Photochemical Modeling Analysis of

8-Hour Ozone for LaPorte County

Indiana Department of Environmental Management
Office of Air Quality

and

Lake Michigan Air Directors Consortium

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Introduction

The purpose of this photochemical modeling analysis is to review available modeling information to determine the ability of LaPorte County to achieve attainment in 2007 and to assess the impact of LaPorte County emissions on local monitors.

Given the time constraints and lack of availability of updated emissions inventories and meteorological files, limited new modeling and a review of older modeling was used to make this determination. For new modeling, a zero-out approach, or removal of all man-made emissions in LaPorte County, was determined to be the best way to show the impact of reductions of local emissions on LaPorte County and downwind ozone monitors. Additional modeling is available from the US EPA's "Technical Support Document for Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements: Air Quality Modeling Analyses", EPA-420-R-00-028, December 2000, and the LADCO White Paper, " 8-Hour Ozone Assessment", May 2, 2001.

These modeling results consistently demonstrate that LaPorte County is heavily influenced by transported pollutants, that local emissions reductions will do little to reduce local ozone concentrations, and county is o track to achieve attainment by 2007.

<u>Zero-out Modeling, 2004</u>

The purpose of this photochemical modeling analysis was to determine the impact of LaPorte County emissions on ozone monitors located in LaPorte County and downwind areas. Two modeling scenarios were run and ozone impacts at the two ozone monitoring sites in LaPorte County were analyzed. The results show that LaPorte County is largely influenced by regional transport of ozone and ozone precursors and local emission control strategies will not greatly reduce ozone concentrations within LaPorte County. Impac on downwind areas was shown by maps with ozone isopleths showing the differences between scenarios.

Photochemical Model and Model Inputs

Comprehensive Air Quality Model with Extensions

The photochemical model that was used for this analysis was the Comprehensive Air Quality Model with Extensions (CAMx4). CAMx4 is a one-atmosphere photochemical model that allows for 2-way nested grid with a 12-kilometer grid nested in a 36-kilometer grid. The purpose of a nested grid is to allow for better pollutant transport and re-circulation of air.

Grid Resolution and Modeling Domains

The photochemical modeling domain covers the eastern and central United States. The grid resolution used in the modeling consists of 36-kilometer grid cells with a 2-way nested grid consisting of 12-kilometer grid cells centered over the Midwest and Great Lakes region. CAMx is run vertically in the atmosphere at 16 layers with the top layer at approximately 15 kilometers above ground level.

Meteorological Inputs

Meteorological input data was processed using the Mesoscale Model (MM5) version 3.5. The meteorological data output from MM5 are translated by processing utility programs to be used by the photochemical model. The meteorological data that was used for this modeling analysis was taken from the June 15, 2002 through August 15th, 2002 period.

Emissions Inputs

All anthropogenic (man-made) emissions from point, area, mobile and biogenic (naturally occurring) sources that were used in the photochemical modeling were processed by the emission model EMS-2003. Point and area source emission inventories were obtained from U.S. EPA through the 1999 National Emissions Inventories (NEI). On-road mobile source inventories were estimated by MOBILE6 model while off-road mobile emissions were estimated by U.S. EPA's NONROAD 2002 model. Biogenic emissions were estimated with EMS-2003 using BEIS3.

Future year modeling runs are necessary to determine the impacts that national emission reductions and emission growth estimates will have on future attainment status of an area. In order to process emissions for future year runs, national emission reductions and emission growth estimates were used as well as U.S. EPA emission adjustment factors.

Initial and Boundary Conditions

Initial conditions are the background concentrations of pollutants and boundary conditions represent the incoming pollutant concentrations into the modeling domain. Boundary conditions and initial conditions for photochemical modeling were based on profiles from U.S. EPA with a June 2002 version of another photochemical model, Community Multiscale Air Quality modeling system (CMAQ).

Modeling Results

Model Execution

Modeling was conducted for days during 2002 where the observed 8-hour concentrations exceeded 85 parts per billion at the two LaPorte County ozone monitors in LaPorte and Michigan City or days leading up to ar 8-hour exceedance day. Two modeling scenarios were completed based on the 1999 emissions and projected 2007 emissions. The first scenario compared ozone concentrations based on modeling all 1999 emissions versus modeling 1999 emission minus LaPorte County man-made emissions. The second scenario compared resulting ozone concentrations based on modeling all 2007 emissions versus 2007 emissions minus LaPorte County man-made emissions. 2007 is the year LaPorte County would be required to attain the ozone standard if classified as "Marginal Non-attainment" if EPA grants a bump-down request.

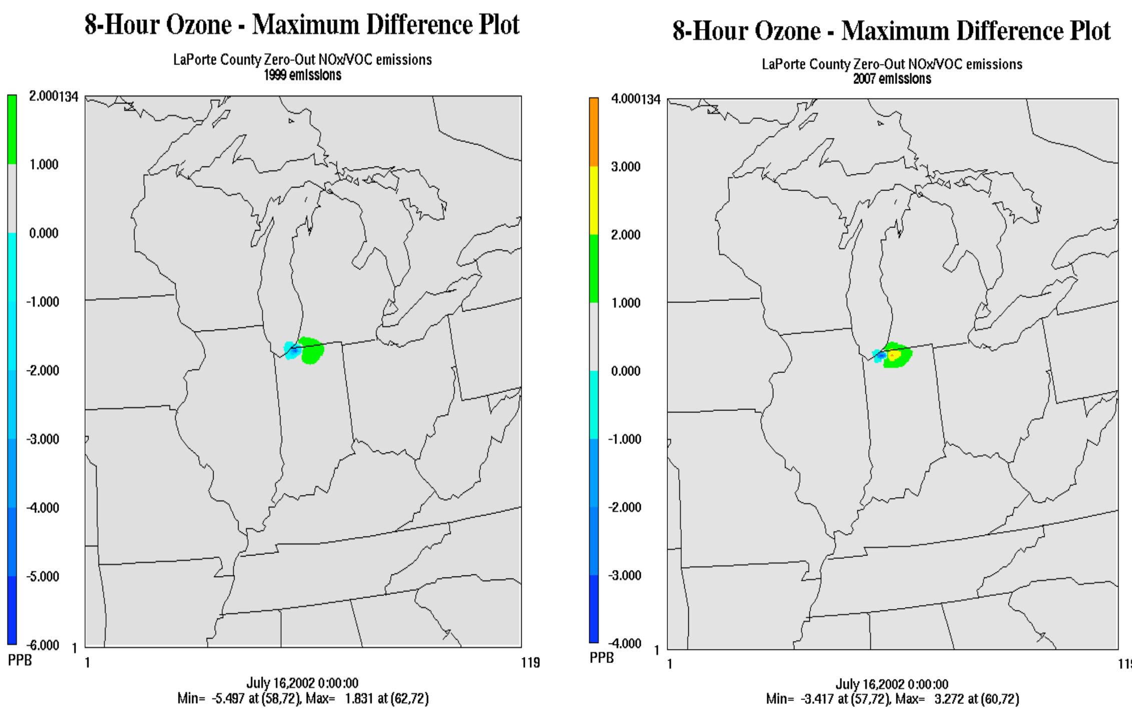
Model performance is not yet at an acceptable level to demonstrate attainment for State Implementation Planning purposes. However, relative reduction factors (RRF) or ratios of concentration from the modeling without LaPorte County emissions to the concentrations from the modeling with LaPorte County emissions can be used to determine future year design values for each monitor for bump-down modeling. This approacl is consistent with U.S. EPA's draft guidance for attainment demonstrations for National Ambient Air Quality Standards for 8-hour ozone where ratios of maximum predicted concentrations for future year emissions to the maximum predicted concentrations for current year emissions are used to determine future year design values for each monitor.

Modeling Results

Maximum modeled 8-hour ozone concentrations are lower than the observed maximum 8-hour ozone concentrations at the LaPorte and Michigan City monitors. By compiling the modeled results over all the episodes, calculating RRFs and then averaging, a trend can be determined for the scenario being modeled. The key features of the RRF are that the absolute accuracy of the model predictions is not as important and the RRF can be applied to the current ozone design value for an area to estimate the effect of the strategy. The relative reduction factors were calculated for each day for each monitoring site.

An example of the modeling is shown in Figure 1. Examining the modeled results does show reduced ozone concentrations at locations downwind, but since elimination of all man-made emissions is an unrealistic scenario, downwind impacts would be a small fraction of this amount, for example, in the case of 15% reductions. However, ozone concentrations locally are not reduced.

Figure 1
8-Hour Ozone Difference Plots for LaPorte County Zero-Out Modeling



Results of the modeling and RRF analysis are shown below in Figure 2 for Michigan City and LaPorte in Figure 3. Modeling was performed for 1999 emissions and 2007 projected emissions with and without LaPorte County emissions. The average RRFs are calculated to be very near 1.00, meaning that at these *local* sites, reducing all emissions has little impact.