**Atmospheric
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Discussions

AMTD

Interactive comment on "The importance of particle size distribution shape for triple-frequency radar retrievals of the morphology of snow" *by* Shannon L. Mason et al.

Anonymous Referee #1

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Title: The importance of particle size distribution shape for triple-frequency radar retrievals of the morphology of snow

Authors: Mason, Shannon L. Hogan, Robin J. Westbrook, Christopher Kneifel, Stefan Moisseev, Dmitri

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General Comments: Overall, this is a very well-written and insightful manuscript. It presents novel results looking at the efficacy of triple-frequency retrievals while still building off prior results, putting its results in context of recent literature, and suggesting pathways for future research. I found no major concerns with any of the underlying

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science; the majority of my comments are minor and related to improving the clarity of the manuscript. For the most part the figures are very clear while containing a lot of information for readers. Based on this, I recommend the paper for publication pending the below corrections.

Specific Comments:

1. This may be personal preference, but throughout the paper "PSD shape" is used to refer to the parameter μ – while I understand in the normalized distribution space μ does modify the actual shape (width) of the distribution, when talking about μ I think it may be clearer to refer to this as the "PSD shape factor" or "PSD shape parameter", as done on P4 L9.

2. P2 L30-L32: Are triple-frequency measurements always at precisely 95 GHz, 35 GHz, and a third frequency below 15 GHz? Or is that just what is used in this study? I would consider modifying this sentence to say something like "Typically, . . ." or "In this study, . . .".

3. P3 L13-L14: This sentence needs some clarification, as numerous studies have already been described that employ triple-frequency radar retrievals. Can the exact novel aspect of this study's triple-frequency radar retrieval be stated more clearly here?

4. P4 L16-17: This sentence is a bit confusing. Given the description of the assumptions on how each particle is treated (e.g., as a homogenous spheroid) when calculating the radar backscatter cross-sections, it might be clearer to state something along the lines of, "Approximations of the microphysical structure are used to calculate the radar backscatter cross-section", or, "The microphysical structure is represented through an approximation when calculating the radar backscatter cross-section".

5. Figure 2: There should be boxes around the legends, particularly in panel (b) to differentiate it from actual data points. It should also be clarified that the y-axis units in (a) are in linear units (or convert them to log units) since it was previously stated DWR

would be expressed in dB. Finally, the y-axis labels have no context – what is f? For (a), either explain in the caption or just convert it to dB, since DWR has already been explained in the text, and for (b) perhaps just state "Volume-Weighted Concentration".

6. P9 L29: ". . .. The many narrow features of the backscatter cross-section ratio spectra are smoothed out" should have "when integrated across the PSD" added to it.

7. P14 L1-L4: I was initially confused with how this differed from the analysis presented in Figure 1, but gathered later that the PSD shape factor and density factor used were informed by the observed precipitation. I suggest making that fact more explicit and putting it earlier in the section.

8. P14 L10: It looks to me like the frontal snow regime has DWR10-35 exceeding 10 dB?

9. P16 L24: The sentence "the state vector is linearly interpolating between the retrieved state vectors at the retrieved value of PSD shape. . ." is unclear to me. Once the optimal μ value is found, which state vectors is the "retrieved" state vector interpolated between? Also, should "found by" be before "linearly interpolating"?

Technical Corrections:

1. P1 L1: "cloud" should be "clouds"

2. P2 L26; P12 L8; P12 L20: "remote-sensed" should be "remotely-sensed"

3. P2 L26-L28: This sentence should be modified to be, ". . . in-situ measurements of snow events (Kneifel et al., 2015), but more detail of how the parameters. . .. remains to be explored."

4. P2 L31-L32: No hyphens are needed between the frequency and unit as they are not acting as compound descriptors in this context. 95 should also have a 'GHz' after it, and I'd add a comma after "35 GHz".

5. P3 L10-13: These sentences should be reworked avoid three separate clauses

strung together with semicolons. Consider making the third clause its own sentence.

6. P4 L16: "in" should be "as".

7. P6 L6: "95-GHz" should be "95 GHz".

8. P6 L20: "assumptions to" should be "assumptions of".

9. P7 L8: "(Kneifel et al., 2015)" should be "Kneifel et al. (2015)".

10. P7 L25: I believe this semicolon should be a comma.

11. P9 L14-L15: I would be consistent and just refer to "the ratios between radar backscatter cross-sections at 10-35-GHz and 35-95-GHz" as the DWR10-35 and DWR35-95 as already done in the text. This applies to the legend and caption of Figure 2 as well.

12. P16 L27: "The retrieved timeseries of PSD…" should be "The retrieved timeseries of PSD shape…"

13. P16 L29: "…the retrieved PSD noisy…" should be "… the retrieved PSD shape [factor] is noisy…"

14. P17 L24: "mixed-phase cloud" should be "mixed-phase clouds".

15. P17 L25: Should "distribution" be "relation"?

16. P18 L5: A space is needed after "surface".

17. P19 L1: "case comprised compact graupel…" should be "case was comprised of compact graupel…"