LADCO | LAKE MICHIGAN AIR DIRECTORS CONSORTIUM

REQUEST FOR PROPOSAL

Observation-Based Analyses of the Sensitivity of Ozone Formation in the Lake Michigan Region to NO_x and VOC Emissions

The Lake Michigan Air Directors Consortium (LADCO) is seeking contractor assistance to determine the sensitivity of ozone formation in Chicago and along Wisconsin's Lake Michigan shoreline to changes in NO_x and VOC concentrations.

Proposals must be received no later than 5 p.m. Central on December 13, 2019. An electronic PDF copy of the proposal is required and should be sent to:

Zac Adelman
Executive Director
Lake Michigan Air Directors Consortium
adelman@ladco.org

No late proposals will be accepted, and the offer shall remain effective for a period of 60 days from the date of the mailing.

Your response to this Request for Proposal (RFP) should include a complete technical proposal that describes your approach for accomplishing the activities outlined below in the Scope of Work. The technical proposal should include a draft work plan that clearly describes your technical activities, schedule, and deliverables. The technical proposal should include a summary of your capabilities and your experience in the field of work. Include a complete cost proposal with a detailed breakdown of projected expenditures by task, including person hours and other direct charges. LADCO does not anticipate there being any travel expenses for this project.

Please limit the proposal to 15 pages (single spaced, 12-point font).

In addition, your response should include an appendix with supplemental information, such as references, resumes, and descriptions of recent relevant work. The supplemental information has no page limit.

All contracts will be issued by LADCO and managed by LADCO's Executive Director. It is anticipated that LADCO will award a fixed price contract as a result of this solicitation. LADCO may consider awarding another type of contract, provided that its use is consistent with the objectives and interests of the Consortium.

Funds available for this contract are federal funds from the U.S. Environmental Protection Agency (EPA) and contractors must meet requirements associated with the use of federal funds (2CFR 200).

All information and data produced and delivered under this contract will be in the public domain. While LADCO does not anticipate restricting the publication or presentation of results obtained from this study, LADCO reserves the right to review all presentations and manuscripts derived from this study.

LADCO will make positive efforts to utilize small, minority business enterprises (MBE), women's business enterprises (WBE), and disadvantaged business enterprises (DBE), whenever possible.

Details of the LADCO procurement process, including draft contract terms, are available in the LADCO Procurement Policy Manual.

All inquiries regarding this RFP should be directed to Zac Adelman (adelman@ladco.org) no later than 5 p.m. Central on December 2, 2019. LADCO will post responses to all received inquiries to the LADCO website RFPs page by December 6, 2019.

We expect to award the project and enter a contract with the winning bidder by January 17, 2020.

If your organization would like to be included on the interested bidders list for this and subsequent work, then please send an email to the LADCO Executive Director with your email address and contact information.

Scope of Work

Introduction

Ozone concentrations at monitors around Lake Michigan have consistently violated ozone National Ambient Air Quality Standards (NAAQS) over the last 40 years. The monitors with the highest ozone concentrations are generally located tens to hundreds of miles downwind of major emissions source regions, indicating that long-range transport of emissions contributes to the elevated ozone levels. Emissions of the ozone precursors, nitrogen oxides (NO_x) and volatile organic compounds (VOC), have decreased since the 1990s, with emissions of anthropogenic sources of both precursors being cut in half from 2002 to 2014 alone. While these reductions have helped to decrease monitored ozone concentrations, ozone concentration reductions

have lagged reductions in ozone precursor emissions. As a result, areas around Lake Michigan have been designated as nonattainment for multiple ozone standards.

Wisconsin currently has Lake Michigan lakeshore areas designated nonattainment for both the 2008 and the 2015 ozone NAAQS. These nonattainment area designations require the state to develop plans for how to bring the areas into attainment. These attainment plans should include an evaluation of different control strategies for NO_x and VOC emissions. As such, it is important for the state to understand the factors driving ozone formation in this region. Ozone is formed through complex, nonlinear reactions of NO_x with VOC in the presence of sunlight. Under certain conditions, ozone formation may be limited by emissions of NO_x; under these conditions, reductions in VOC emissions would have no impact on ozone formation. Under other conditions, ozone formation may be limited by emissions of VOCs; under these conditions, reductions in NO_x emissions may actually increase ozone formation. In order to develop effective ozone control strategies, it is crucial to better understand whether ozone formation is sensitive to NOx or VOC emissions (denoted as ozone-NO_x-VOC sensitivity).

A number of ground-based monitors around Lake Michigan have collected decades-long records of ozone, NO_x, reactive nitrogen (NO_y), carbonyl VOC and hydrocarbon VOC concentrations.[1] These records extend back to when ozone precursor emissions were much higher than they are today, leading to higher rates of ozone formation. Researchers have developed methods to use these monitored concentrations to infer the sensitivity of ozone formation to NO_x and VOC emissions.[2] The use of molecular ratios has proven particularly effective at probing ozone-NO_x-VOC sensitivity.

The Wisconsin Department of Natural Resources (WDNR) is currently conducting an initial study into the ozone-NOx-VOC sensitivity in the Lake Michigan region based on ozone NAAQS exceedence probability and monitored concentrations of NO_2, using the approach presented in Pusede and Cohen (2012)[3]. WDNR will share the results of this work with the contractor as it develops. In addition, other research focused on determining the ozone-NOx-VOC sensitivity during the 2017 Lake Michigan Ozone Study (LMOS 2017).[4] For example, a study by Vermeuel et

[1] LADCO_NOx-VOC-Met_Data-Table_Nov2019.xlsx.

[2] E.g., Observation-based methods (OBMs) for analyzing urban/regional ozone production and ozone-NOx-VOC sensitivity, website by Dr. Sanford Sillman, http://www-personal.umich.edu/~sillman/obm.htm, or Sillman (1999) The relation between ozone, NOx and hydrocarbons in urban and polluted rural environments, *Atmospheric Environment* **33**, 1821-1845.

[3] Pusede and Cohen (2012) On the observed response of ozone to NOx and VOC reactivity reductions in San Joaquin Valley California 1995-present. *Atmos. Chem. Phys.* **12**, 8323-8339.

[4] LMOS 2017 was a collaborative, multi-agency field study of ozone chemistry and meteorology along the Wisconsin-Illinois Lake Michigan shoreline using a combination of aircraft, ground-based and ship-based measurements. See https://www-air.larc.nasa.gov/missions/lmos/ for more information and LMOS 2017 data.

al. (submitted)[5] used the indicator ratio H_2O_2/HNO_3 to determine that ozone formation in the Chicago plume on one high-ozone day was primarily VOC-limited but became more NOx-limited as the plume traveled over the lake. The contractor should compare their results with the results of these studies, as available, and consider these results in their conclusions.

Objectives

The objective of this work is to determine the sensitivity of ozone formation in Chicago and along Wisconsin's Lake Michigan shoreline to changes in NO_x and VOC concentrations. The principal focus should be on current ozone-NO_x-VOC sensitivity along the western shore of Lake Michigan, including the spatial variability of such sensitivity within this region. The work should also describe how this sensitivity has changed over time within the region. This work should rely on already existing ground-based and remote sensing data sets, as well as complementary modeling analyses.

This work should be complementary to ongoing work by LADCO, WDNR, and groups involved with LMOS 2017 to evaluate ozone-NO_x-VOC sensitivity in the region.

Nature of the Work Assignment

Under this work assignment, the contractor shall perform the following technical tasks, with the results of these tasks to be thoroughly discussed and interpreted in a project final report (Task 5). LADCO and WDNR will evaluate the technical and cost proposals for each individual task. We may contract for some or all of the tasks, based on the merits of the proposal and available funding. For the purposes of the proposal, the contractor shall provide separate statements of work and cost estimates for each task.

Task 1: Apply observation-based methods (OBMs) to ground-level monitoring data to determine ozone-NOx-VOC sensitivity.

The contractor shall provide an initial assessment of data quality for the ground-based NO_x and VOC data available, and subsequent analyses shall consider and discuss the quality of the data relied upon. The contractor shall then apply OBMs to monitoring data from the Wisconsin, Illinois and Indiana shoreline areas of Lake Michigan. These methods shall include the use of indicator ratios, such as O_3/NO_y, O_3/NO_z, $HCHO/NO_2$, reactivity-weighted VOC/NO_x and hydrocarbons/NO_x. The contractor may also apply any other methods of analyzing the ground-based monitoring data in order to determine the ozone-NO_x-VOC sensitivity in this region. The contractor shall evaluate the spatial variability in the ozone-NO_x-VOC sensitivity as well as how such sensitivities have changed over time in response to historical reductions in ozone

[5] Vermeuel et al. (submitted) Sensitivity of ozone production to NO_x and VOC along the Lake Michigan coastline. *J. Geophys. Res. Atmos.* (Also presented at the American Geophysical Union 2018 Fall Meeting: https://agu.confex.com/agu/fm18/meetingapp.cgi/Paper/426337 and https://www.ladco.org/wp-content/uploads/Documents/RFPs/WDNR_NOxVOC/AGU_2018v3_6.pdf)

precursor emissions. The contractor shall evaluate monitoring data beginning in the year 2000 and extending through the year 2018.

In interpreting their results, the contractor shall consider ozone-NO_x-VOC sensitivity results obtained by the Bertram group at University of Wisconsin as part of the LMOS 2017 campaign. The contractor shall also consider the results of WDNR's ozone sensitivity analysis project, when available. (These studies are described in the Background.)

The contractor shall identify to LADCO and WDNR the value and reliability of using indicator ratios for identifying VOC-sensitive, transition and NO_x-sensitive ozone formation regimes, along with a thorough discussion of the caveats to applying such indicator ratios. The contractor shall also discuss whether the threshold values for these indicator ratios have changed over time in this region.

Deliverables:

1. Draft memo describing the methodology for use of indicator ratios to determine ozone-NO_x-VOC sensitivity.
2. Final memo describing the methodology for use of indicator ratios to determine ozone-NO_x-VOC sensitivity.
3. Results from the OBMs should be thoroughly discussed in the project final report (Task 5).

Task 2: Use simple transport and/or chemical models to assist interpretation of OBM data to determine ozone-NO_x-VOC sensitivity

Simple models can aid in the interpretation of ozone-NO_x-VOC sensitivity. In particular, 0-d chemical models can be used to calculate the instantaneous rates of ozone production and to simulate anticipated observations under different types of ozone-NO_x-VOC sensitivities.
The contractor shall apply simple transport and/or chemical models to further interpret the OBM data. Such models could include trajectory box models that use emissions from inventories and incorporate photochemical mechanisms such as the Master Chemical Mechanism. Air path trajectories could be determined using models such as NOAA's Hybrid Single-Particle Lagrangian Trajectory (HYSPLIT) model. These models allow better exploration of the dominant chemical regimes and atmospheric circulation patterns that lead to the conditions observed at the ground-based monitoring sites. These models can also estimate ozone concentrations and formation chemistry in areas away from monitors, including during transport over Lake Michigan.

Deliverables:

1. Results from the transport and/or chemical models should be thoroughly discussed in the project final report (Task 5).

Task 3: Analyze satellite formaldehyde to NO_2 ratios and compare with ground-based ratios to better determine spatial variability in ozone-NO_x-VOC sensitivity.

Satellites such as the Ozone Monitoring Instrument (OMI) and TROPOspheric Monitoring Instrument (TROPOMI) provide daily measurements of column NO_2, formaldehyde and other pollutants around the globe. The satellite data are available for locations without ground-based monitors, and when linked with ground-based OBM data, could provide insight into the spatial variability of ozone-NO_x-VOC sensitivity along the western Lake Michigan shoreline.

The contractor shall apply satellite-derived column formaldehyde to NO_2 ratios to determining ozone-NO_x-VOC sensitivity along the Wisconsin-Illinois-Indiana Lake Michigan shoreline. The contractor shall use these satellite-based ratios in combination with ground-based data to best interpret the satellite data.

Deliverables:

1. Draft memo describing the methodology for use of satellite formaldehyde to NO_2 ratios, if useful.
2. Final memo describing the methodology for use of satellite formaldehyde to NO_2 ratios, if useful.
3. Results from the analysis of satellite data should be thoroughly discussed in the project final report (Task 5).

Task 4: Analyze data from the LMOS 2017 campaign to investigate the ozone-NOx-VOC sensitivity

This task builds directly from the work completed by the Bertram group at UW-Madison, as described in Task 1 and footnote 5. That work used the indicator ratio H_2O_2/HNO_3 and the Master Chemical Mechanism to determine the ozone-NO_x-VOC sensitivity on June 2nd, 2017, the highest ozone day of the field campaign. Work on this task shall apply a similar OBM approach to data collected during at least one other high-ozone day during LMOS 2017 to study the variability in ozone formation chemistry during the field study. Results from this task should be discussed in the context of results from the other tasks.

Deliverables:

1. Results from analysis of LMOS 2017 data should be thoroughly discussed in the project final report (Task 5).

Task 5: Workplan, check-ins and report to LADCO/WDNR

At the beginning of the project, the contractor shall develop a draft workplan describing the approach they plan to take to address Tasks 1 through 5, including a project timeline and schedule of deliverables. They shall share this workplan with LADCO and WDNR for comment.

The contractor shall produce a final workplan that addresses the comments from LADCO and WDNR.

During the project, the contractor shall have regularly (at least monthly) scheduled calls with LADCO and WDNR to discuss the progress of the work. The contractor shall take and circulate notes and action items from these calls with LADCO and WDNR.

At the end of the project, the contractor shall develop a draft final report to LADCO and WDNR that thoroughly discusses the work done, the results found, the conclusions drawn and recommendations for further research and analysis. The contractor shall provide a draft final report outline to LADCO and WDNR for comment. The contractor shall provide a final report outline based on the comments received from LADCO and WDNR. The report shall discuss the apparent sensitivity of ozone formation in different parts of the region to NOx and VOC emissions today and in the past. This report is the primary deliverable for this contact.
The report shall include a thorough discussion of the conclusions and implications of this project. The report shall also include discussion of alternative conclusions that could be drawn from the evidence. The report shall also suggest future types of monitoring data that could be collected in the region to help better define the ozone-NO_x-VOC sensitivity, as well as future analyses of existing data that could be conducted to address the same question.
The contractor shall share the draft final report with LADCO and WDNR for comment. The contractor shall produce a final report that addresses the comments received from LADCO and WDNR on the draft report.

Deliverables:

1. Draft workplan
2. Final workplan
3. Monthly conference calls, notes, and action items
4. Draft outline of report
5. Final outline of report
6. Draft report
7. Final report

Proposal Requirements

Proposals should include the following elements:

1. Project statement - summarize the project from the perspective of the bidder
2. Technical proposal - detail the approach by task used to accomplish the objectives and requirements of the project
3. Project Timeline - detail the schedule of deliverables by task
4. Cost proposal - description of the projected expenditures by task, including person hours and other direct charges
5. Bidder qualifications - description of the qualifications should include years of experience, number of staff, and a narrative highlighting the bidders capabilities
6. MBE/WBE statement - statement of whether the bidder is a registered minority or woman-owned business
7. Appendix - references, resumes, and descriptions of recent relevant work

Please limit proposal elements 1-6 to 15 pages; there is no page limit for element 7.

Level of Effort and Project Timeline

The project should be completed by September 30, 2020. Additional funding and time considered necessary to conduct a more complete analysis should be included as options to the primary work effort.

Evaluation Criteria

The following criteria will be used in evaluating the responses to this RFP. A review panel will score each of the five factors below from 1 (worst) to 5 (best). The proposal with the highest weighted score will be selected for funding.

1. Project statement: 10%
2. Technical proposal: 45%
3. Cost proposal: 20%
4. Bidder qualifications: 20%
5. MBE/WBE statement: 5%