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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Theoretical basis for convective invigoration due to increased aerosol concentration" *by* Z. J. Lebo and J. H. Seinfeld

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I have a few questions regarding this manuscript:

First of all, I'm wondering about the time period over which the majority of the results are analyzed (which also forms the basis for a large part of the conclusions). Why do you choose to analyze the results over 4-8 hours of simulation (Figures 6, 7, 8, 12, 13, 14, 19, 20, 20, 21) and not the full time period of 12 hours? Looking for example at the high RH case and Figures 3-5, it is quite obvious that the time development for the convection is very different in the bulk and bin cases. For the bulk case, the main part of the active convective event takes place between 2 and 6 hours of simulation while for the bin case the event mainly occurs between 4 and 8 hours. I'm not surprised that you then see very a different response and almost no change in w for the bulk

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case (the main difference in w usually takes place during the first hour of development, cf. e.g. Ekman et al., 2007 and Khain et al., 2005 for examples of both bulk and bin microphysics). For the low RH case, there is a similar problem. The active convective cycle for the bulk case takes place between 4 and 8 hours while the development for the bin case is mainly between 6 and 10 hours. I think the authors should show that their conclusions are not dependent on the chosen time period of analysis.

The two schemes activate aerosols differently and it is unclear how many aerosols are actually activated into cloud droplets. If the CDNC is different between the two simulation series (bulk and bin), then the resulting change in updraft should also be quite different (cf. e.g. Ekman et al., 2011).

For the bin scheme, the authors state that they insert all activated aerosols in the smallest size bin of the cloud droplet distribution (i.e. at 3.25um). This should artificially narrow the droplet spectrum. Why not calculate the equilibrium radius and insert the newly formed droplets in the corresponding size bin? According to e.g. Khain et al. (2000) (based on detailed calculations by Ivanova et al. 1977): if the radius of a soluble part of an aerosol particle is <0.03 um, the mass of water condensing can be calculated under the equilibrium assumption while for r >0.03 um, the mass of water condensing on these CCN at zero supersaturation can be calculated as m= K*(4/3)*pi*rˆ3*rhow , where 3<K<8.

For the bulk scheme, what is the size of the activated aerosols, i.e. for the newly formed droplets? Is this also assumed to be 3.25um? If the size of the activated aerosols is different, then the amount of condensate (and thereby also release of latent heat) will be different than for the bin case.

In general, how are the aerosols (or CCN) treated in the model? What is the average size? Are the aerosols advected and scavenged or is the aerosol size distribution constant in time?

Finally, the authors state that the bin microphysics scheme performs “better” than the

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bulk scheme. How can you confirm that the bin microphysical scheme is better without any observations of the simulated case? Bin microphysical schemes also have issues (e.g. artificial droplet spectrum broadening) are also based on a number of assumptions and parameterizations (for example for ice activation) so they cannot be considered as the truth.

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