This study introduces a method for the retrieval of snow microphysical properties (ice water content, mean size, shape) from polarimetric and dual-wavelength radar observations. The method as introduced here is based on a bunch of rather rude assumptions, in particular the shape model (homogeneous spheroids) and the mass-size relation. In my view, the study lacks to show the effect that these assumptions have on the retrieval results and to properly state the limitations of the method.

To detail and justify my concerns:

The authors write (L588) “we have to assume a suitable m(Dmax) relationship” and I cannot agree more.
The authors obviously define “suitable” from the agreement of their scattering calculations with statistics of observations of DWR and ZDR. The scattering calculations are based on a range of assumptions, including e.g the size distribution, the mass-size relation, the spheroidal particle model, the shape of the spheroids.
Out of these, mass-size relation is rather well constrained by observations of a range of different measurement techniques (including 3D imaging of falling snow “in the wild” (Leinonen et al., 2021)) and its range of variation is comparably small. Moreover, it is a crucial microphysical parameter in weather and climate models.
On the other hand, the spheroidal particle model is a highly artificial model that is known to be not well suited to represent scattering properties of particles of low effective density like snow aggregates. This regards microwave scattering properties in general (e.g. Eriksson, 2015; Eriksson, 2018), but polarimetric properties in particular (eg. Schrom and Kumjian, 2018). Aspect ratio, in addition, is a highly simplistic parameter to describe the shape of typically irregularly shaped particles. That is, it is questionable how well aspect ratios observed from irregularly shaped particles can constrain reasonable values for homogeneous soft particles (like spheroids or even plates).
To summarize, mass-size relation is a well-constrained parameter, while aspect ratio is not and is a rather artificial parameter. Hence, I wonder (and question), why the authors chose to use a mass-size relation that is unreasonable for snow aggregates but insist on keeping the aspect ratio within “reasonable” bounds.

As I understand, the results of the retrieval method presented here strongly depend on the choice of mass-size relation. This poses the question how reliable retrieved microphysical properties (primarily IWC) are when selecting a relation that is far off the range of commonly accepted values. As stated above, I miss a comprehensive estimate of the uncertainties (or, actually, errors) that this unreasonable assumption results in - not within the (forward modelling-retrieval) system here, which is self-consistent, but in more realistic retrievals (if independently measured IWC are not available, e.g. by analysing the retrieved IWC based on a range of for different m(Dmax) in the retrieval).

The introduction to the discussion section points out two a priori assumptions on the particle properties as limitations of the method: the already discussed mass-size relation and the choice of particle model between oblate and prolate spheroids, missing to point out the much more crucial assumption of spheroids in general. This continues in the discussion of “unsuitability” of the BF95 mass-size relation, where no other reasons for the very low ZDR than the low density, seemingly exclusively resulting from the m(Dmax) assumption is discussed, which is re-iterated in the conclusions.

As source for their aggregate model, the authors cite Yang et al. (2000). I find this highly misleading. Yang et al. (2000) (as well as a range of follow-up papers building on it and extending it, including Hong et al., 2009, and Ding et al., 2017) targets the explicit modeling of scattering properties of irregularly shaped particles. The irregular, non-spherical and(!) non-spheroidal(!) shape is the crucial aspect of their shape model, the core element of that research. The authors of this study, however, reduce this complexity to the minor aspect of the underlying mass-size relation (L356: “another m(Dmax) that we use is the aggregates from Yang et al. (2000)”, falsely implying the equivalence of the m(Dmax) with the entire Yang et al. aggregate definition). Mass-size relation is likely the most un-aggregate-ish characteristic of the Yang aggregate model, was - probably - selected with not much care at that time (is that even originating from Yang et al. themselves, or where has it been taken from by Yang et al.?), and has been pointed out as a shortcoming of the Yang-aggregates by other authors (e.g. Eriksson, 2018).
To justify reference to Yang, it would be interesting to see how the scattering properties of the authors’ aggregates compare to microwave properties of the actual, irregularly shaped aggregate of Yang. As far as I am aware, they are not available for preferential orientation, but both Ding et al. (2017) and Eriksson et al. (2018) provide scattering properties for this habit (“8-column aggregate”) at radar wavelengths for totally randomly orientation, which should allow for a comparison of the predicted reflectivities and dual-wavelength ratios.

Minor comments:

L376: Could you provide a reference for that Dm from the equation you provide is the Median mass diameter? In my understanding, when D therein is the melted mass equivalent diameter, then Dm is the mean mass diameter. Are median and mean really equal here?

L384: Please specify more precisely, what Maxwell-Garnett approach was used, in particular what material forms the matrix, what the inclusions, as this can make a lot of a difference (see e.g. Eriksson, 2015).

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