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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Transport and mixing patterns over Central California during the Carbonaceous Aerosol and Radiative Effects Study (CARES)" *by* J. D. Fast et al.

J. D. Fast et al.

jerome.fast@pnl.gov

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Reviewer: The manuscript provides a nice and well-organized description of the meteorological conditions and of the performance of WRF-Chem during the CARES field campaign. In particular, the transport and mixing patterns affecting the Sacramento plume are described.

The findings in the paper are not unexpected and I suppose the main purpose is to serve subsequent papers focusing on aerosol chemistry that can refer to the transport and mixing patterns described in the current paper. Slope flows, mixing heights, and mountain venting processes are well-known to affect transport and mixing patterns in complex terrain as confirmed by the observations in the current study. These transport and mixing patterns are very important for understanding the chemistry and I am glad to see a paper focusing on these aspects. I only have a few comments that need to be addressed by the authors.

1) The performance of WRF-Chem is remarkable but it is not entirely clear how the WRF-Chem set-up/configuration was chosen. Does this configuration result in the best performance? Were there any modeling issues encountered that needed to be addressed before WRF-Chem could be run operationally? Did anything need to be changed in the WRF code compared to the released code to make the simulations work so well? If there is no space in the manuscript to describe these issues, please provide this information in an online supplement to the paper. I expect that various modeling groups would like to do simulations for various case studies during CARES and it would be helpful for them to know what was done to make WRF-Chem perform so well.

Response: We did not perform an exhaustive study to determine which parameterization worked best for California for this time of year. There are several options available for each parameterization; therefore, the number of possible permutations one is large. Instead, we chose parameterizations we have used previously in prior applications and were reasonably satisfied with their overall performance. The only modeling issue we encountered was choosing a time step that was sufficiently short so that the model would not develop numerical instabilities for a wide range of meteorological conditions. WRF-Chem was run operationally in May prior to the campaign to ensure that there were no major problems. During this period we needed to reduce the time step to 12 seconds, which was used then throughout June. We did not need to change anything in the WRF code. As is stated in the revised text, we are using parameterizations that are available in the public release of the code. There are three reasons that contribute to the good model performance: 1) the size of domain chosen, 2) terrain-induced forcing, and 3) lack of clouds and precipitation. While the domain encompasses all of

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California, it is still small enough that boundary conditions have a large impact on the predicted synoptic fields in the interior. A larger domain size could permit the forecasts to “drift” more from reality. The terrain-induced forcing is consistent from day to day during sunny conditions, leading to regular near-surface circulations. Since the synoptic patterns are predicted well, their influence on the near-surface winds are also likely to be well represented. Finally, mesoscale models are known to produce large errors during periods of cloudiness and precipitation. The lack of clouds and precipitation during CARES likely contributed to good performance in simulated near-surface meteorology. Some additional text along these lines has been added to Section 3 regarding the comment on model performance.

Reviewer: 2) WRF-Chem is only briefly described. Since this paper focuses on transport and mixing processes in the ABL, the authors should at least include a short paragraph about the selected ABL and surface layer parameterizations and the justification for the use of these parameterizations.

Response: The first paragraph of this section has been altered that refers to a new table that lists the specific physics parameterizations used and why we chose them.

Reviewer: 3) The model top at 12 km appears very low to me, especially given the high and complex terrain in the model domain including the Sierra Nevada mountains. The authors need to comment on this and provide a justification for using such a low model top (other than computational resources).

Response: We double-checked the top of the model domain, and it is actually between 16 and 20 km above the ground surface, with 16 km over the Sierra Nevada and 20 km over the ocean. The model top varies because of the vertical coordinate in WRF. We thank the author for pointing this out. The text has been revised to indicate the correct number, which is much higher than before.

Reviewer:Typing error: line 27 on p. 29951: WRF-Chem, not WF-Chem

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Response: This was correct in the paper we submitted, but “WF-Chem” occur in the type-setting process and we missed that error. It will be fixed in the final version of the paper.

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