Date: June 15, 2016

MEMORANDUM

To: Tom Moore, WESTAR-WRAP
From: Ralph Morris and Sue Kemball-Cook, Ramboll Environ
Zac Adelman, University of North Carolina
Subject: SNMOS CAMx Sensitivity Tests and Source Apportionment Simulation

---

BACKGROUND

Doña Ana County in Southern New Mexico experiences the highest observed ozone concentrations in the state. Two monitors in Doña Ana County have preliminary 2013-2015 Design Values that exceed 70 ppb, the October 2015 National Ambient Air Quality Standard (NAAQS) for ozone. The Southern New Mexico Ozone Study (SNMOS) is performing photochemical grid model (PGM) modeling for the year 2011 using the Comprehensive Air Quality Model with Extensions (CAMx) version 6.20. The study is leveraging the Western Air Quality Study (WAQS) 2011 PGM modeling platform that is available from the Intermountain West Data Warehouse (IWDW[1]). The SNMOS expanded the WAQS CAMx 2011 modeling platform through addition of a 4 km domain covering Doña Ana County and vicinity, conducting WRF meteorological and SMOKE emissions modeling, and performing a CAMx 2011 base case simulation and model performance evaluation. SNMOS also conducted a CAMx simulation using 2025 emissions estimates. The projected 2025 ozone Design Values for all monitors in Doña Ana County were below the 70 ppb ozone NAAQS. Details and deliverables from the SNMOS completed tasks are available on the project website[2].

Purpose

The next two tasks under the SNMOS are to conduct CAMx emission sensitivity tests (Task 11) and source apportionment (Task 12) simulations to better understand the source regions and source categories that contribute to elevated ozone concentrations in Doña Ana County and vicinity. These simulations will help set the ground work for the development of a potential State Implementation Plan (SIP) to demonstrate attainment of the ozone NAAQS. This document discusses proposed sensitivity tests and source apportionment configuration for the SNMOS.

---

[1] http://views.cira.colostate.edu/tsdw/
[2] http://www.wrapair2.org/SNMOS.aspx

PROPOSED SENSITIVITY TESTS AND SOURCE APPORTIONMENT CONFIGURATION

The SNMOS CAMx sensitivity tests and source apportionment simulations will be conducted on the 12/4 km SNMOS modeling domains. Figure 1 displays the SNMOS 12/4 km modelling domains along with the major NO_X emissions point sources in operation in 2011. The 4 km domain includes Doña Ana County and nearby counties in New Mexico, El Paso and other counties in far western Texas, and Ciudad Juarez and nearby areas in Mexico. The 12 km domain includes all of New Mexico, west Texas, northern Mexico, eastern Arizona and small portions of other states. The CAMx 12/4 km domains are run using two-way grid nesting with boundary conditions (BCs) around the 12 km domain define by processing output from a CAMx 36/12 km CONUS/WESTUS domain simulation.

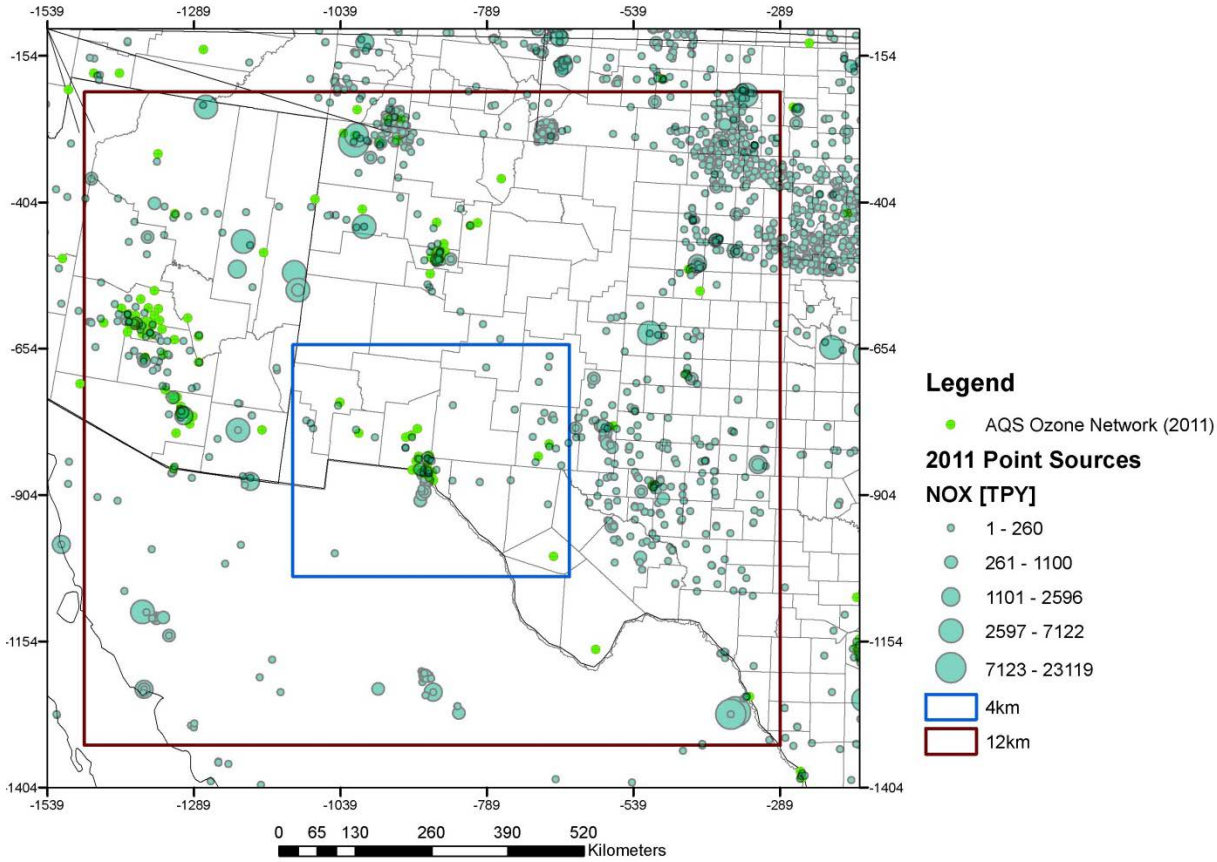

Figure 1. SNMOS 12/4 km modeling domains used in the CAMx 2011 and 2025 modeling.

Sensitivity and Source Apportionment Constraints

The CAMx sensitivity simulations will involve simple manipulation of pre-processed 2011 base case and/or 2025 future year CAMx-ready emission inputs within the CAMx 12/4 km domain. The SMOKE emissions processing is broken down by inventory sectors (e.g., on-road mobile, non-road mobile, oil and gas, EGU point, non-EGU point, biogenic, fires, etc.) that are merged together to make the final CAMx-ready point source and low-level (surface) gridded emission inputs. For the sensitivity simulations, we will adjust the emissions by a pollutant-specific scalar for an individual inventory sector and merge the adjusted emissions with the other emission sectors to make CAMx-ready 2011 or 2025 emission sensitivity inputs. Example sensitivity tests may include a 20% increase in U.S. on-road mobile source NOx emissions or a zero-out (i.e. 100% decrease) of all VOC emissions in Mexico. Emissions sensitivity simulations may be designed to target specific pollutants, inventory sectors, and source regions within the modeling domain. While sensitivity modeling is limited to adjusting only a single sector or source region at a time, source apportionment modeling supports identifying multiple source-receptor relationships in a single simulation.

For the SNMOS, CAMx source apportionment modeling will be used to provide an accounting of selected Source Groups that contribute to ozone concentrations at the Doña Ana monitoring sites and throughout the 12/4 km modeling domain. Source Groups are typically defined as the intersection between source regions (e.g., states) and source categories (e.g., on-road mobile sources). Because of computational requirements, the number of Source Groups should be limited to 20-30.

While sensitivity and source apportionment modeling can provide similar results, they each produce a unique perspective of the simulated air quality. A sensitivity test answers a "*what if*" question. For example, *what* would the 2011 ozone concentrations in Doña Ana County have been *if* there were no anthropogenic emissions in Mexico? We propose to explore this question in SNMOS Task 11 by conducting a 2011 zero-out Mexico anthropogenic emissions sensitivity test. We will compare the results of this test with the 2011 base case modeling, which included the effects of emissions from Mexico, to determine the impacts of Mexico's emissions on air quality in Doña Ana County. Source apportionment modelling, on the other hand, estimates the contribution of a Source Group for a given set of emission conditions. For example, under 2011 base case emissions conditions, what was the contribution of the emissions from sources located in Mexico. As the removal (zero-out) of Mexico emissions in the sensitivity simulation alters the chemistry of ozone formation in the CAMx model, the emissions sensitivity and source apportionment modeling will provide two different estimates of the contributions of Mexico emissions sources to ozone concentrations. Although the source apportionment simulation is more computationally intensive than the sensitivity modeling, it will provide much more information on the relationships between sources and receptors in the modeling domain. Where a sensitivity test estimates the ozone response for one set of conditions (one piece of information), a source apportionment simulation with 30 Source Groups estimates the contributions for 30 Source Groups (30 times the information).

The SNMOS budget includes up to four (4) sensitivity tests under Task 11 and one (1) source apportionment run with 20-30 Source Groups under Task 12. However, we see some advantages in performing source apportionment using the same Source Groups using both the 2011 and 2025

emissions so we believe under current resources we could instead perform three (3) sensitivity tests under Task 11 and two (2) source apportionment simulations under Task 12 provided the two source apportionment runs are configured in the same way and use the same post-processing approach.

Proposed Sensitivity and Source Apportionment Simulations

The source apportionment modeling provides a complete accounting of the contributions of all sources delineated by the defined Source Groups, whereas the sensitivity modeling provides information pertaining to one source type.

Source Apportionment Configuration

For the CAMx 12/4 source apportionment simulation we propose to define four Source Regions and 7 Source Categories as follows:

Source Regions (4):

- New Mexico
- Texas
- Mexico
- Arizona and remainder of other states in the 12 km domain

Source Categories (7):

- Natural (biogenics and lighting NOx)
- On-Road Mobile
- Non-Road Mobile
- Oil and Gas (point and non-point)
- Electrical Generating Unit (EGU) Point
- Non-EGU Point
- Open Land Fires (wildfire, prescribed, and agricultural burning)
- Remainder Anthropogenic.

Initial concentrations (IC) and boundary condition (BC) are always included as Source Groups, so there will be a total of 30 Source Groups (30 = 4 x 7 + 2) for the source apportionment modelling. We propose to perform the source apportionment simulation using both the 2011 and 2025 emissions so that:

- We can obtain the contributions of Mexico to 2011 ozone Design Values and demonstrate that, without anthropogenic emissions from Mexico, Doña Ana County would have attained the ozone NAAQS;
- We can calculate 2025 ozone projections removing the contributions of fires that have high uncertainties as well as year-to-year variations.

- The changes in contributions between 2011 and 2025 can be assessed to explain the reductions in Doña Ana County Design Values and provide a rough estimate of ozone levels if the emission reductions are not as large as projected.
    - For example, the reduction in ozone due to on-road mobile sources can be examined to determine what the 2025 ozone DVFs would be if we obtained a lower level of emission reductions.
- We can provide an accounting of ozone contributions in 2025 that can be used to identify those sources that contribute the most to ozone levels in Doña Ana County.

Sensitivity Tests

During the June 3, 2016 SNMOS conference call with New Mexico, several sensitivity tests were discussed related to: Mexico emissions, fires, on-road mobile source emissions reduction uncertainties, and potential shutdown of El Paso Electric EGU units. Thus, we recommend the following three sensitivity tests:

- Zero-Out Mexico 2011 Anthropogenic Emissions: Although we would obtain the contributions of Mexico anthropogenic emissions from the 2011 and 2025 source apportionment runs, the Section 179B "but for" demonstration is really a sensitivity question. This sensitivity question will be directly addressed by this sensitivity simulation.
- On-Road Mobile Emissions Reductions: Investigate the ozone levels in 2025 if emissions reductions from on-road mobile sources were smaller than the reductions calculated by MOVES2014. Assume 2025 on-road emissions are twice as high as projected by MOVES2014.
    - For example, the Doña Ana County 2025 on-road mobile NO_X and VOC emissions are, respectively, ~71% and ~72.5% lower than 2011[3] emissions. Assuming a doubling of the 2025 on-road mobile emissions, this sensitivity test will use on-road mobile NOx and VOC emissions in Doña Ana County that are 42% and 45% lower than in 2011, respectively.
    - In this simulation, we will double the 2025 NOx, VOC and CO emissions from on-road mobile sources in all U.S. counties.
- El Paso EGU Shutdown: Assume shut down of units from the El Paso Electric Rio Grande EGU near Sunland Park.
    - Need to confirm EGU was operating in 2025 emission scenario and obtain from NMED which units should be shut down in this sensitivity.

We will conduct attainment testing using the EPA Modeled Attainment Test Software (MATS) to estimate the effects of each of these sensitivity simulations on current or future ozone Design Values (DVFs) in Doña Ana County and throughout the 12/4 km modelling domain. For the zero-out Mexico emissions sensitivity simulation, MATS will be used to estimate the 2011 ozone design values (average of DVs from 2009-2013) in the absence of anthropogenic emissions from Mexico. MATS

[3] See slides 43 and 48 from the April 21, 2016 PowerPoint presentation on SNMOS Tasks 7 and 8 results (http://www.wrapair2.org/pdf/SNMOS_Tasks_7-8_Summary_21Apr2016_Final.pdf).

will also provide 2025 ozone DVFs under less aggressive mobile emissions reductions and without the El Paso Electric EGU. The uncertainties associated with fires were also considered for investigation in the sensitivity simulations but this is probably not as important given that the issue will be investigated in the source apportionment simulations.