Updates on Regional Air Quality Issues in the Great Lakes Region

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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 O₃ NAAQS
• Research and planning support activities @LADCO
Energy Sector Changes Impact on Midwest Air Quality

US EPA Transport Modeling: Annual EGU SO2 Emissions

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

SO2 Emissions (tons/year)

- 2011en
- 2016fc
- 2023en
- CSAPR Group 2 Budget
- 2023el
- CSAPR Assurance Level
Energy Sector Changes Impact on Midwest Air Quality

US EPA Transport Modeling: O3 Season EGU NOx Emissions

- Illinois
- Indiana
- Michigan
- Minnesota
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- Wisconsin

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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$_4$

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Recent PM$_{2.5}$ Design Values

Annual PM$_{2.5}$ DV
3 year average of annual mean PM$_{2.5}$
Recent Ozone Design Values

O₃ DV
3 year average of annual 4th highest daily maximum 8-hour average O₃
Ozone: 3-Year Design Value Trend

Long-running LADCO Monitors

Design value plotted by end year of 3-year period.
Lake Michigan Ozone Study

May – June 2017
Western Shore of Lake Michigan
Motivations for LMOS

• Persistent high O₃ at some coastal sites
• Planning needs of the LADCO states require further clarity on regional O₃ production
• Last field campaign: summer 1991
• Need for a new study: New instruments/satellites and scarce aloft and over-lake observations

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Persistent High O₃ at Coastal Sites

Legend set to 2015 O₃ NAAQS
Typical Regional Ozone Event

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

Credit: A. Dickens, WI DNR
LMOS Study Design

- **Observations**
  - Aircraft
  - Ship
  - Mobile on-shore
  - Zion, IL Supersite
  - Sheboygan, WI Ground Site

- **Forecasts**
  - WI DNR
  - NOAA NESDIS
  - U. Iowa
  - NWS
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 Flights during LMOS provided vertical profiles of O$_3$, NO$_2$, CO$_2$, CH$_4$, altitude, T, RH, winds, and pressure.
Weekday/weekend NO₂ column differences in Chicago as seen by GeoTASO

Credit: L. Judd, NASA/LaRC
Preliminary analysis indicates that the regional air quality models estimate too much NOx.
Preliminary LMOS Results

• Significant O₃ 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 O₃ formation occurring in a shallow layer near the Lake Michigan surface.
• An experimental network of lower cost O₃ 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 O₃ 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 O₃ exceedance events

• Meteorological and photochemical model skill in forecasting these events needs improvement.
  • Models of the LMOS period underestimated peak O₃ concentrations and overestimated NO₂ 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 O₃
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\textsubscript{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\textsubscript{3} NAAQS**
  - Chicago and Sheboygan reclassification from moderate to serious status in January 2019

• **Regional Haze**
  - Round 2 SIPs due July 2021
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 forecast 4 monitors in the Northeast to be nonattainment of the 2015 O₃ NAAQS by 2023.
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 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

• Exceptional Events
  • Studying smoke impacts on air quality in the region
Questions and Contact

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