Comments to
EPA Clean Air Scientific Advisory Committee, Ozone Review Panel
3rd External Review Draft
Integrated Science Assessment for Ozone and Related Photochemical Oxidants
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Modeling Estimates of North American Background Ozone

Christopher Emery
ENVIRON International Corporation

The Third External Draft of the Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants is a substantial improvement over previous drafts. Among the many important changes to this document, the EPA staff has included a detailed comparison of recent background ozone estimates from two models (Section 3.4.3): a high-resolution version of the GEOS-Chem global chemical transport model (Zhang et al., 2011) and the CAMx regional chemical transport model (Emery et al., 2012). I commend the authors on presenting this comparison in a thorough and balanced manner. I have just a few general comments on the ISA in this regard.

- We have recently discovered that surface snow cover was errantly omitted from the CAMx simulations reported by Emery et al. (2012). Snow cover reduces the rate of ozone deposition to the ground. Therefore, a simulation lacking snow cover over estimates ozone loss, which contributes to ozone under predictions. New simulations with snow cover included indicate that ozone is higher by typically 5 ppb in the western US during the winter and early spring (November through March). Therefore, inclusion of snow cover reduces CAMx ozone under prediction bias during cold months, especially at high elevations (see ISA Figure 3-14), and further increases background ozone estimates. However, we do not believe that the omission of snow cover significantly impacts the conclusions of Emery et al. (2012) or EPA's analyses as documented in the ISA because the assessment of CAMx performance against observations and estimates of background ozone focused on the spring/summer seasons (March-August).

- We have also run EPA's CMAQ regional chemical transport model employing identical grids and inputs from the 2006 CAMx modeling. Snow cover was properly supplied to CMAQ. CMAQ results were very similar to CAMx, except that CMAQ typically estimated slightly higher ozone (by typically a few ppb), particularly over the high terrain of the west. We believe that the higher ozone predictions likely result from: (1) inclusion of snow cover effects on ozone deposition rates; (2) more efficient downward boundary layer mixing of ozone aloft; and (3) more downward deep tropospheric transport of ozone aloft via convective cloud mixing and diffusive vertical advection. A full report on our CAMx-CMAQ inter-comparison is available from the American Petroleum Institute.

- The ISA states at page 3-147, lines 3-4 that "… neither model [GEOS-Chem or CAMx] is currently capable of simulating day specific base-case O_3 concentrations within reasonable bounds."

  While I understand the intent of this statement with respect to the modeling results summarized in the ISA, I disagree with the implication that all model error is systemic to current formulations and therefore the models themselves are incapable of better performance at short timescales. Elsewhere, the ISA correctly states that a large proportion of model error is related to uncertainties in inputs (e.g., emissions, meteorology) and factors associated with spatial resolution. The input datasets used by GEOS-Chem and CAMx for these analyses were grossly representative of 2006 over large spatial and temporal scales. Given high-fidelity, accurate, comprehensively evaluated emissions and meteorological inputs, high resolution applications of regional chemical transport models like CAMx and CMAQ can and have performed well in simulating hourly ozone distributions. Indeed, the EPA requires the use of models like CAMx and CMAQ to adequately simulate ozone at hourly and intra-urban scales as part of the development of ozone State Implementation Plans (SIPs). The quoted statement in the ISA could be easily taken out of context to question EPA's requirement for the use of current state-of-the-science models to support the SIPs.

  I suggest revising the quoted text above to place more emphasis on ***model results***, ***uncertainties*** in the input datasets, and ***resolutions*** employed. For example:

  "… neither of the ***modeling results were*** capable of ***replicating*** day specific base-case O_3 concentrations within reasonable bounds ***given the models' respective resolutions and specific input datasets***."

  Such revisions should be extended throughout the ISA wherever similar statements are made.

- I suggest that EPA briefly mention two issues related to GEOS-Chem and CAMx model performance in Section 3.4.3. First, summer ozone over predictions in the southeast US may be related to two particular factors (among others): (1) over estimates of lightning NOx and assumed vertical profiles; and (2) over estimates of biogenic emissions, either due to error in temperature and solar radiation estimates or to uncertainties in vegetative emission factors. Second, the ISA mentions that GEOS-Chem and CAMx model performance inCalifornia is similar but not as good as in other regions. It is important to note in the ISA that this similarity in West Coast performance stems from the fact that both CAMx and high-resolution GEOS-Chem results are dictated by boundary conditions derived from similar coarse-resolution (2×2.5°) GEOS-Chem predictions.

The ISA notes at page 3-147, lines 27-36 "… that the calculations of background concentrations presented in this chapter were formulated to answer the question, '***what would O_3 concentrations be if there were no anthropogenic sources'***. This is different from asking, '***how much of the O_3 measured or simulated in a given area is due to background contributions'***.

Because of potentially strong non-linearities—particularly in many urban areas—these estimates [from GEOS-Chem and CAMx] by themselves should not be used to answer the second question posed above. The extent of these non-linearities will generally depend on location and time, the strength of concentrated sources, and the nature of the chemical regime. Further work is needed on how these estimates of background concentrations can be used to help determine the contributions of background sources of O_3 to urban concentrations."

This is an important point and it is appropriate that EPA has distinguished the two questions. We are addressing the second question in modeling work that will be available by the end of the year. We are conducting modeling for 2006 using the same CAMx database as Emery et al. (2012) to develop sensitivity assessments and background estimates under the influence of full 2006 US anthropogenic emissions for all of the cities addressed in the REA. We can share these results with EPA once they are available.

References

Emery, C., J. Jung, N. Downey, J. Johnson, M. Jimenez, G. Yarwood, R. Morris, 2012. Regional and global modeling estimates of policy relevant background ozone over the United States. *Atmospheric Environment*, doi:10.1016/j.atmosenv.2011.11.012.

Zhang L., Jacob D.J., Downey N.V., Wood D.A., Blewitt D., Carouge C.C., van Donkelaar A., Jones D.B.A., Murray L.T., Wang Y., 2011. Improved estimate of the policy-relevant background ozone in the United States using the GEOS-Chem global model with 1/2°×2/3° horizontal resolution over North America. *Atmospheric Environment*, doi:10.1016/j.atmosenv.2011.07.054.