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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Rapid ice aggregation process revealed through triple-wavelength Doppler spectra radar analysis" *by* Andrew I. Barrett et al.

Anonymous Referee #2

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1 Summary

This manuscript proposes a new algorithm to retrieve the particle size distribution (PSD) from vertically pointing Doppler profilers at 3 frequencies, using the spectral dual-wavelength ratio and not the ratio of integrated reflectivity values as in previous work. This algorithm is then applied in the context of the study of a given cloud, to investigate the dominant microphysical processes taking place and explaining the measured Doppler spectra. Rapid aggregation appears to be the best candidate among various processes to explain the observed behavior.

2 Recommendation

The algorithm and the application for microphysical interpretation that are presented in this manuscript are innovative and relevant. A "direct" PSD estimation without any assumption about its mathematical functional form is promising and useful. But there are also a number of assumptions that are required to run this "inversion", and they are not all clearly described and discussed. It is hence difficult to understand in which framework this approach can be safely used, and the example presented in this manuscript remains rather specific. The manuscript is pleasant to read with quality illustrations. Overall, I am convinced that this manuscript presents innovative and original material that are worth publication, but after having addressed the issues listed below.

3 General comments

1. Information about the methodological side is missing: no detailed/exhaustive description of the proposed PSD spectral retrieval algorithm is provided, making it difficult to check or reproduce for instance. I suggest the authors to add detailed description (including equations and so on) of the different steps of the algorithm.
2. The case study is too limited (40 min of a single cloud) to derive general insights beyond the demonstration that the proposed method works, at least for one cloud. I understand the difficulty to expand the analysis, but this example is too limited in itself (see below).
3. From a more general point of view, I have the feeling that this manuscript "oscillates" between the two Copernicus journals AMT and ACP, between a more methodological point of view (e.g. the retrieval algorithm) and a more meteorological point of view (case study of rapid aggregation in a cloud). So in the end, the reader is somehow frustrated: on the one hand, the paper proposes

a new retrieval method (AMT side), but does not provide enough description of this method for the reader to implement it; on the other hand the case study is too limited to gain any general insights into cloud microphysics (ACP side). I am fine with the authors choosing ACP, but I would strongly recommend to add more explanations about the proposed retrieval technique, as well as more discussion about the limitations and the conditions in which this approach is valid. There is some content in this direction in the conclusion (p.15, l.7-11) but only the verticality and the beam width are discussed, not the requirements in terms of turbulence, (supercooled-)liquid water or not, the geographical representativity, etc.

4 Specific comments

1. P.8, l.2: optimal with respect to what? Which fitting method is employed to estimate the power-law parameters?
2. P.8, l.2: why using a power law between vertical terminal velocity and the size?
3. P.8, l.10: so the 3 GHz spectra are used “only" for large particles? If so, the proposed approach is essentially dual-frequency. Should the title be adapted?
4. P.10, l.26-27: what are the plausible mechanisms to explain the generation of these new ice particles? Maybe it was mentioned somewhere but if so, I missed it.
5. P.11, l.25-27: is a SNR threshold applied prior to run the retrieval, in order to filter out the noisy values?

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