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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Are simulated aerosol-induced effects on deep convective clouds strongly dependent on saturation adjustment?" *by* Z. J. Lebo et al.

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We thank the anonymous reviewer for his/her thoughtful comment and criticism. Our responses to the specific comment are as follows:

We agree that the representation of the ice formation processes in the bin and bulk models has the ability to influence the resulting amount of precipitation and the change in precipitation due to an increase in aerosol loading. The goal of this work is to systematically address the differences between the two model types, starting with activation and condensation/evaporation as these are the two processes most directly linked to aerosol (CCN) changes. Processes such as ice formation are further removed from

the aerosol activation process (activating as cloud droplets) and are thus left for a future study. As the reviewer notes, ice processes are critical to precipitation formation in supercells but an investigation of aerosol impacts on these processes is beyond the scope of this paper. To emphasize this point in the paper, we have modified the first paragraph of Section 2 to read:

"In order to analyze potential dependencies of simulated aerosol-induced effects on deep convective clouds on model formulation we utilize, as a benchmark, a detailed bin microphysics scheme (*Lebo and Seinfeld*, 2011) in conjunction with a two-moment bulk microphysics model (*Morrison et al.*, 2009) that has been modified specifically for the study. There are systematic differences in the representation of all microphysical processes between the bin and bulk microphysics schemes. For specifically addressing how differences in the two models can alter the simulated aerosol induced changes in convective strength, aerosol activation and droplet condensation/evaporation are the first two processes that link changes in aerosol loading (acting as CCN) to changes in cloud properties and dynamics. Thus, we present here the essential modifications and details required to rigorously assess the impact of saturation adjustment for condensation/evaporation on the simulations. It is important to note that the representations of additional processes within the cloud, e.g., collection, sedimentation, and ice formation processes, are also likely to cause differences in the predicted storm strength and precipitation pattern between bin and bulk microphysics. However, detailed investigation of these processes is beyond the scope of the current study."

Technical corrections (in the order listed in the reviewer's comment):

1. The references have been put into brackets.

2. We changed 'with' to 'due to increased'.

3. The references have been put into brackets.
4. The last sentence in Section 1 has been split into two sentences for clarity.
5. We added commas to the first and last line of Eq. (2).
6. As per the reviewer's suggestion, the long sentence has been split into two shorter sentences.
7. The phrase 'shown are profiles up to 15 km' has been changed to 'profiles up to 15 km are shown'.
8. We corrected the spelling of graupel.
9. A period has been added to the sentence.
10. We added the appropriate quotation marks that were missing from Semi-Polluted.
11. As per the reviewer's suggestion, we changed the sentence so as not to reference Fig. (11) before Fig. (10).
12. We changed 'horizontally-average' to 'horizontally-averaged'.
13. We changed 'Thus, net error ...' to 'Thus, the net error ...'.
14. The subscript 'tot' has been reduced in size to match all other subscripts in the paper.

References

Lebo, Z. J., and J. H. Seinfeld (2011), Theoretical basis for convective invigoration due to increased aerosol concentration, *Atmos. Chem. Phys.*, *11*, 5407–5429, doi:10.5194/acp-11-5407-2011.

Morrison, H., G. Thompson, and V. Tatarskii (2009), Impact of cloud microphysics on the development of trailing stratiform precipitation in a simulated squall line: Comparison of one- and two-moment schemes, *Mon. Wea. Rev.*, *137*, 991–1007.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 10059, 2012.