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Comment on amt-2021-78

Anonymous Referee #1

Referee comment on "Analysis of the microphysical properties of snowfall using scanning polarimetric and vertically pointing multi-frequency Doppler radars" by Mariko Oue et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-78-RC1, 2021

This paper presents a detailed case study of snowfall observed at the Stony Brook Radar Observatory on Long Island, NY, using triple-frequency and polarimetric radar measurements, and supported by in-situ particle imaging at the surface. The authors first demonstrate that triple-frequency radar analysis depends on the selection of radar frequencies, and that the K and Ka bands aren't sufficient differentiated to use in this study; this motivates the use of mean Doppler velocity (MDV) and differential MDV, which are shown to effectively differentiate unrimed and rimed snowfall. Polarimetric radar variables and in-situ information are used to confirm and support microphysical insights, and in finally the processes of aggregation and riming observed in this case study are mapped to the MDV-DWR diagram.

This is an important study, well-written and clearly presented: it introduces a new source of high-quality snowfall data, presents a comparison of triple-frequency, dual-frequency and Doppler, and dual-frequency and dual-Doppler diagrams in terms of how effectivity they can differentiate the observed snowfall regimes, and applies additional insights using polarimetric variables and in situ measurements. The introduction provides strong links to the literature, and the significance of the work is clear in the discussion and conclusions. The figures are generally clear and easy to read.

I recommend this paper for publication subject to a few, mostly technical, revisions, according to the comments below.

Major comments:

- My only major comment is that the paper could benefit from a more specific and meaningful title: this title tells us very little about the measurements taken, the snowfall observed, or the process insights that are made.

Minor comments:

- Figure 1: the key in panel (a) is very difficult to read; it might be possible to add a secondary key showing that solid lines are used for mu=0, and dashed lines for mu=4, so that the number of lines in the first key can be almost halved, and the font size increased.
- Figure 1: the extents of the axes are almost consistent between panels, but not quite. This would help to make the panel intercomparable.
- L111: Mason et al. (2018) is the better citation for using Doppler velocity to infer particle properties
- Titles of sections 2.1, 2.2 and 2.3, and Table 1. This is mostly done well throughout, including the captions to Figures and 1 and 3, but please ensure consistent use of radar bands and frequencies. For example, MRRPro is introduced as a K-band radar in Section 1 (L158) and Section 3 (L306), but not within Section 2.3 or Table 1, whereas both notations are used for KASPR (Section 2.1) and ROGER (Section 2.2). This is all obvious to most readers, but might as well be consistent.
- Figure 2 caption: no Hogan and Westbrook (2017) paper is included in the bibliography; which particle fall velocity model should this refer to?
- Figure 5 & 6: there's a lot of visual comparison asked of the reader in this paper, between different radar variables. Is it possible to use the same height coordinates across different panels for ease of comparison? I'm aware this isn't always practicable, but it is appreciated where possible.
- Figures 5 & 11: the time axes here are in decimal hours UTC, which conflicts with the "HH:MM" values referred to throughout the text, and used in Fig. 4f and in the titles to Fig. 6. Again, might as well be consistent, especially where these terms are used to refer to very specific features.
- L749—50: do I understand this first criterion correctly, that you remove data that relate to particles that are both smaller than 1mm and falling faster than 1.5 m/s? This seems to be the correct reading, but on first glance I thought it meant you were excluding all data with particles smaller than 1mm, and all data with velocities greater than 1.5 m/s. A slight rewording might help make this clearer.
- Figure 12, L820--854: Is it possible to strengthen the links between this diagram and the features identified in the case study by relating the different stages (1—4 in the diagram) to the different regions in the case study (A—D)? When the paragraph starts "Regions that included fallstreaks were dominated by..." , the reader will want to be reminded of which regions, and in which figures these features were

evident. This diagram helps to make more explicit the processes linking regions A to B and C to D, so it's worth using the regions that have been used throughout the rest of the paper.

Typos:

- L279: a missing space
- L302: "non-precipitating cloud case"?
- L333: "should"
- Table 1: Are these really the range of velocity resolutions used for MRRPro in this study?
- L511-2: "...each of which had similar..." I think "similar" is ambiguous here, since it could be read to mean that the four regions had similar values to each other, not similar values within each region. Perhaps something like "distinct" or "characteristic" would be better.
- L664: "winter storms"
- L695: A leftover period.
- L715: "envelope"
- Figure 10 caption: I think the reference to Sect 3.4 should now be Appendix A
- L759: "...series are..."
- L775: "...2D particle projections..."
- L783—5: "...which heavily rimed having faster fall speeds" is confusing, and either "polarimetic variables" or "polarimetric observations" probably works better.
- L800: A missing sentence, or an extra period.
- Figure 12: There are no values on the x-axis