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Interactive Comment

Interactive comment on "Modeling regional aerosol variability over California and its sensitivity to emissions and long-range transport during the 2010 CalNex and CARES campaigns" *by* J. D. Fast et al.

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Reviewer: The manuscript examines the spatial and temporal variability in aerosol concentrations, composition, and size distribution simulated with a version of the WRF-Chem model. The model predictions are evaluated in great detail with measurements from the two field experiments (CalNex and CARES) during May and June of 2010. It presents an extensive review of meteorology, trace gases and aerosol distributions in the California region using both observations and regional model. The manuscript is

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suitable for publishing in the ACP but could be improved by largely reducing its length and being more focused on its center objectives. Currently, it is titled as modeling regional aerosol variability, although not until half way through the main text, there are discussions on aerosol properties. Analyses of meteorological conditions and gaseous precursors are important, however, it is more appropriate to include them for explaining the biases in aerosol simulations, than giving a full and detail evaluation upfront. The second- half discussions on aerosol extinction profile and AOD seem to be detached from the extensive comparison of surface meteorology and trace gases in the first half; because as pointed by the authors, the latter in this region/time is dominated by the uncertainty in the long-range transport (boundary conditions) of aerosols.

Response: We thank the reviewer for taking the time to read our long paper and giving us valuable comments regarding the organization and objectives. We have revised the paper by taking into account the reviewer's suggestions and provide responses to the individual comments below. The other reviewer suggested we add summaries at the end of each results sub-section and that has added to the length of the paper. To shorten the paper, we moved Section 2.2 and Figure 2 to the supplemental information. We also moved Figures 3 and 4 and much of the discussion in Section 4.1 on the meteorological evaluation to the supplemental information. In this way, the aerosol evaluation appears earlier in the text, but the trace gas evaluation is also needed to explain some of the biases in the aerosol predictions. The title of the paper has been changed somewhat to reflect precursors of aerosols that affect the simulated aerosol distributions.

The text on the aerosol extinction and AOD is presented last because those quantities are affected by the distributions of aerosol mass, composition, and size. The vertical profiles of extinction from the lidar provide the key piece of information needed to understand why simulated AOD was too high, when many aerosol species (e.g. OA, sulfate in southern CA) were too low compared with aircraft and surface measurements. In the revised text we have added some additional discussion to tie Section 5 back to Section

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4.

Several specific comments are suggested below:

Reviewer: 1. Introduction (Page 7194, lines 24-): the first objective of this study is said to describe how the multi-platform observational data sets have been integrated into the Aerosol Model Testbed (AMT). This may be more appropriately included as part of the methodology rather than a science objective: except for 2.2, most of the discussions are about the evaluation of the WRF-Chem simulations and uncertainties. Also, will this AMT testbed case and toolkit mentioned become available at the time of publication? If so, the link to the ARM front page needs to be replaced with the correct webpage.

Response: The paragraph objectives have been changed as suggested. There is a more direct link now available that will still be valid by the time of the publication, but it could be moved in the future so it is better to contact the first author directly for the datasets. Therefore, the link has been replaced and moved to the supplemental information along with some additional contact information.

Reviewer: 2. Section 3: Model description: Consider to move the discussions in the first two paragraphs about the WRF-Chem set-ups and emissions (i.e., second paragraph on page 7202) to the Appendix.

Response: While we understand that moving the text to the Appendix would shorten the paper, we prefer to leave this material where it is. Based on past studies, we find that many readers want to have some details on how the model was configured. This is an issue of reproducibility of the model results. The paragraph associated with the emission uncertainties provides motivation for the simulations chosen in this study. Readers may not see these important points in an appendix.

Reviewer: 3. Section 4: please refer to the main comment above.

Response: See response to the main comments.

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Reviewer: 4. Section 5: what's the difference between AOT and AOD here? Usually they are inter-exchangeable in the modeling world. How important is the relative humidity bias in the model and aerosol water take contributing to the AOD differences in the column? What is the main aerosol type being reduced in the 50%_LBC case? If initial conditions are reduced by half too, does it mean this sensitivity study also include adjustment of local aerosol contributions?

Response: These are not interchangeable terms. AOD is the aerosol optical depth computed through the entire atmosphere column, whereas AOT is the aerosol optical thickness computed over a portion of the atmospheric column. The lidar only sees a portion of the troposphere (in this case within 9 km of the ground), so it is more appropriate to label the vertically integrated extinction as AOT. The lidar's AOT is not the same as a satellite or AERONET measurement of AOD. To avoid confusion, text at the beginning of Section 5 is included to clarify the differences.

Relative humidity (RH) is very important; however, RH over the inland aircraft flight paths was usually very low (< 55%) so that uptake of aerosol water would be much lower than other locations of the world. Still, it is likely to be one source of uncertainty contributing to the low bias in simulated extinction. This is an important point and we have added a few sentences to this section.

Dust and sulfate are the two primary aerosol species coming from the boundaries. Other species are much smaller. 50%_LBC simulation also includes the reduction in local anthropogenic emissions. As seen in Figs. 27 and 28, extinction is reduced in both the free troposphere and boundary layer. Most of this is due to dust and sulfate (to a lesser extent), so the changes in local BC and POA emissions contribute the most to changes in those concentrations (as shown in Fig. 12).

minor comments:

Reviewer: 1. Page 7237, line 8: should be "due to missing"

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Response: Done.

Reviewer: 2. Figures 27 and 28: title of panel (a) is missing from the graph

Response: The captions for (a) were included in the files uploaded, but we failed to notice that in the galley-proofs they were cut off for some reason. We will check them in the final revision.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 7187, 2014.