Atmos. Chem. Phys. Discuss., 11, C2972–C2974, 2011
www.atmos-chem-phys-discuss.net/11/C2972/2011/


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

**Z. J. Lebo and J. H. Seinfeld**

zachlebo@caltech.edu

Received and published: 9 May 2011

We first would like to thank Dr. Ekman for her thoughtful comments.

Since the precipitation curves are plotted on the same $y$-axis, the degree to which the slopes increase in the bin simulations is a bit misleading. The figures showing cumulative precipitation have been changed in the final draft in that all curves (both bin and bulk) are in the same figure but with different $y$-axes. As result, the curves for the simulations performed with bin microphysics are no longer suppressed to the bottom of the figure.

Regarding aerosol activation, it is true true that if the number of cloud droplets predicted by the bin and bulk schemes differ, the resulting change in updraft velocity and other



microphysical properties of the cloud will be different. However, it is not the purpose of this study to minimize the differences in bulk cloud properties, updraft velocity, etc., between the bin and bulk schemes. The fact that the models do differ can result in large part to the way in which certain processes are parameterized or represented in the schemes. With that said, we do realize that the current method of activation in the bin scheme may not permit us to accurately predict changes in cloud properties and ultimately precipitation. As a result, we have included in the revised draft of the manuscript a detailed description of the binned aerosol size distribution and activation characteristics based upon the work of *Kogan* (1991); *Khain et al.* (2000) and *Xue et al.* (2010). With the new scheme, the aerosol number concentration is no longer fixed. The details of the initial size distribution are included in the methods section of the revised manuscript and the activation scheme is coupled to both microphysics schemes.

In regard to the use of the term "better" when referring to the performance of the bin scheme in comparison to that of the bulk scheme, we do feel that the bin model should provide more accurate results in such detailed simulations given that the bulk model assumes the cloud is at saturation at the end of each timestep (i.e., the model includes a saturation adjustment) while the bin scheme does not. Given that the growth timescale of cloud droplets can be larger than that of the model timestep (i.e., *Chuang et al.*, 1997), the cloudy environment could, and often does, remain supersaturated after the microphysical calculations are performed. In order to verify which model is in fact "better", one would need to perform real simulations using ambient soundings taken from the field along with correspond data collected from within the cloud and precipitation amounts at the surface as opposed to the idealized runs done for the current study. Performing such a field study is quite difficult since nature does not permit us to look at the same storm twice, once with low aerosol loading, and then again with an increased aerosol loading. Determining a superior model is beyond the scope of this study and we leave this point for future work.

## References

Chuang, P. Y., R. J. Charlson, and J. H. Seinfeld (1997), Kinetic limitations on droplet formation in clouds, *Nature*, *390*, 94–96.

Khain, A., M. Ovtchinnikov, M. Pinsky, A. Pokrovsky, and H. Krugliak (2000), Notes on the state-of-the-art numerical modeling of cloud microphysics, *Atmos. Res.*, *55*, 159–224.

Kogan, Y. L. (1991), The simulation of a convective cloud in a 3D model with explicit microphysics. Part I: Model description and sensitivity experiments, *J. Atmos. Sci.*, *48*, 1160–1189.

Xue, H., A. Teller, R. Rasmussen, I. Geresdi, and Z. Pan (2010), Effects of aerosol solubility and regeneration on warm-phase orographic clouds and precipitation simulated by a detailed bin microphysics scheme, *J. Atmos. Sci.*, *67*, 3336–3354.

---

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 2773, 2011.