Sensitivity of ozone concentrations in Macon to reductions in NO_x emissions from various sources in Georgia

Introduction

GA-EPD has performed an analysis of the sensitivity of ozone concentrations to reductions in emissions of both nitrogen oxides (NO_x) and volatile organic compounds (VOCs). The analysis was based off of the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) modeling, using the "Base D" emissions inventory (for both 2002 and 2009), and CMAQ version 4.4 with the CB-IV chemical mechanism. A 12-km modeling grid was used, covering most of the southeastern USA. The episode modeled was May 23 – June 25, 2002, as it contained many days of elevated ozone concentrations and has been found representative of longer term trends in ozone concentrations. More details regarding the model setup and sensitivity analysis can be found in Marmur et al., 2005.

Cases modeled

Results from the sensitivity analysis indicated that the region modeled is NO_x limited. Therefore, the focus here is on the effect of NO_x reductions from various sources/regions within GA on ozone levels in Macon. Two main NO_x emissions reductions scenarios/cases have been modeled, and their effect on ozone concentrations in Macon analyzed. Below is a summary of the cases modeled (also see Table 1):

Case 1: NO_x reductions from the existing SCRs at GA-Power Plants Bowen (all four units), Wansley (both units) and Hammond (unit #4), compared to the pre-installation conditions. These SCRs reduce total combined NO_x emissions by 184 tons per day (TPD).

Case 2: Reductions in Atlanta NO_x emissions from 2002 to 2006, totaling 96.4 TPD (GA-DNR, 2006) .

Table 1: Summary of emissions reduction scenarios modeled

Case #	Plant/Region modeled	NO_x TPD reduction
1	Bowen, Hammond and Wansley (benefits of existing SCRs)	184
2	Reduction in Atlanta NO_x emissions from 2002 to 2006	96.4

Modeling results

Reductions in daily maximum 8-hour ozone concentrations for each of the above cases, along with the modeled base-case concentrations (based on both 2002 and 2009 VISTAS Base D emissions), are shown in Figure 1. Case 2 (modeled benefits of lower NO_x emissions from Atlanta) shows the highest benefits in terms of ppb reduction in 8-hour ozone concentrations in Macon, with reductions of up to 4.5 ppb. Case 1 (modeled benefits pf existing SCRs at Bowen, Wansley and Hammond) shows reductions of up to 3.5 ppb. Both these reductions are the highest on days of high ozone concentrations, which demonstrates the contribution of Atlanta and the modeled power plants to elevated ozone concentrations (and to the design-value) in Macon. The average and normalized reductions in ozone, for days in which the 2002 base case concentration was above 75 ppb (8 days total), are given in Table 2. Also evident in Figure 1 are the impacts of NO_x emissions reductions expected by 2009, compared to the 2002 case (most of the reductions are from the mobile-source and EGU sectors; for more details see Marmur et al., 2005). This further demonstrates that ongoing reductions in NO_x emissions will continue to lower concentrations of ozone in Macon.

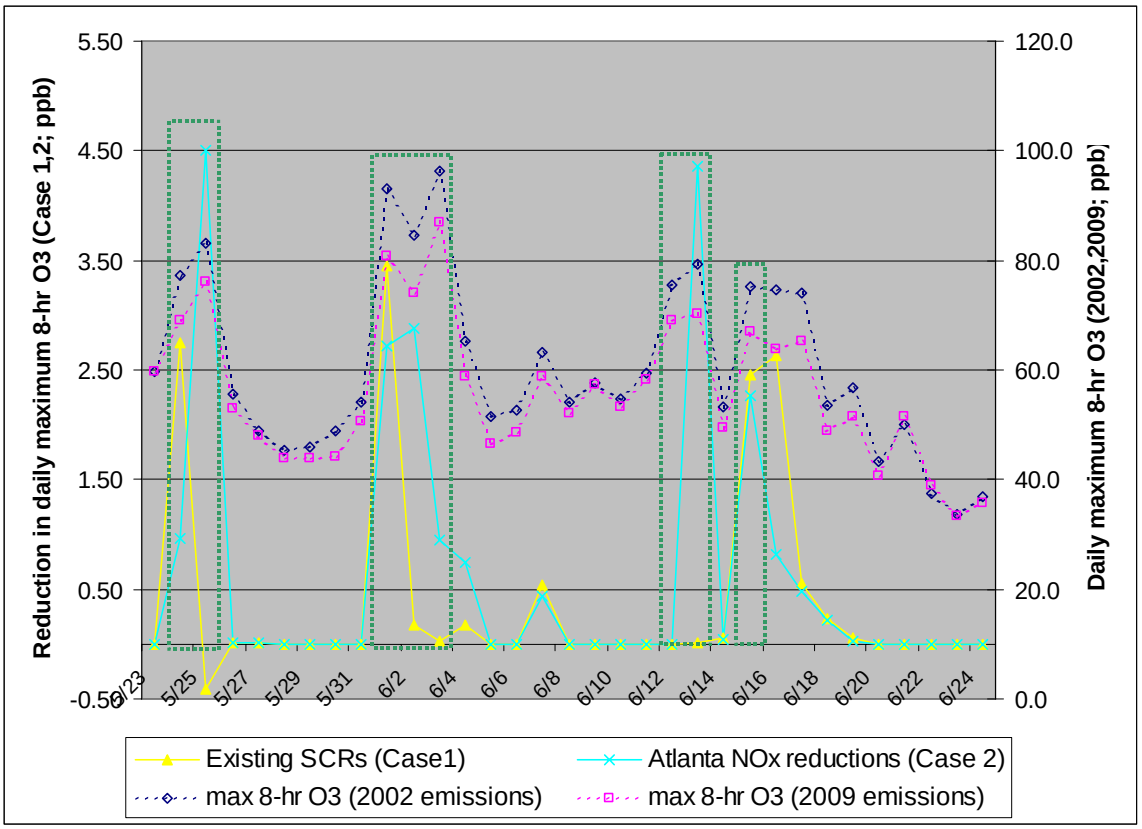

Figure 1: Daily reductions in maximum 8-hour ozone concentrations corresponding to cases 1,2 (Table 1), along with base-case ozone concentrations in Macon (2002 and 2009 inventories). Green rectangles indicate days in which the 2002 base case maximum daily 8-hr ozone concentration was above 75 ppb (used for calculations presented in Table 2).

Table 2: Average reductions in 8-hour ozone concentrations (ppb) and normalized reductions (ppt O3 / TPD NO_x) for days in which the 2002 base case concentration was above 75 ppb (8 days total)

Case #	Average reduction (ppb)	Normalized reduction (ppt O3 / TPD NO_x)
1	1.06	5.73
2	2.33	24.2

Meteorological patterns

To assess whether the observed reduction in ozone concentrations in Macon is due to favorable meteorology, rather than emissions reductions, we analyzed the number of "ozone conducive days" during the ozone seasons of 1998-2004. An "ozone conducive day" is defined here as a day of "high" temperature (T) and "low" relative-humidity (RH) and wind-speed (WS), since such meteorological conditions are favorable to the formation of ozone. We defined "high" and "low" in a relative manner, and report the count of days based on two sets of definitions (Figure 2): [1)] T above the 90th percentile (for 1998-2004), and RH and WS below the 50th percentile; [2)] T above the 75th percentile, and RH and WS below the 50th percentile. These data clearly show (Figure 2) that ozone concentrations have decreased regardless (and in some cases despite) of the frequency of occurrence of ozone-conducive meteorological conditions.

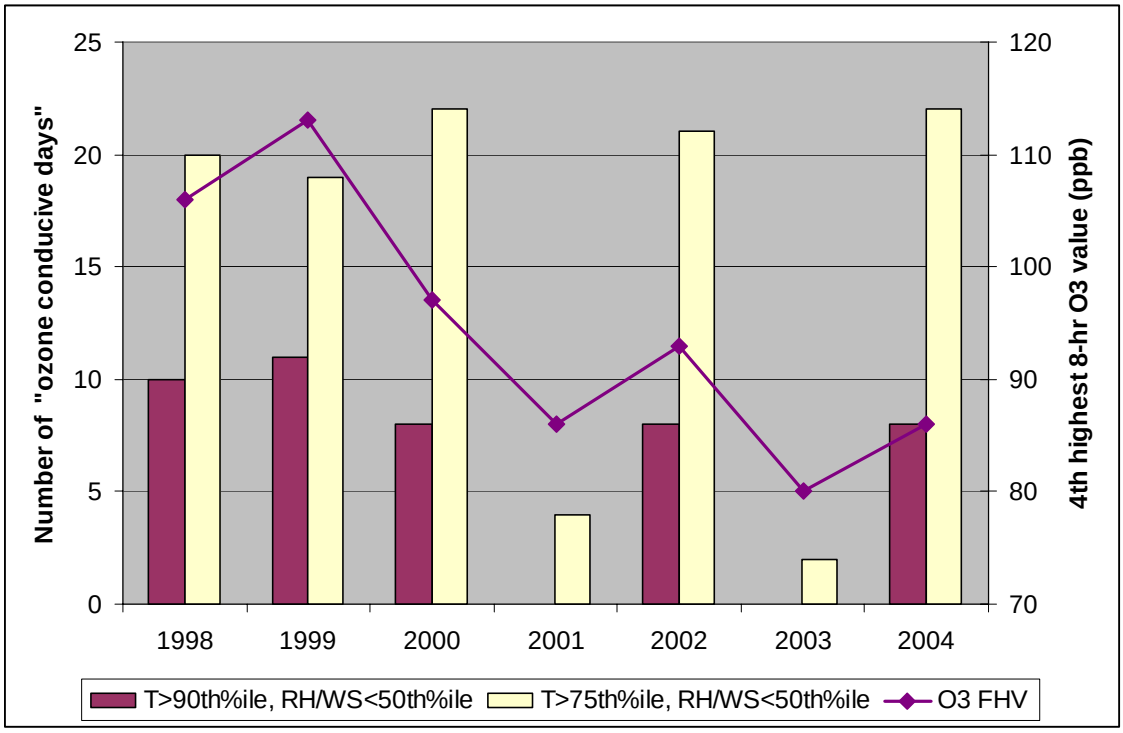

Figure 2: Count of "ozone conducive days" based classifications of temperature, relative-humidity and wind-speed, along with trends in observed ozone concentrations in Macon (4th highest 8-hr ozone value (FHV) per ozone season)

Summary and conclusions

This analysis has shown that reductions in NO_x emissions from the Atlanta area, along with reduced EGU NO_x from existing SCRs in several power-plants throughout northern Georgia have lead to reduced ozone concentrations in Macon, regardless/despite of the frequency of occurrence of ozone conducive metrological conditions. Since further reductions in Atlanta emissions are expected (fleet turnover, as indicated by data from the emissions inventory), ozone concentrations in Macon are expected to decrease further.

References

Georgia Department of Natural Resources (2006), Georgia's Draft Early Progress State Implementation Plan Revision for the Atlanta 8-Hour Ozone Non-attainment Area, Environmental Protection Division, Air Protection Branch, October 26, 2006 (http://www.gaepd.org/Files_PDF/plans/sip/draft_early_progress_sip_narrative4_clean.pdf).

Marmur, A., Boylan, J., Khan, M., and Cohan, D. (2005), 8-Hour Ozone and $PM_{2.5}$ Modeling to Support the Georgia SIP, 4th Annual CMAS Models-3 Users' Conference, Chapel Hill, NC (http://www.cmascenter.org/conference/2005/ppt/7_6.pdf)