Comment on acp-2021-382
Anonymous Referee #1

Referee comment on "Improving the Representation of Aggregation in a Two-moment Microphysical Scheme with Statistics of Multi-frequency Doppler Radar Observations" by Markus Karrer et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-382-RC1, 2021

In this study the authors use detailed multi-frequency radar observations in order to constrain key parameters in a 2-moment bulk microphysics scheme that are important for the parameterization of snow aggregation. The authors examine the problem in detail in a simple 1D context and then expand their tests using a 3D LES model. Overall, I think this is a great paper and a solid piece of scientific work. I liked the authors’ initial premise that tuning of physics parameterizations based on “large-scale” results can be deceiving due to the potential for compensating model errors and their strategy of attacking the problem on an observation-based process level study. This paper is an excellent illustration of how to tune (constrain) a microphysics scheme on a process level – which is a difficult task – using observations.

I really do not have any constructive comments to add regarding things that could be improved in the paper, which I think is essentially publishable in its current form. The comments I made below are simply offered as food for thought for the authors, which they may wish to comment in the paper (as they see fit). Overall, great paper.

Specific Comments

- This study makes comparisons between direct radar measurements (i.e. variables in radar space) to comparable model variables that are computed using instrument simulators. If I understand correctly, the alternative approach would be to apply retrievals to the radar observations and convert those to fields that are more directly
comparable to model fields. Could you please comment on the relative strengths and weaknesses of the two approaches? For modelers, the second approach seems more intuitive. (I may be getting confused with dual-polarization retrievals.)

- Could (and should) the approach used in this study be applied to parameterize tendency rates for the spectral width (i.e. for triple-moment treatment of snow) for aggregation (and other processes, such as break-up)? Could you please comment on whether triple-moment snow would improve the representation of the effects of these processes?

- In the collection kernels, is there not a slight “break-down” for the situation where the collector and collectee particles have similar sizes, and hence fall speeds, for the analytic solutions (that is, is the kernel values are underestimated)? It was my understanding that that was one of the reasons some schemes use numerical calculations and lookup tables to compute collection rates. On the other hand, I guess the good results summarized in Fig. A1 speak for themselves.

Minor Points

- Line 139 and beyond: Probably at this point you could stop using quotation marks when writing “snowshaft”.
- Line 160: “horizontal resolution” should be “horizontal grid spacing”; “vertical resolution” should be “vertical grid spacing”.
- Line 293: On the other hand, the use of look-up tables allows for accurate and numerically efficient run-time integration, both of which are non-trivial advantages.