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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Quantifying the aerosol effect on droplet size distribution at cloud-top" *by* Lianet Hernández Pardo et al.

Anonymous Referee #1

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In the manuscript by Pardo et al., the Authors perform a series of simple model based sensitivity tests on aerosol-cloud interactions, with the intention of mapping the sensitivity of cloud properties (number of droplets, droplet size) to several parameters describing the aerosol population. The modelling work is performed with a sectional cloud microphysics scheme coupled to a 1-dimensional column model, which is driven by initial conditions representative of those in the Amazone region and an idealized vertical velocity profile.

Basically, the analysis appears sound, revealing the importance of several aerosol parameters to key cloud microphysical properties. While this is all very interesting, my primary concerns are about the representativeness of the results and the modelling methods used to produce the data for this purpose. Indeed, the Authors state that

the 1-d model (the KiD kinematic driver) is designed mainly for testing microphysical schemes with a consistent kinematic framework. This is true, and in my opinion, it cannot account for important cloud dynamical responses to aerosol perturbations, which we by now know are essential to really understand the aerosol effects on clouds, particularly so in convective cumulus clouds. In particular, I find it rather surprising that the Authors do not consider e.g. how entrainment would affect their results. To back up the representativeness of the results compared to actual clouds, the importance of the dynamics should be somehow evaluated. This would most likely require at least a major review before being published in ACP. I will try to outline my concerns in more detail in the specific comments below.

1. First and foremost, how do you justify using a simple 1-d model, which obviously cannot treat e.g. effects of entrainment, to study aerosol effects on highly dynamic convective cumulus clouds? I agree that you can capture the purely microphysical response with this system (that's what it is designed to do). Even though this is interesting to an extent, I think the results from this setup describe the functionality of the microphysics scheme instead of telling us what we should expect to observe in reality (which can be very different things).

2. The representation of the aerosol size distribution seems very static. I get the impression that cloud activation does not affect the size distribution shape or mean size, just the number. I think this is not a very robust assumption for a study like this. Do the model simulations assume some sort of aerosol replenishment mechanism?

3. Is the assumed vertical velocity profile consistent with the initial temperature profile, if you think about it in terms of releasing an actual thermal? Moreover, since also the evolution of the updraft profile in time is prescribed, do the initial temperature/humidity profiles evolve consistently with the updrafts?

Minor questions:

1. Regarding the discussion on the role of r_a on pages 8-9: the Authors appear to

specify a simple unimodal aerosol size distribution for their simulations (which is fine for this study, I suppose). However, the accumulation mode can most of the time be distinguished in observations and the accumulation mode number concentration specifically is often contrasted to the number of cloud droplets. So doesn't the apparent sensitivity on r_a really fall back to separating the specific mode number concentrations?

2. The manuscript does not really say anything about precipitation. Does precipitation form in the clouds you're simulating? If so, is the aerosol population subject to wet scavenging effects?

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