

# ***Interactive comment on “Impacts of Different Characterizations of Large-Scale Background on Simulated Regional-Scale Ozone Over the Continental United States” by Christian Hogrefe et al.***

## **Anonymous Referee #2**

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Review of Hogrefe et al., 2017

The authors present results from a number of 12 km WRF-CMAQ base and sensitivity simulations and process analysis related to CONUS ozone in 2010. A great amount of model evaluation (against AQS, CASTNET and sondes observations) work was carried out. The paper does contain a number of highlights and is highly relevant to AQMEII/HTAP2, so I think is publishable after the following comments are addressed.

Specific comments:

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1. Table 1 is helpful. For some cases of species mapping, not all CMAQ chemicals had a match from its boundary condition model - Did the authors use a constant (default value)? How was the mapping of aerosol species handled?

I'd like to see some comments on how the completeness of boundary condition model species and the species mapping approach may have contributed to CMAQ model errors (and CMAQ-boundary condition model discrepancies). When we evaluate a given global model's suitability of being used as CMAQ (and other regional CTMs) boundary conditions, should the similarity of CMAQ/boundary condition model's chemistry be considered as an important factor?

2. P5, L7: "Note that these analysis regions do not cover the entire modeling domain." Could the authors explain why they focus on the selected five regions for some of their analyses? The paper does also show the model behavior over other CONUS regions (e.g., Figures 7, 10, 12, and elsewhere). Perhaps an additional panel (named as "entire CONUS" or "all other CONUS regions") could be added to Figures 3 and 13?

3. P5, L7: some clarification is needed on how observations and model data are paired. This is particularly important for understanding the AQS-model evaluation as the numbers of observations in each grid can differ substantially, and can be quite large for some models.

4. Section 2 and Table 2: I suggest adding some brief introductions on non-anthropogenic emissions used in CMAQ and its boundary condition models. These would help us understand each model's performance presented later, and support "the treatment of vertical mixing, lightning emissions, chemistry, deposition and biogenic emissions" in P10, L24-25 and other related statements in the results section.

5. I like the way vertical grid of CMAQ is introduced in P7, L16, i.e., listing the number of vertical layers by altitude range. I suggest adding such information for other models which would nicely complement Figure 1.

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6. The authors suggested in P17, L6-8 that “Future work analyzing long-term simulations from multiple global models linked to corresponding regional-scale simulations would be beneficial in better constraining the effects of large-scale interannual variability on regional-scale ozone burdens.” I suggest adding some supporting sentences here, e.g., including the differences of ozone and its variability in CMAQ and its boundary condition models (e.g., GEOS-Chem and BC GEOS Chem; AM3 and BC AM3; HCMAQ and BC HCMAQ; C-IFS and BC C-IFS). Such information is included in quite a few figures and discussions but should also be well summarized here (and perhaps in abstract as well if there is space).

Minor issues:

1. In Figure 2 caption or in P5 in text: define lat/lon ranges of each box (region) and numbers of observation sites within each box; provide lat/lon of the ozonesonde sites; Showing the names of the ozonesonde sites in Figure 2 would also be helpful.
2. Define the seasons somewhere.
3. Figure 4, x axis label: is it possible to write it as a math equation?
4. Figures 7, 11: “i” appears to be “l” in the figure captions
5. Unit is missing in Figures 7, 8, 10, 12. Both ppb and ppbV (e.g., Figure 9) are used in the paper and it'd be better to just stick to one of them throughout the paper.
6. Typo in P18, L3: Fiore et al. (2004) Fiore et al. (2014)
7. Typo in Table 4c: BC AM4[56] in the second column should be “BC AM3”
8. Use subscripts for chemical species (e.g., in Table 1)
9. Add data sources of AQS, CASTNET, ozonesondes in the “Acknowledgements and Disclaimer” section

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