LADCO Winter 2018 Update

Zac Adelman
LADCO Executive Director

Presented to the Three Rivers Manufacturers Association

March 21, 2018
MJOs in 2018

WRAP Includes
AK & HI
• 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

SO2 Emissions (tons/year)

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

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

- Illinois
- Indiana
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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 $SO_4$
Recent PM$_{2.5}$ Design Values

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

Legend set to 2016 PM$_{2.5}$ NAAQS
Recent Ozone Design Values

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

Legend set to 2015 O₃ NAAQS
Recent Ozone Design Values

O$_3$ Design value = 3 year average of annual 4$^{th}$ highest daily maximum 8-hour average O$_3$

Chiwaukee Prairie
DV = 78 ppb
2017 4$^{th}$ Highest = 79 ppb

Legend set to 2015 O$_3$ NAAQS
Lake Michigan Ozone Study

May – June 2017
Western Shore of Lake Michigan
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. 2008 data are preliminary.
Persistent High $O_3$ at Coastal Sites

Legend set to 2015 $O_3$ NAAQS

Fourth High Value Trends, Nonattainment Area

2016 Data are Preliminary
We Know…

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

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

• $\text{NO}_x + \text{VOCS} + \text{sunlight} \rightarrow O_3$

But not the ratio of NOx to VOCs across the region → 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

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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
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

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

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

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

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 $O_3$ 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

Nowlan et al., 2016

Geostationary Trace gas and Aerosol Sensor Optimization

Zion, IL
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
1\textsuperscript{st} Law of Measurement Campaigns?

**LMOS 2017 - Sheboygan Ozone**

<table>
<thead>
<tr>
<th>Site</th>
<th>KA</th>
<th>Haven</th>
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**LMOS 2017 - Chiwaukee, Kenosha WT and Zion**

<table>
<thead>
<tr>
<th>Site</th>
<th>CP</th>
<th>WT</th>
<th>Zion</th>
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<tbody>
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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
NASAgEO-TASO
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
National Inventory Collaborative

• A new multi-purpose emissions modeling platform (EMP) based on the 2014 National Emissions Inventory version 2 (2014NEIv2) is needed
  • State Implementation Plans, federal analyses

• Regional organizations and states asked to be more involved in the development of national EMPs
  • Need for broader input into the methods used, especially for “projections” of emissions to future years

• For the first time, EPA, states, and MJOs are engaging in collaborative EMP development
  • The 2016 base year was selected via a collaborative process
  • Process and timing are evolving
  • Participation in the EMP collaborative is voluntary
Organizational Structure

• **Coordination co-leads**: Zac Adelman (LADCO) and Alison Eyth (EPA OAQPS)
  - Developed process and communication structures, facilitate discussions, help resolve issues, documentation requirements, coordinate distribution of data to stakeholders

• **Coordination committee**: regional, state, EPA leaders
  - Define processes, resolve issues, co-lead workgroups
  - Includes overall and WG co-leads plus MJO directors

• **Sector-specific Workgroups**: one regional/state staff and one EPA staff (where possible)
  - Focus on preparing emissions estimates for 2016 and future years, plus improve how the emissions sectors are modeled
  - Include participants from EPA/states/locals/regions
## Workgroup Overview

<table>
<thead>
<tr>
<th>Workgroup</th>
<th>Co-leads</th>
<th>Members</th>
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<tbody>
<tr>
<td>Biogenics</td>
<td>Jeff Vukovich (OAQPS), Doug Boyer (TCEQ)</td>
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<tr>
<td>Fires</td>
<td>Jeff Vukovich (OAQPS), Tom Moore (WESTAR)</td>
<td>30+</td>
</tr>
<tr>
<td>Oil and gas (point+nonpoint)</td>
<td>Tom Moore (WESTAR), Jeff Vukovich</td>
<td>30+</td>
</tr>
<tr>
<td>Nonpoint (dust, RWC, ag, other)</td>
<td>Caroline Farkas (OAQPS), Chris Swab (OR)</td>
<td>30+</td>
</tr>
<tr>
<td>Non-EGU point (includes aircraft)</td>
<td>Caroline Farkas (OAQPS), Tammy Manning (NC)</td>
<td>30+</td>
</tr>
<tr>
<td>EGU$s$</td>
<td>Julie McDill (MARAMA), Serpil Kayin (OAP)</td>
<td>30+</td>
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<tr>
<td>Onroad</td>
<td>Julie McDill (MARAMA), Alison Eyth (OAQPS)</td>
<td>30+</td>
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<tr>
<td>Marine</td>
<td>Mark Janssen (LADCO), Michael Aldridge (OTAQ)</td>
<td>20+</td>
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<tr>
<td>Rail</td>
<td>Mark Janssen (LADCO), EPA OAQPS EIAG</td>
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<tr>
<td>Nonroad</td>
<td>Sarah Roberts (OTAQ), Joe Jakuta (OTC)</td>
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<tr>
<td>Meteorology</td>
<td>Chris Misenis (OAQPS)</td>
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<tr>
<td>International</td>
<td>Alison Eyth (email only)</td>
<td>10</td>
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• Several versions of 2016 platform will be developed
  • **Alpha**: preliminary version with 2014 NEIv2 scaled for most and 2016 emissions for some sectors for initial testing of 2016 model runs (March, 2018)
  • **Beta**: improved and/or new version of actual 2016 emissions for most sectors and preliminary projected emissions to 2023 and 2028 (Summer-Fall, 2018)
    • Exact timing of beta 2016 and projections is uncertain
  • **V1.0**: fully updated 2016 emissions and complete projected emissions for 2023 and 2028 (Winter, 2019)

• Schedule overlaps with 2017 NEI Development
  • Prioritize the 2017 NEI over the 2016 platform, as needed
  • Any missing data for 2016 will be filled in based on 2014 NEI data and nationally consistent methods
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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