LADCO Winter 2018 Update

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

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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?

US EPA Transport Modeling: Annual EGU SO2 Emissions

- Illinois
- Indiana
- Michigan
- Minnesota
- Ohio
- Wisconsin

- 2011en
- 2016fc
- 2023el
- CSAPR Group2 Budget
- CSAPR Assurance Level

Lake Michigan Air Directors Consortium • 9501 West Devon Avenue, Suite 701 Rosemont, IL 60018
How Have Energy Sector Changes Impacted LADCO Class I Areas?

US EPA Transport Modeling: O3 Season EGU NOx Emissions

- 2011en
- 2016fc
- CSAPR Group2 Budget
- 2023el
- CSAPR Assurance Level
How Have Energy Sector Changes Impacted LADCO Class I Areas?

- 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$_4$
How Have Energy Sector Changes Impacted LADCO Class I Areas?

• Seney (MI) shows improvement in Most Impaired Days metric, starting around 2008
• 2011 to 2016 trend follows emissions
• Driven by SO₄
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

O₃ Design value = 3 year average of annual 4th highest daily maximum 8-hour average O₃
O₃ Design value = 3 year average of annual 4th highest daily maximum 8-hour average O₃

Chiwaukee Prairie
DV = 78 ppb
2017 4th Highest = 79 ppb
Lake Michigan Ozone Study

May – June 2017
Western Shore of Lake Michigan
Background on LMOS

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

Design Value Trends, LADCO States

Design value plotted by end year of 3-year period. 2006 data are preliminary.
Persistent High $\text{O}_3$ at Coastal Sites

Legend set to 2015 $\text{O}_3$ NAAQS
We Know…

• $\text{NO}_x + \text{VOCS} + \text{sunlight} \rightarrow \text{O}_3$

Credit: T. Holloway, U. Wisconsin
We Know…

• \( \text{NO}_x + \text{VOCS} + \text{sunlight} \rightarrow \text{O}_3 \)

But not the ratio of NOx to VOCs across the region \( \rightarrow \) key to policy design

Credit: T. Holloway, U. Wisconsin
We Know…

• $\text{NO}_x + \text{VOCS} + \text{sunlight} \rightarrow \text{O}_3$
• Ozone precursors from IL, IN, MI, WI (& more!) “cook up” over Lake Michigan

Credit: T. Holloway, U. Wisconsin
We Know…

• $\text{NO}_x + \text{VOCs} + \text{sunlight} \rightarrow \text{O}_3$

• 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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But not over water bodies, or away from the monitors on land

Credit: T. Holloway, U. Wisconsin
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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

Credit: T. Holloway, U. Wisconsin
We Know…

- $\text{NO}_x + \text{VOCS} + \text{sunlight} \rightarrow \text{O}_3$
- 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

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

Credit: T. Holloway, U. Wisconsin
Motivations for LMOS

- Persistent high O\textsubscript{3} at some coastal sites
- Planning needs of the LADCO states require further clarity on regional O\textsubscript{3} production
- Last field campaign: summer 1991
- Need for a new study: New instruments/satellites and scarce aloft and over-lake observations

Nowlan et al., 2016

Geo
stationary Trace gas and Aerosol Sensor Optimization

Zion, IL
LMOS Objectives

• Measure the concentrations of O₃-relevant compounds
• Quantify the relative contribution of inter- and intra-state NOₓ and VOC emissions and emissions sources on O₃ production rates along Lake Michigan
• Evaluate and improve meteorological and chemical transport model skill
• Study link between lake breeze circulations and O₃
• Analyze the causes of concentration differences between coastal and inland sites with observations and model data
• Develop best practices for O₃ planning modeling
1st Law of Measurement Campaigns?

LMOS 2017 - Sheboygan Ozone

LMOS 2017 - Chiwaukee, Kenosha WT and Zion

Credit: A. Dickens, LADCO
Lake Breeze - Friday, June 2, 2017
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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