Response to Comments by Reviewer 1

General Comments

In "Impacts of Different Characterizations of Large-Scale Background on Simulated Regional-Scale Ozone Over the Continental United States", Hogrefe et al. evaluated ozone concentrations at the surface and throughout the column from the Community Multiscale Air Quality (CMAQ) model against observations for 2010 with a careful experimental design that investigated the influence of modeled background ozone concentrations. Additionally, they calculated the contribution to the modeled ozone concentrations of different information used by the model (i.e., boundary conditions, emissions) with a brute force approach as well as processes within the model with an instrumented modeling approach. Leveraging results of the Air Quality Model Evaluation International Initiative (AQMEII) and Task Force on Hemispheric Transport of Air Pollution (TF-HTAP) projects, they quantified the impacts to ozone concentrations at the surface and ozone burdens at different heights aloft of using boundary conditions from four different hemispheric or global models.

The authors showed that the choice of global or hemispheric model for boundary conditions has potential to influence substantially the regulatory metric for ozone on the regional scale on an individual day and the model performance metrics, including the direction of bias. The language and structure of the manuscript are impeccable. The manuscript clearly describes the scope of the investigation, places it in the context of previous research as well as the AQMEII and TF-HTAP efforts, highlights novel results of the analysis, and suggests future research directions this analysis uncovered. I recommend this manuscript for publication in Atmospheric Chemistry and Physics with only editorial changes suggested.

Response: We would like to thank the reviewer for the overall positive assessment of our manuscript. We would also like to thank the reviewer for the careful review and helpful suggestions which have led to improvements in some of the figures. Our responses to the specific reviewer comments and the changes incorporated in the revised manuscript are shown below in italics.

Specific Comments

Comment: p. 10, l. 14 "regional-scale simulation". Consider adding "especially near boundaries." The following paragraph highlights the different performance further inland, so it seems important to highlight that this statement is pertinent especially near the boundaries.

Response: This suggested change has been incorporated into the revised manuscript.

Comment: p. 10, l. 29 Please change "Figure" to "figure".

Response: Thank you for catching this typo, it has been corrected in the revised manuscript.

Comment: p. 12, l. 8 Might "downward" have been intended to be "downwind"?

Response: Thank you for catching this typo, it has been corrected in the revised manuscript.

Comment: Table 4c Is the orange in this table a different color than in Tables 4a and 4b?

Response: No, the colors are the same. However, upon reviewing Tables 3 and 4b, we noticed that the Normalized Mean Error (NME) values for the BASE simulation included in those tables were incorrect. Specifically, the NME values for the BC H-CMAQ were shown instead of the NME values for BASE in these tables, this has been corrected in the revised manuscript.

Comment: Figure 3 "right row", "left row" are likely intended to be "right column", "left column".

Response: Thank you for catching this typo, it has been corrected in the revised manuscript.

Comment: Figures 3, 6, 9, 11, 13 These figures nicely represent a single statistical metric (e.g., median, mean) for the information shown; however, more information could be conveyed if the standard deviation about the mean or the 5%/95% about the median were displayed with shading or error bars. Could this additional information please be added?

Response: We appreciate this suggestion and considered it for all the figures listed by the reviewer.

For Figure 3 and 13, the variability that could be depicted in addition to the median would represent the spatial variability of model-observation differences across all stations in a given region for a given observed percentile. We prepared versions of these figures that included dashed lines for the 25th and 75th percentile values but decided not include them in the revised manuscript because (i) we found them to be too cluttered especially for the paired-in-time analysis and (ii) we did not consider the additional information on spatial variability contained in these alternate versions to add additional insights for the discussion. However, for completeness, these alternate versions of the figures are included at the end of these responses so that they are available to interested readers as part of the manuscript discussion.

For Figure 6, the average represents a temporal average (monthly) of spatially summed hourly ozone column mass values or spatially averaged hourly surface ozone mixing ratios. For the revised version, we updated the figure to include dashed lines that represent the 5th and 95th percentile of the hourly values used to compute the monthly average values.

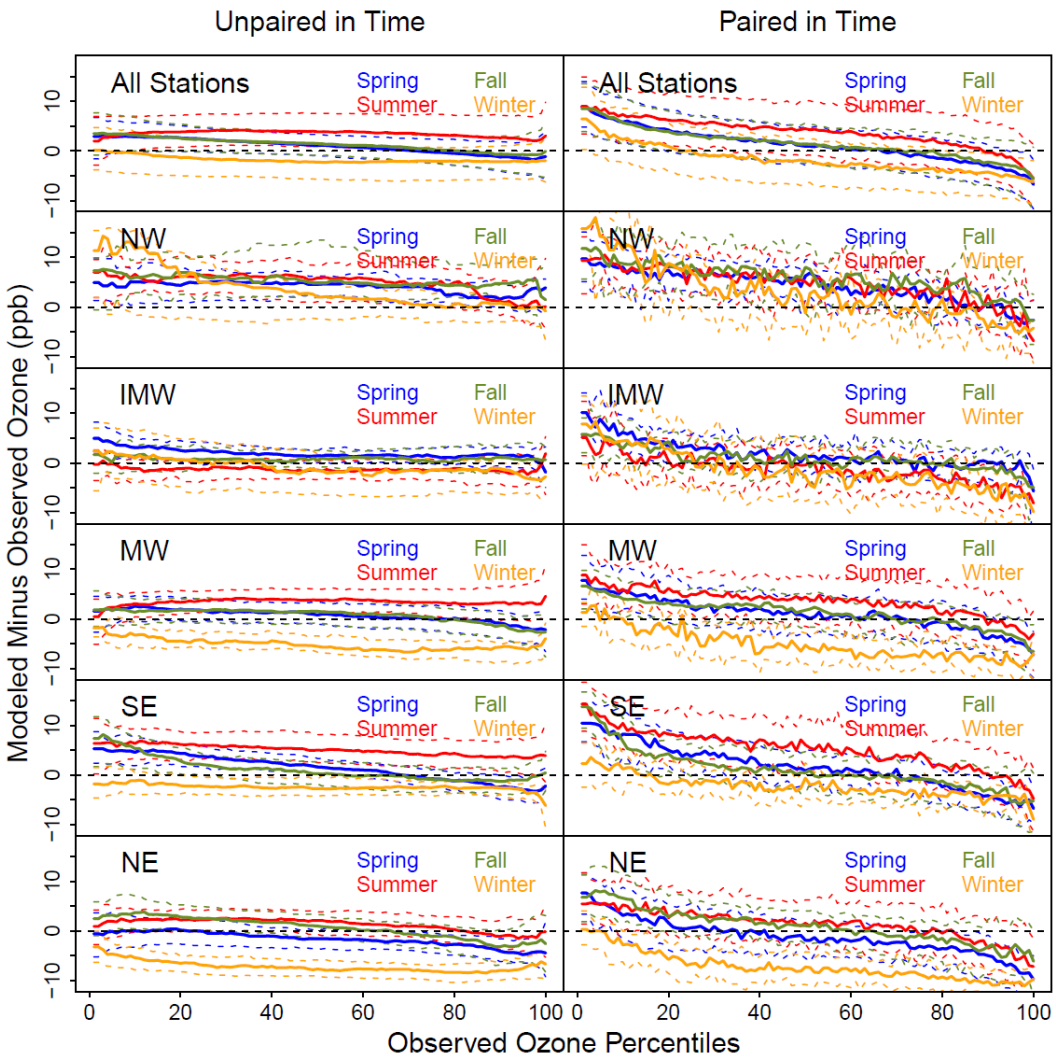
For Figure 9, we considered it too confusing to add more lines or shading since the panels already include four solid and four dashed lines (representing global and regional-scale model results, respectively) as well as a shaded range (depicting the range of observed values averaged over the different altitude ranges represented by the specific model layers at which the individual model values were extracted). Thus, no alternate version of this figure was prepared.

For Figure 11, the issue of temporal variability is already addressed by comparing panels c)-d) which show monthly average model-observation differences with panels e)-f) which show the corresponding daily values. The issue of spatial variability of model-observation differences is already addressed in Figure 12 which shows these differences for spring at summer at CASTNET stations. Thus, no alternate version of this figure was prepared.

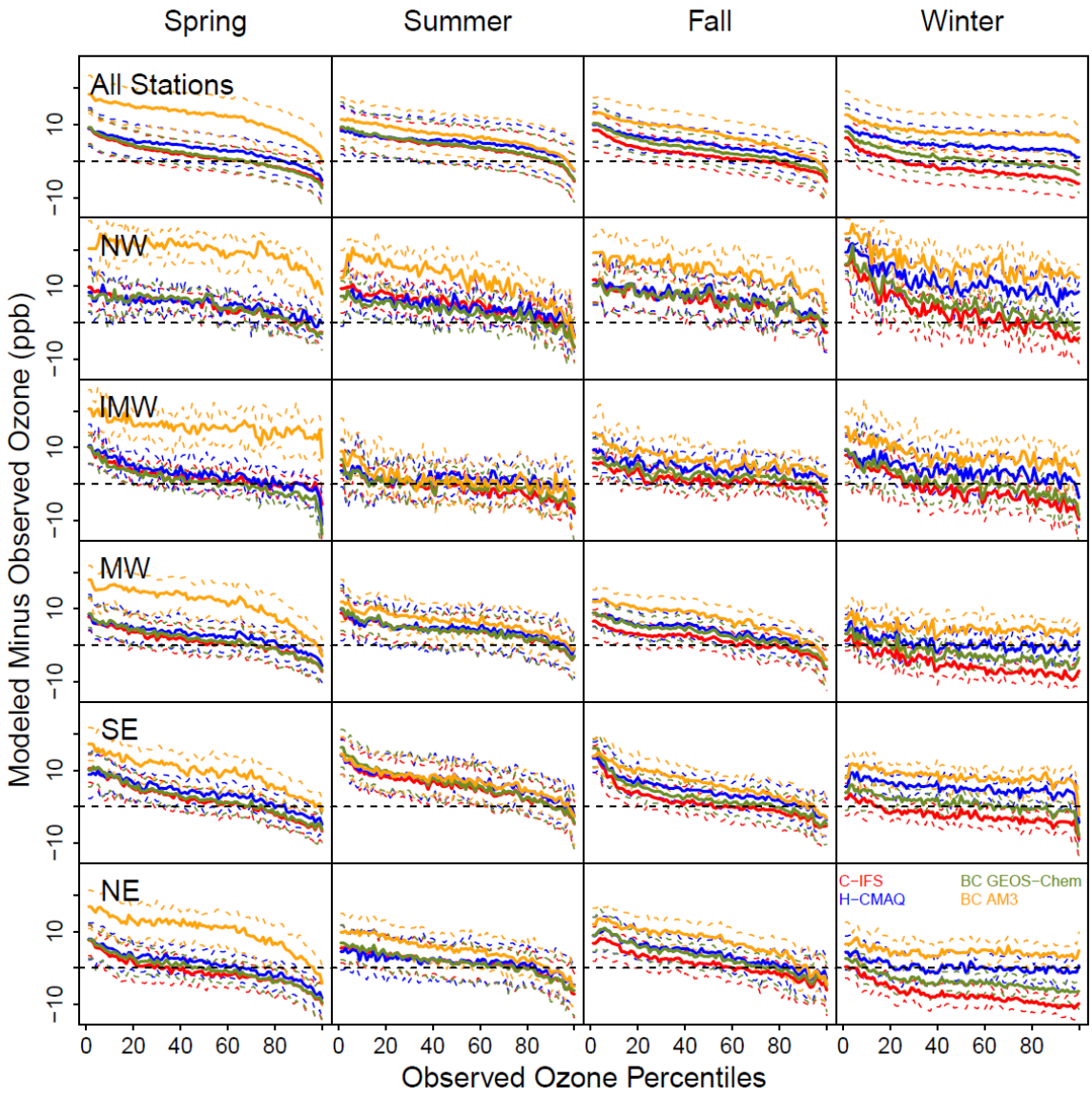
Comment: Figure 8 The units seem to have been cut off of the colorbar for these figures. Please include them. Also, for the sake of ease in comparison of the regional figures with the global ones, would it be possible to have the y-axes reach the same extent in each but leave white (e.g., a bar across the bottom in the global, a bar across the top in the regional) to indicate that the model did not calculate values at those pressure levels?

Response: Thank you for this helpful suggestion, Figure 8a-b has been updated to use the same extent of the vertical axes in all panels. Missing units have been added to the color-bar of Figures 8a-b as well as to the color-bars of Figures 7, 10, 12, and S1. Furthermore, we have also added the following text to Section 3.2.1 when introducing Figure 8a-b

"Note that even though observations and large-scale model predictions (except H-CMAQ) are available for higher altitudes (see Figure 1), only values up to the highest model level below 50 mb were extracted for these figures to be comparable to the output from the regional-scale CMAQ simulations (specifically, C-IFS values were only extracted up to layer 38, GEOS-Chem values were only extracted up to layer 37, and AM3 values were only extracted up to layer 26 for this comparison). For easier comparison between models and sites, all figures use a common vertical pressure range of 1025 mb to 50 mb even though this full range is not covered at all sites and by all models."



Alternate version of Figure 3 including dashed lines representing the 25th and 75th percentiles of model-observed differences across all stations in a given region for a given observed percentile. The solid lines represent the median across all stations for a given region and given observed percentile.



Alternate version of Figure 13 including dashed lines representing the 25th and 75th percentiles of model-observed differences across all stations in a given region for a given observed percentile. The solid lines represent the median across all stations for a given region and given observed percentile.