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Interactive Comment

Interactive comment on "An explicit study of aerosol mass conversion and its parameterization in warm rain formation of cumulus clouds" *by* J. Sun et al.

Anonymous Referee #1

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Review of ACPD-13-590 manuscript:

"An explicit study of aerosol mass conversion and its parameterization in warm rain formation of cumulus clouds" by Sun, Fen and Ungar.

General comments:

This manuscript presents a detailed numerical study on aerosol mass conversion within water drops using a bin aerosol-microphysics scheme coupled with a 1.5-dimensional non-hydrostatic cloud model. The aerosol mass conversion rates associated with drop autoconversion and accretion processes have been examined under different initial aerosol size distributions and different radius thresholds for raindrops. The authors found that the aerosol mass conversion rate can be generally parameterized as a power-law relation to water mass coalescence rate. The exact relation and fit uncertainty (dispersion) are determined by initial aerosol size distribution.

The topic of cloud processing of aerosol is appropriate for ACP in general. The work being done in this manuscript is valuable to aerosol-cloud interaction modeling community. However, the work presented here has been more or less covered by a recent study published in JAS (Lebo and Morrison, 2013). Also, some important aspects of the study are missing, which makes me hesitate to recommend publication on ACP.

Major comments:

1. The authors mentioned several times in the manuscript that the aerosol activation is a dominant process to determine the initial cloud droplet size distribution and initial aerosol mass distribution inside drops which then determine the aerosol mass conversion process. Indeed, Lebo and Morrison (2013) also found that once a reasonably accurate aerosol activation scheme is included in a bulk scheme, the simple scaling method (aerosol mass conversion rate scales with water mass conversion rate) can simulate the cloud processing of aerosol reasonably well compared to results simulated be detailed 2-dimensional aerosol-microphysics scheme. However, there is no discussion and description of how aerosol activation is treated in this study. Given the extremely important role the aerosol activation plays in the aerosol-cloud interaction, it is necessary for the authors to explore the relation between such process and the subsequent aerosol mass conversion process in detail.

2. The case simulated here is a convective mixed-phase cloud. Although the ice-phase microphysics was turned off in the model, the warm-phase processes at high altitude are essentially unrealistic. The exclusion of ice processes will make vapor saturation ratio higher than it should be at levels below freezing point. The condensation process of water droplet is then artificially exaggerated, which impacts coalescence process

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and aerosol mass conversion process subsequently. Therefore, a pure warm-phase cloud case is more appropriate for the topic investigated here.

3. Under many conditions, the errors of the power-law relation reach an order of magnitude (Fig. 16 (g)-(i)) which indicate the uncertainties of such relations. It might be interesting to see if power-law relations of the envelop (in these cases, the majority of the points reside on the boundaries of the scatter plot) can provide better parameterization.

4. The manuscript is a bit verbose. Many discussions are redundant. Significant efforts are needed to improve the readability of the manuscript.

Reference

Lebo, Z. J. and Morrison, H. 2013: A Novel Scheme for Parameterizing Aerosol Processing in Warm Clouds. J. Atmos. Sci., 70, 3576–3598. doi: http://dx.doi.org/10.1175/JAS-D-13-045.1

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 25481, 2013.