Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC1
https://doi.org/10.5194/acp-2021-506-RC1, 2021

Comment on acp-2021-506

Anonymous Referee #1

Referee comment on "Impact of hygroscopic seeding on the initiation of precipitation formation: results of a hybrid bin microphysics parcel model" by Istvan Geresdi et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-506-RC1, 2021

The authors develop a hybrid bin microphysical parcel model to study the impact of hygroscopic seeding on the precipitation formation. Moving bins and condensational growth of droplets with solute effect are used below and close to the cloud base. Fixed bins are applied at 100 m above the cloud base, where solute effect is ignored but collision coalescence is considered. Initial background aerosol conditions and updraft profiles for control cases are obtained from two weather modification field campaigns. For comparison, three types of seeding materials with different concentrations, sizes, and hygroscopicity are used to test how hygroscopic seeding might affect the precipitation formation. Although the hybrid parcel model is suitable and the observational data is valuable, results and conclusions from different model setups (e.g., aerosol size distribution, concentration, size, compostion of background aerosol and seeding materials, vertical velocity) are not clearly described. More efforts are needed to make the manuscript clear and convincing. I suggest major revision to improve the quality of the manuscript and my comments are listed below.

1. Figure 1. Is temperature also prescribed for the parcel model? If so, the parcel model used in this study is not adiabatic, which might explain why the ratios of liquid water content are large for some cases in Figure 8a (see my comment 13).

2. Eq. 1 approximates the Kappa-Kohler theory. The approximation might not hold for coarse-mode aerosols. I suggest using the complete Kappa-Kohler theory for the saturation ratio over an aqueous solution droplet (Eq. 6 in Petters and Kreidenweis 2007). If not, at least justification is needed.

3. Eq. 3 and Eq.6. The “new” parameters are confusing, e.g., it looks like that doubling the hygroscopicity parameter is equivalent to half coarse particles, which is not true. In my point of view, “Hc” is not a general parameter that can be used for future applications, because it is not derived from the first principle. I suggest the authors add more

justifications and discussions of why and the benefit to introduce this new parameter.

4. Line 164. “kappa = 20 is the hygroscopicity of dry nanoparticles”. Any reference to support such high value of hygroscopicity? I cannot find it in Tai et al., 2017.

5. Lines 187-189: “The monotonic increase of the reflectivity with increasing Hc…” This statement is not convincing. To support this argument, the authors need to do sensitivity studies by just changing the hygroscopicity of the coarse particles but keep other variables (e.g., droplet size distribution, aerosol number concentration, and vertical velocity) the same.

6. Figure 4a. Sub-micrometer droplets (r<1 um) exist at 100 m above the cloud base, but they do not exist at 1000 m above the cloud base. Please explain why? Are they all activated as cloud droplets?

7. Figure 4c. Droplet radius for r0=5 um is already over 10 um at the beginning of the simulation. How do you calculate the initial droplet radius at the beginning of the simulation?

8. Line 206. “Figure 4c shows the evolution of drop sizes with different initial dry radii.” I’m confused. Are monodisperse aerosols used for Figure 4c and 4d?

9. Lines 258-261. “the broadening effect is found to be negatively associated with the concentration of the background coarse particles…” Text here might mislead the reader that seeding is more efficient when the concentration of the background coarse particles is less. It is unfair to make comparisons between BGQNC_1 and BGQNM_1 because they have different aerosol size distributions, number concentrations, and compositions.

10. Figure 8. What are the reasons for the cases with high ratio of liquid water contents (up to 1.6)? I would expect the liquid water content at 100 m above cloud base is similar (close to adiabatic value) for different cases, as shown in Figure 4b.

Minor comments:

1. Line 105: Add more descriptions of bin method, e.g., gridded uniformly in radius, or mass.

2. Line 155: Please add more descriptions of the seeding materials (nanoparticles, ICE70, and NCM).

3. Figure 1. Solid circles are cases for BGUAE_1? It is not clear in the Figure and captions.

4. Line 184. “27 control cases are simulated. Figure 3a…” Not all 27 control cases are shown in Figure 3a. Add more discussions of which cases are plotted in Fig. 3.

5. Figure 4a and others (e.g., Figure 5). The y label should be “dN/dlog(r)”. “d” is missing.