Review of "Sizing ice hydrometeor populations using dual-wavelength radar ratio" by Matrosov et al.

Anonymous Referee #1

Referee comment on "Sizing ice hydrometeor populations using the dual-wavelength radar ratio" by Sergey Y. Matrosov et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-174-RC1, 2022

The study by Matrosov et al. evaluates a retrieval of hydrometeor characteristic size based on multi-frequency observations from the ICICLE campaign. The dual-beam radar configuration at W- and X-band provide a unique dataset to investigate sensitivities in the radar reflectivity affected by non-Rayleigh scattering from larger ice and the preferential orientation of hydrometeors. The authors leverage in situ microphysical observations and radar measurements near the aircraft to determine how dual-wavelength ratio impacts the magnitude and uncertainty of the characteristic particle size. While there are areas in which the authors should consider further details and analysis, I believe that the manuscript should be accepted for publication in AMT once the following Minor comments are addressed.

Minor Comments

- Manuscript title: Consider adding which types of clouds this retrieval applies to or include the ICICLE campaign as these results were not extensively tested on other cloud/system types.
- L90: More details on the microphysics are needed. What combinations of probes were used (e.g., PIP vs. HVPS) for the composite size distributions? What size ranges were used for the 2D-S and PIP/HVPS when combining the distributions? How were the probes oriented?
- 2b and L156: Can you comment on whether only 2D-S images were used in the habit classification? I assume this is the case. If so, you should mention that the true habit breakdown may be different than shown since larger crystals may constitute aggregates from columns or planar crystals.
- L176 & Fig. 4: "…provide a better fit…" could probably use a statistic quantifying this agreement.
- L220: Specify the DWR and Dv bin increments used to generate Fig. 6.
- L292: Can you elaborate on the prefactor in the Brown and Francis m-D relationship?

The value listed doesn't seem to reflect the a = 7.38 x 10^-11 g μm^-1.9 in their study after converting to cgs units. Further, their study used a Dmean definition for particle size (Hogan et al. 2012; DOI: 10.1175/JAMC-D-11-074.1), while this study uses a Dmax definition (L329).

- Fig. 8 nicely demonstrated how the different definitions of characteristic size relate to Dv. The end of Sec. 4 alludes to how this analysis "can facilitate meaningful comparisons of characteristic particle sizes from different retrievals" but falls short of demonstrating this link to the DWR measurements. To extend upon the Dv-DWR fits shown in Fig. 4, have the authors thought about adding a figure showing either a power law or a polynomial fit for each combination of characteristic size – DWR?

Technical Corrections

- L103: References should be moved to be in line with the rest of the sentence rather than in parentheses.
- L208: process -> processes
- L315: MacFarquhar -> McFarquhar
- L322: From -> from