Ozone Sensitivity in Atlanta in Relation to the SEMAP Sensitivity Study

As part of the **S**outh**E**astern **M**odeling, **A**nalysis, and **P**lanning (SEMAP) project, Georgia Tech performed an analysis of the sensitivity of ozone concentrations in the Eastern U.S. to reductions in emissions of both nitrogen oxides (NOx) and volatile organic compounds (VOCs). This analysis was based off of the 2007 and 2018 SEMAP modeling which used CMAQ version 5.01 with updates to the vertical mixing coefficients and land-water interface. The entire "ozone season" was modeled (May 1 – September 30) using a 12-km modeling grid that covered the Eastern U.S. Details of the modeling platform set-up can be found in Appendix E.

Sensitivities were modeled relative to 2018 emissions to evaluate the impact of NOx and VOC reductions on daily 8-hour maximum ozone concentrations. Each emission sensitivity run reduced the 2018 anthropogenic NOx or VOC emissions (point, area, mobile, NONROAD, marine/aircraft/rail) within a specific geographic region by 30%. The 14 geographic regions included Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia, Maryland, MANE-VU (minus MD), LADCO, and CENRAP. This resulted in a total of 28 model runs (2 precursors x 14 regions). The NOx and VOC sensitivities were evaluated at every ozone monitor in the domain.

GA EPD used the SEMAP NOx and VOC sensitivity modeling to examine the normalized sensitivities of NOx and VOC emissions on 8-hour daily maximum ozone concentrations (part per trillion ozone/ton per day, ppt/TPD) at 10 ozone monitors in Atlanta. This analysis started with the day-by-day NOx and VOC emission sensitivities (ppb) for May 1 – September 30. Not all modeled days were used in the calculations. The criteria for selecting days to include in the calculation generally follows the approach used by EPA to select days to include in the relative response factor (RRF) calculation as described in EPA's "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze". For our analysis, the following criteria were used to select the days that would be included in the average sensitivity calculation:

- To address the 1997 ozone NAAQS, an initial threshold value of 85 ppb was used. If the 2018 modeled 8-hour daily maximum ozone concentration was at or above the threshold, then those days were included in the calculation. If at least 10 modeled days were at or above the initial threshold, then an average sensitivity was calculated based on those days. If fewer than 10 days were available, the threshold was dropped until 10 days were available or the minimum allowable threshold value of 80 ppb was reached. If there were fewer than four days available when the minimum allowable threshold value was reached, the minimum allowable threshold was lowered until at least four days were available to include in the average sensitivity calculation.

- To address the 2008 ozone NAAQS, an initial threshold value of 75 ppb was used. If the 2018 modeled 8-hour daily maximum ozone concentration was at or above the threshold, then those days were included in the calculation. If at least 10 modeled days were at or above the initial threshold, then an average sensitivity was calculated based on those days. If fewer than 10 days were available, the threshold was dropped until 10 days were available or the minimum allowable threshold value of 70 ppb was reached. If there were fewer than four days available when the minimum allowable threshold value was reached, the minimum allowable threshold was lowered until at least four days were available to include in the average sensitivity calculation.

The average absolute sensitivity was calculated for NOx (85 ppb threshold), NOx (75 ppb threshold), VOCs (85 ppb threshold), and VOCs (75 ppb threshold) at each Atlanta ozone monitor location (Table 1). Next, the average absolute sensitivity was normalized by the emission reduction to give the normalized sensitivity (ppb/TPD). The SEMAP 30% emission reductions were statewide, but the ozone impacts at

the Atlanta monitors will mostly results from the local NOx and VOC emission reductions in the nearby 15 ozone nonattainment counties. Therefore, it was not appropriate to normalize the local NOx and VOC sensitivity results by the statewide emission reduction. Instead, a conservative approach would be to assume the ozone impacts at the 10 Atlanta monitors resulted solely from the local NOx and VOC emission reductions in the nearby 15 ozone nonattainment counties. Therefore, the average absolute sensitivity was normalized by the emission reductions from NOx and VOC reductions in the nearby 15 ozone nonattainment counties. The anthropogenic NOx emissions in the 15 ozone nonattainment counties are 281.5 TPD, so a 30% reduction is 84.5 TPD. The anthropogenic VOC emissions in the 15 ozone nonattainment counties are 280.0 TPD, so a 30% reduction is 84.0 TPD. Finally, the normalized sensitivities (ppb/TPD) were multiplied by 1000 to convert the units to ppt/TPD (Table 2).

Table 1. Absolute NOx and VOC sensitivity at 10 Atlanta ozone monitors.

AIRS ID	County	Site Name	30% NOx w/ 75 ppb threshold (ppb)	30% NOx w/ 85 ppb threshold (ppb)	30% VOC w/ 75 ppb threshold (ppb)	30% VOC w/ 85 ppb threshold (ppb)
13-067-0003	Cobb, GA	Kennesaw	-6.272	-6.733	-0.380	-0.407
13-077-0002	Coweta, GA	Newnan	-6.807	-8.087	-0.148	-0.131
13-085-0001	Dawson, GA	Dawsonville	-5.252	-5.252	-0.059	-0.059
13-089-0002	DeKalb, GA	South DeKalb	-6.515	-7.385	-0.487	-0.576
13-097-0004	Douglas, GA	Douglasville	-6.732	-7.073	-0.350	-0.607
13-121-0055	Fulton, GA	Confederate Ave.	-5.167	-5.653	-0.644	-0.888
13-135-0002	Gwinnett, GA	Gwinnett	-6.440	-7.608	-0.222	-0.246
13-151-0002	Henry, GA	McDonough	-7.341	-7.645	-0.282	-0.388
13-223-0003	Paulding, GA	Dallas /Yorkville	-5.849	-5.849	-0.096	-0.096
13-247-0001	Rockdale, GA	Conyers	-7.580	-8.461	-0.262	-0.270

Table 2. Normalized NOx and VOC sensitivity at 10 Atlanta ozone monitors.

AIRS ID	County	Site Name	NOx w/ 75 ppb threshold (ppt/TPD)	NOx w/ 85 ppb threshold (ppt/TPD)	VOC w/ 75 ppb threshold (ppt/TPD)	VOC w/ 85 ppb threshold (ppt/TPD)
13-067-0003	Cobb, GA	Kennesaw	-74.265	-79.719	-4.530	-4.851
13-077-0002	Coweta, GA	Newnan	-80.595	-95.757	-1.762	-1.563
13-085-0001	Dawson, GA	Dawsonville	-62.190	-62.190	-0.702	-0.702
13-089-0002	DeKalb, GA	South DeKalb	-77.139	-87.440	-5.796	-6.854
13-097-0004	Douglas, GA	Douglasville	-79.705	-83.744	-4.165	-7.225
13-121-0055	Fulton, GA	Confederate Ave.	-61.173	-66.934	-7.664	**-10.577**
13-135-0002	Gwinnett, GA	Gwinnett	-76.251	-90.082	-2.638	-2.926
13-151-0002	Henry, GA	McDonough	-86.918	-90.519	-3.354	-4.624
13-223-0003	Paulding, GA	Dallas /Yorkville	-69.252	-69.252	-1.145	-1.145
13-247-0001	Rockdale, GA	Conyers	-89.754	**-100.186**	-3.121	-3.210

These results show that NOx emission reductions are generally 10-20 times more effective than VOC emission reductions at reducing ozone concentrations. In order to look at the impact of removing NOx or VOC controls on the 1997 and 2008 ozone NAAQS, the most conservative approach would be to use the highest normalized NOx and VOC sensitivity value across the 10 Atlanta ozone monitors. The highest normalized NOx sensitivity is 100.2 ppt/TPD and the highest normalized VOC sensitivity is 10.58 ppt/TPD.