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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A comparison of atmospheric composition using the Carbon Bond and Regional Atmospheric Chemistry Mechanisms" *by* G. Sarwar et al.

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Comment: This manuscript presents a comprehensive comparison of CMAQ regional air quality model output from model simulations with two different chemical mechanisms. The more standard implementation of CMAQ is with the CB05TU mechanism, and the paper represents the first use of the RACM2 mechanism in this model. The paper demonstrates considerable change in a number of chemical species between the two model simulations. For example, the RACM2 mechanism produces more ozone than does the CB05TU mechanism. This improves the predictions relative to observations at high ozone mixing ratios. However, when the models are applied for control

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strategy evaluation, there is no significant difference in the result between mechanisms for either ozone or fine particles.

In general the manuscript is very well written. I am assuming that the figures will be sized somewhat larger when the paper is published than they are in the pdf file have reviewed. Some of them are too small and difficult to read in their current size.

Response: We appreciate the reviewer's thoughtful comments and suggestions to improve the article.

Specific comments:

Comment: Page 6932, lines 16-25: How do you know H2O2 in Houston should be comparable to that in the Northeast? I don't think the paper benefits from having the Northeast data used here.

Response: We agree. The difference between the model predictions is small and the uncertainty in this comparison is likely to be equal to or greater than the difference of the two model predictions. Thus, we will remove the related paragraph in the final article.

Comment: Page 6933, lines 25-27: What support is there for this assumption about similar magnitude PACD over China and the US? Again, might be better to leave this out if there is no support for this.

Response: PACD is a secondary pollutant and formed from the reactions of acetyl peroxy and higher acyl peroxy radicals with HO2. Many studies have already reported that current air pollution levels in China are greater than the US. Thus, PACD levels in China are likely to be greater than those in the US. In the absence of any measurements in the US, we compare our predictions to the higher observed values in China and suggest that CB05TU predictions in the US are an order of magnitude greater than the higher observations in China. We believe the uncertainty in this comparison is lower than the difference of the two model predictions. Thus, we plan to keep the paragraph

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and add the following sentences:

Many studies have reported that current air pollution levels in China are much greater than the US. Thus, PACD levels in China are likely to be greater than those in the US. In the absence of any measurements in the US, we compare our predictions to the higher observed values in China and find that CB05TU predictions are an order of magnitude greater than the higher observed values in China. While the CB05TU predictions are too high, the RACM2 predictions appear to be similar in magnitude for such a comparison. Measurements of atmospheric PACD levels in the US are needed for a more robust comparison with the model predictions.

Comment: Page 6934, lines 14-23: How do you know MEPX is comparable in Houston and the Northeast? Again, I don't think the paper benefits from this type of comparison.

Response: We agree. The difference between the model predictions is small and the uncertainty in this comparison is likely to be equal to or greater than the difference of the two model predictions. Thus, we will remove the related paragraph in the final article.

Comment: Page 6935 – Section 3.2: Why is model and observed NOx (from TEXAQS and SEARCH) not compared?

Response: Difference in predicted NOx concentrations between the two mechanisms is small (domain-wide mean difference is 2%). A number of other studies (e.g., Godowitch et al., 2010, Yu et al., 2012; Zhou et el., 2012) compared CMAQ predicted NOx to observed data. In this study, we focused on secondary species resulting from the two mechanisms and avoided comparisons of primary species. We plan to revise Table 3 to include the comparison of NOx predictions from the two mechanisms.

References: Godowitch, J. M., Pouliot, G., Rao, S. T., 2010: assessing multi-year changes in modeled and observed urban NOx concentrations from a dynamic model evaluation perspective, Atmospheric Environment, 44, 2894-2901.

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Yu, S., Mathur, R., Pleim, J. E., Pouliot, G., Wong, D. C., Eder, B. K., Schere, K. L., Gilliam, R. C., Rao, S. T., 2012: comparative evaluation of the impact of WRF-NMM and WRF-ARW meteorology on CMAQ simulations for O3 and related species during the 2006 TexAQS/GoMACCS campaign, Atmospheric Pollution Research, 3(2):149-162.

Zhou, W., Cohan, D., Pinder, R. W., Neuman. J., Holloway, J. S., Peischl., J., Ryerson, T. B., Nowak., J. B., Flocke, F., Zheng, W. G., 2012: observation and modeling of the evolution of Texas power plant plumes, Atmospheric Chemistry and Physics, 12(1):455-468.

Comment: Page 6940, lines 17-27: Can you provide a quantitative assessment of the improvement in predicting high ozone provided by RACM2?

Response: We revised the entire paragraph as follows: High concentrations occur during O3 episodes. Thus, it is important that air quality models capture these high observed values. Results of average daily maximum 8-h O3 predicted by the two mechanisms are compared to observations from all AQS sites in Fig. 7. We use data only when observed 8-h O3 values are greater than 75 ppbv. While both mechanisms tend to under-predict high observed concentrations, RACM2 captures the data better than CB05TU. The CB05TU captures the observed data better only on 7 days while RACM2 captures the observed data better on 19 days. Values do not appear in the Figure on days when no observed data exceeded the threshold. Mean bias for CB05TU was –6.6 ppbv while mean bias for RACM2 was only -2.2 ppbv for the entire period. RACM2 improves mean bias by 4.4 ppbv when observed daily maximum 8-h O3 >75 ppbv. Thus, CB05TU underpredicts O3 at the higher end of observed concentrations while RACM2 enhances and improves O3 predictions at such conditions. On the other hand, RACM2 predictions are greater than the CB05TU predictions and observed concentrations at the lower end of observed values.

Comment: Page 6942, line 25 and following page: Are these data from all CASTNET sites in the US?

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Response: Indeed, these data are from all CASTNET sites in the US. For further clarification, we plan to revise the sentence as follows: Ambient monitoring data from all monitoring sites in the CASTNET network are used to compare model predictions for SO42-, NO3-, and NH4+ [Figure 10(c-e)].

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 6923, 2013.