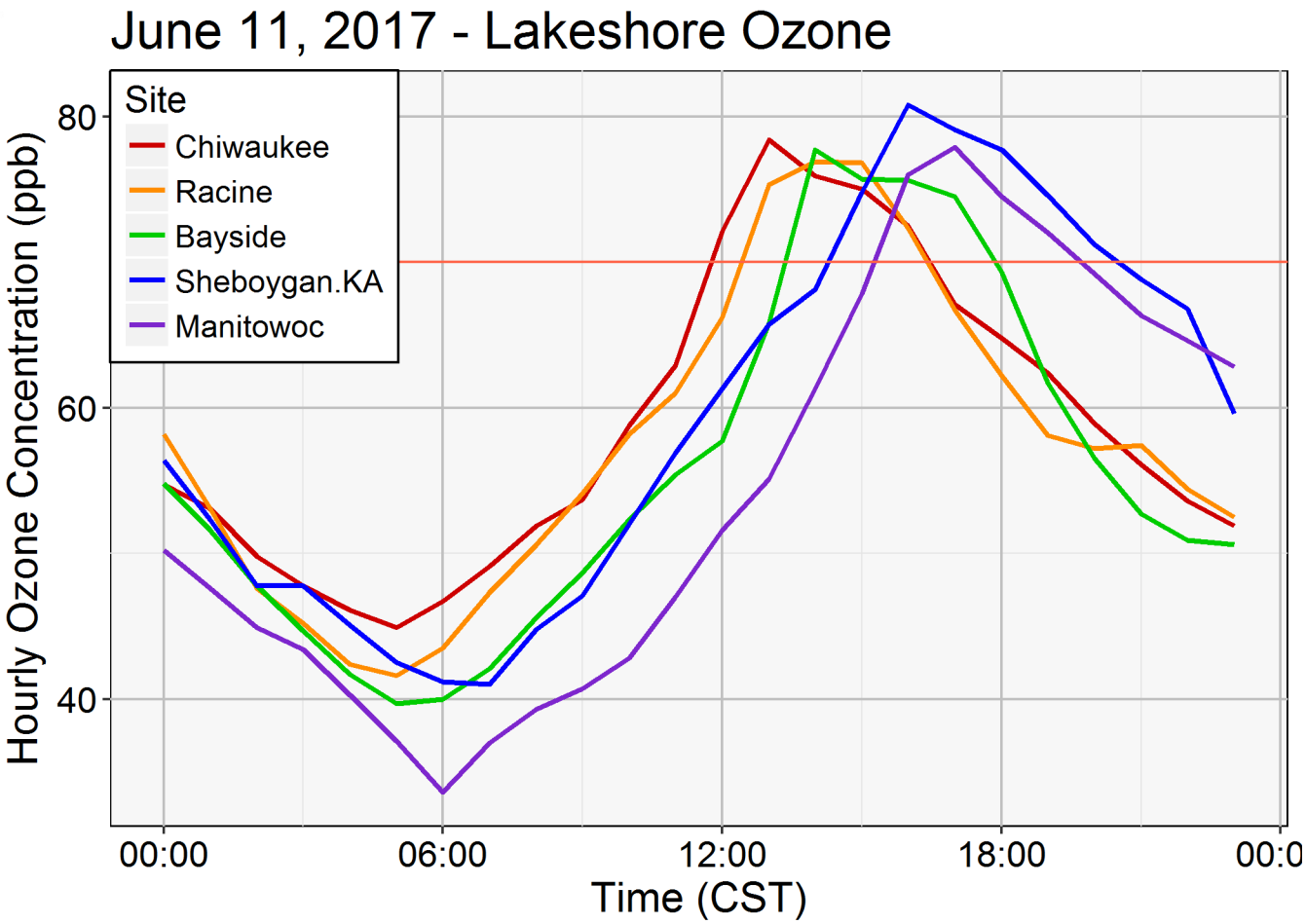


Credit: A. Dickens, LADCO


Restart
NEXRAD Reflectivity (dBz)
2200 UTC 02 Jun 2017 (05:00 PM CDT)
Lake Breeze – Friday, June 2, 2017
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75dBZ

Typical Regional Ozone Event



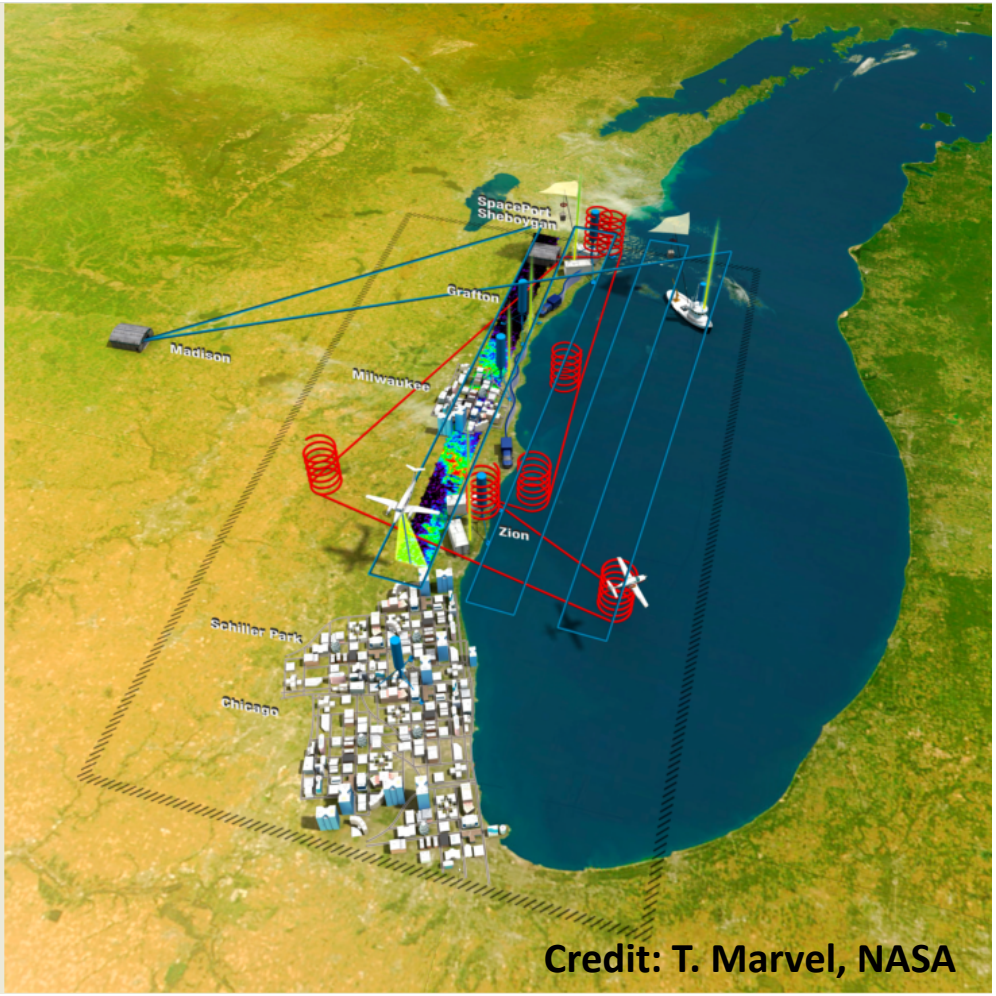


- Ozone peaks first at southern monitors
- Ozone plume moves northward

Credit: A. Dickens, LADCO

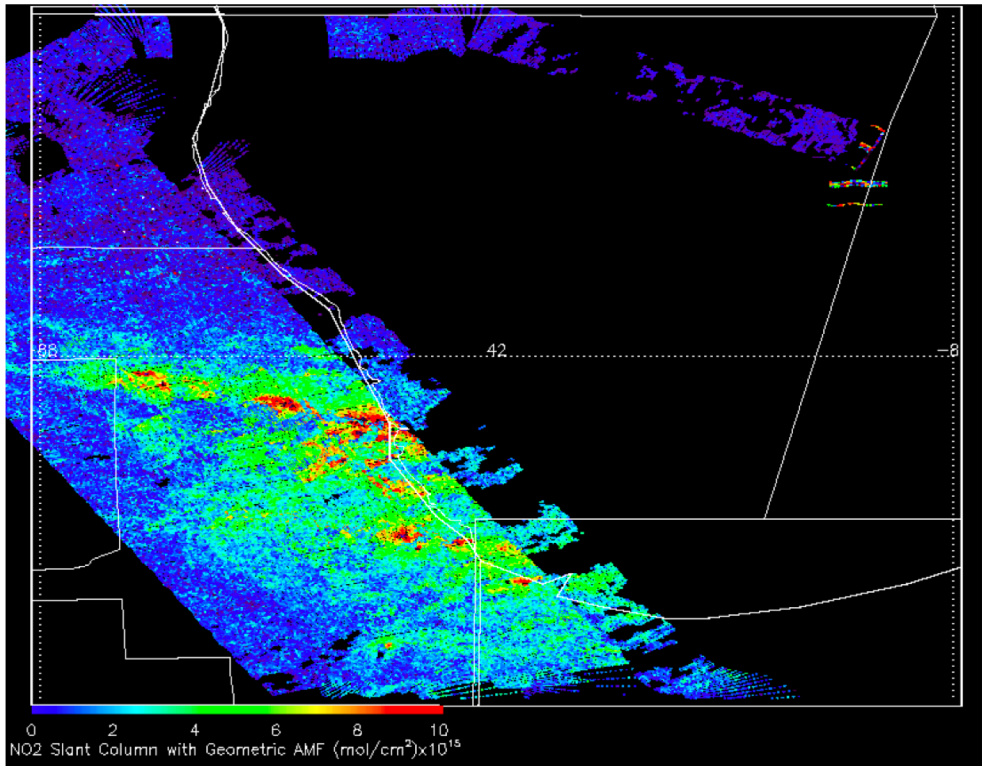
LMOS Study Design

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

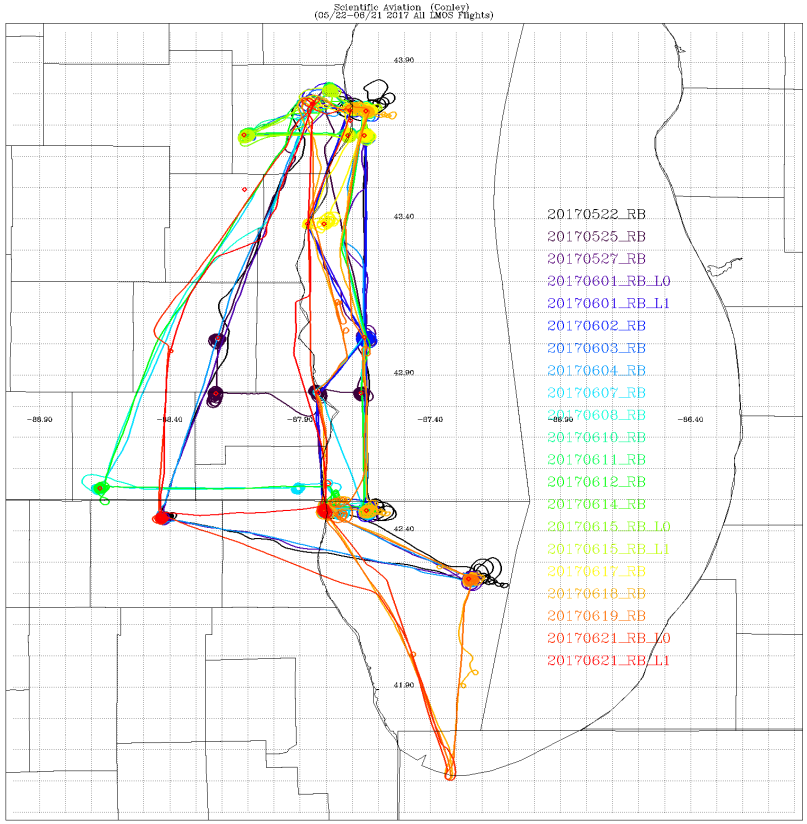


Credit: T. Marvel, NASA

LMOS Airborne Platforms



NASA GeoTASO
NO2 Column Mapping Over Chicago
June 19, 2017



Scientific Aviation Measurement
Flight Paths

Next Steps

- Internal synthesis report detailing the measurements, modeling, and data collected during LMOS (early 2018)
- Meteorology & photochemical modeling best practices for modeling ozone in the region (early 2018)
- Explore a long-list of scientific questions with LMOS data (2018 and beyond)
- Synthesis paper in the peer-reviewed literature (summer 2018)
- Merge datasets for public release (fall/winter 2018)
- Technical papers in the peer-reviewed literature (2019)

LMOS Investigators

- M. Christiansen, C. Stanier, G. Carmichael, E. Stone (University of Iowa)
- T. Bertram (University of Wisconsin)
- D. Millet (University of Minnesota)
- P. Cleary (University of Wisconsin - Eau Claire)
- A. Czarnetzki (University of Northern Iowa)
- B. Pierce (NOAA/NESDIS)
- J. Szykman, R. Long, M. Fuoco (U.S. Environmental Protection Agency)
- A. Dickens, (Wisconsin Dept. of Natural Resources)
- R. Kaleel, D. Kenski (LADCO)
- J. Al-Saadi, L. Judd (NASA Langley Research Center)
- S. Janz, M. Kowalewski (NASA Goddard Space Flight Center)
- S. Conley (Scientific Aviation, Inc)
- N. Abuhassan (GSFC/UMBC)
- S. Shaw (Electric Power Research Institute)

LMOS Funding

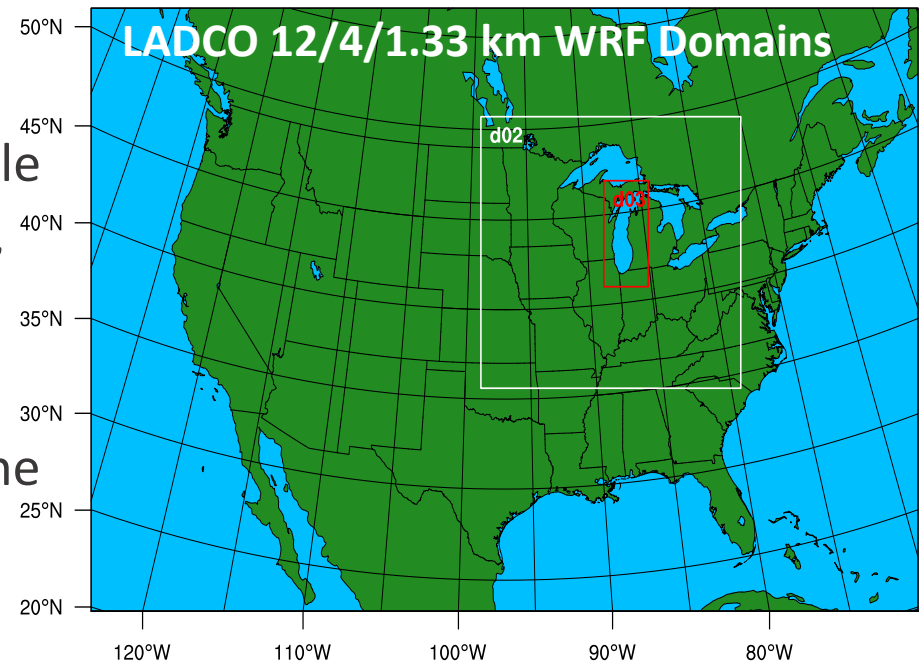
- NSF AGS-1712909, NSF 1712828, NSF 1713001
- NOAA/NESDIS GOES-R Program Office
- Electric Power Research Institute (EPRI)
- Lake Michigan Air Directors Consortium (LADCO)
- Significant personnel and equipment contributions from USEPA, NASA, EPA Region V, and LADCO member states

Regulatory Issues @ LADCO

- 2015 O_3 NAAQS
  - Final designations in April
  - Likely marginal status for all violating LADCO monitors
  - iSIPs (including ”Good Neighbor” SIPs) due October 2018
  - Marginal NAA SIPs due October 2019
  - Attainment demonstration (SIP) not required for marginal
- 2008 O_3 NAAQS
  - Chicago bump up from moderate to serious status this summer
- Regional Haze
  - Round 2 SIPs due June 2021

Technical Analyses @ LADCO

- Regional Photochemical Modeling
  - 2023 CAMx Source Apportionment for 2015 O3 NAAQS Transport
  - 2016 WRF/CAMx/CMAQ modeling for O3 and Regional Haze
- Emissions Modeling
  - Inventory Collaborative
  - Analysis/improvement of mobile sources: onroad, offroad, rail, marine
- Meteorology Modeling
  - WRF optimization for high ozone conditions



Questions and Contact

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