Ammonia Sensitivity Analysis for the Logan Nonattainment Area

Chris Pennell, Utah Division of Air Quality

This document is intended to serve as an addendum to the Logan Moderate SIP Technical Support Documentation (TSD, section 4.e)

1. Background

The Logan Nonattainment Area is very ammonia rich. High ammonia levels in Cache Valley are largely due to an abundance of animal agriculture activity unique to this region of Utah. Utah DAQ ran modeled sensitivities in order to assess the impact of hypothetical ammonia reduction controls in the Cache Valley. Model inputs included 2014 NEI emissions data and WRF-simulated winter-time meteorologically. The simulated January, 2011 episode included a persistent cold air pool period that coincided with 24-hr PM2.5 concentrations that nearly reached 90 ug/m3 at Logan, Utah (Figure 1.1).

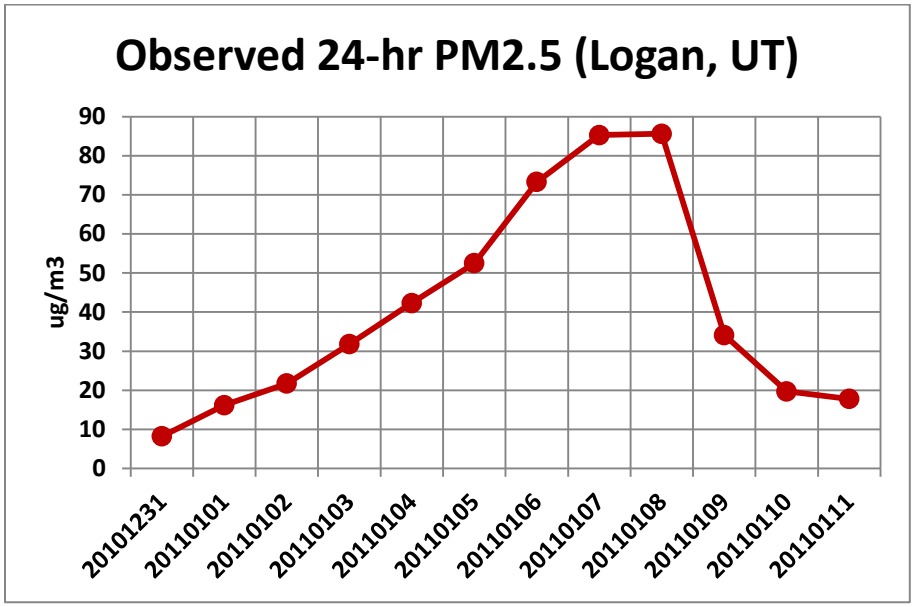

Figure 1.1: Measured 24-hour PM2.5 concentrations (ug/m3) at UDAQ's FRM site in Logan, Utah (Dec. 31, 2010 – Jan. 11, 2011)

Most of the Cache Valley PM2.5 during elevated days of modeled winter-time pollution is ammonium-nitrate. Because the amount of inventoried ammonia was too low to produce adequate secondary aerosol, ammonia was added to the valley floor such that CAMx ammonia was on par with field study measurements. Below, is speciation breakdown of modeled 24-hr PM2.5 on January 7, 2011 at the Logan monitor:

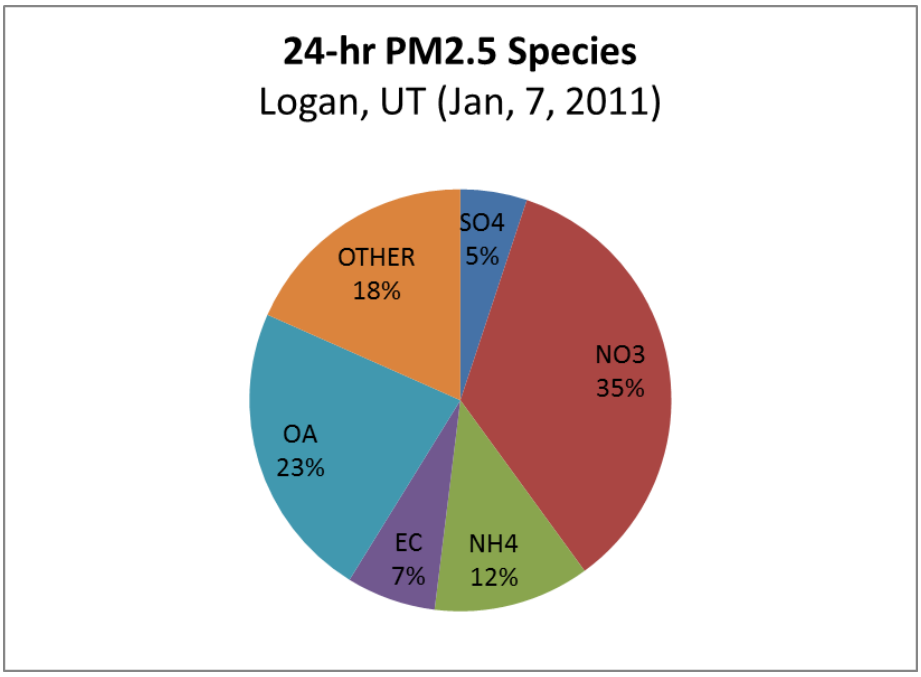

Figure 1.2: Modeled 24-hr PM2.5 species concentrations for Jan. 1, 2011 at Logan, UT. Total 24-hr PM2.5 concentrations here are 46.7 ug/m3. Figure shows that ammonium-nitrate made up most of the simulated PM2.5 on this day.

2. Methodology

For this analysis, UDAQ used the CAMx 6.30 air quality model. Emissions were prepared for CAMx using the SMOKE 3.5.6 emissions processor. Temporal and spatial emission profiles used in SMOKE were appropriate for the winter-time season and region. The model domain resolution over the Cache Valley was 1.33 km. This domain was nested in a much larger 4 km domain for boundary/initial conditions. Modeling parameters to note are listed in the following table:

Table 2.1: List of important CAMx model parameters.

Number of Grids	2
Grid size(s)	4 km/1.33 km
Vertical layers	41
Grid interaction	Two-way nesting
Boundary conditions	MOZART
Emissions processor	SMOKE Version 3.6.5
Point Sources processing	Plume-in-grid model
Aerosol scheme	CF
Chemistry	cb6r2h
Chemistry solver	EBI
Advection scheme	PPM
Dry deposition	ZHANG03
Wet deposition	On

To examine the effect of ammonia reductions, we reduced total ammonia emissions in Cache County by 20%, 30%, and 50%. Next we plotted concentrations of particulate nitrate (NO3) and ammonium (NH4) at the 1.33 km grid-cell collocated with our Logan (L4) FRM monitor. Results of this analysis are documented in the next section.

3. Results

Even with an ammonia emissions reduction of 50%, we barely see a decrease in ammonium and nitrate during the modeled episode. The following two figures show a comparison in particulate ammonium and nitrate concentrations between the "Base Case", where ammonia emissions are note reduced, and three different levels of total ammonia emissions reductions.

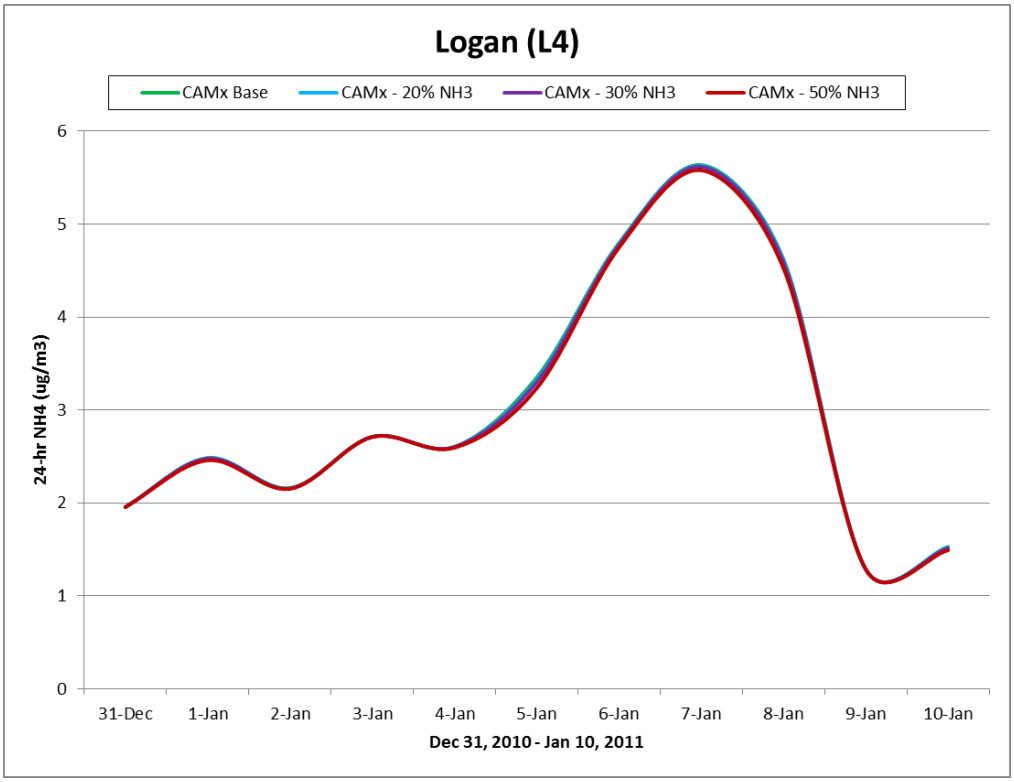

Figure 3.1: CAMx modeled 24-hr Ammonium concentrations at Logan, Utah for Base Case (no NH3 reductions, green trace), 20% NH3 emissions reduction (blue), 30% NH3 emissions reduction (purple), and the 50% NH3 emissions reduction (red). Note that these lines largely overlap since different levels of NH3 reductions show negligible differences in ammonium with the Base Case.

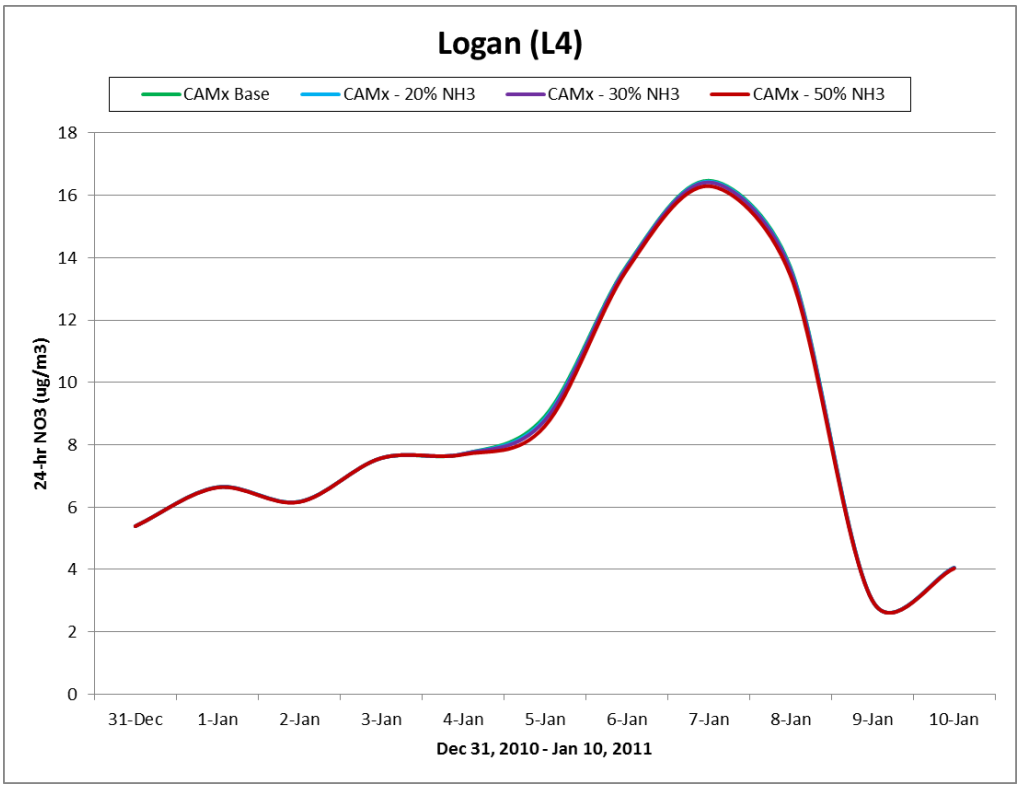

Figure 3.2: CAMx modeled 24-hr Nitrate concentrations at Logan, Utah for Base Case (no NH3 reductions, green trace), 20% NH3 emissions reduction (blue), 30% NH3 emissions reduction (purple), and the 50% NH3 emissions reduction (red). Note that these lines largely overlap since different levels of NH3 reductions show negligible differences in ammonium with the Base Case.

4. Conclusion

Utah DAQ performed modeled sensitivities on emissions data in order to assess the impact of possible ammonia controls. Nitrate and ammonium were individually examined for significant decreases of concentrations at three levels of ammonia reductions. Modeled results suggest that ammonium-nitrate concentrations are highly insensitive to steep ammonia reductions in the Cache Valley. Even an ammonia emissions reduction of 50% did not yield a substantial decrease in simulated aerosol concentrations.