

Review of “Predicting the morphology of ice particles in deep convection using the super-droplet method: development and evaluation of SCALE-SDM 0.2.5-2.2.0, -2.2.1, and 2.2.2” by Shima et al. (gmd-2019-294)

The revised manuscript addresses most of my previous concerns and is almost ready to be published. I enjoyed reading it, and I only have very minor suggestions, which the authors may consider.

Minor Comments

P. 8, ll. 25 – 27: It might also be worthwhile to state that the relaxation of very small particles to the surrounding fluid is so fast that (2) needs to be solved with a very small timestep, which is certainly not in the spirit of a computationally efficient model. See, e.g., Chen et al. (2018).

P. 9, ll. 9 – 17: Why do you state the wrong d_i and q_i in Eq. (4) and give a warning in the following text? It might be clearer to state the correct d_i and q_i in (4) and then state that the wrong values are used in the presented study.

P. 12, l. 15: I suspect this is only the case for the numerical solution of (11). One can see that for $m_i \rightarrow 0 \Rightarrow C \rightarrow 0$ and hence $dm_i/dt \rightarrow 0$, which prevents negative m_i for a (probably impossible) analytical solution.

P. 34, ll. 29 – 30: How do you decide if a droplet is activated or not?

P. 50, l. 11: Why is the freezing/melting timescale restricted by the CFL criterion? It is not directly apparent why a microphysical timestep is restricted by a fluid-dynamical criterion.

P. 50, ll. 22 – 23: You may want to cite Árnason and Brown (1971), who showed nicely that the model timestep for condensation/evaporation needs to be smaller than the phase relaxation timescale.

P. 62, ll. 29 – 30: I agree that evaporation delays the melting process, but how does it delay the “melting onset”? I assume that before the melting onset, the considered particles consist of pure ice, and hence only sublimation might cool the particle.

Technical Comments

P. 2, l. 26: “composition”, not “compositions”

P. 5, l. 15: Although “Appendixes” is technically correct, I suggest using the more common “Appendices”.

P. 12, l. 6: I suggest adding “particle-averaged” before “ventilation coefficient”.

P. 17, l. 5: For clarity, add “real” before “particles”.

Fig. 1: This figure looks more like a table. Consider changing the caption.

Figs. 5, 6, 16, 17: I suggesting removing the (meaningless) empty brackets “[]” from the labels on the abscissa.

References

Árnason, G., & Brown Jr, P. S. (1971). Growth of cloud droplets by condensation: A problem in computational stability. *Journal of the Atmospheric Sciences*, 28(1), 72-77.

Chen, S., Yau, M. K., & Bartello, P. (2018). Turbulence effects of collision efficiency and broadening of droplet size distribution in cumulus clouds. *Journal of the Atmospheric Sciences*, 75(1), 203-217.