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Interactive comment on "Microwave single scattering properties of non-spheroidal rain drops" *by* Robin Ekelund et al.

Anonymous Referee #2

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This manuscript describes a database of single scattering properties (SSP) developed for non-spheroidal raindrops following the Chuang and Beard (1990) equilibrium shape model parameterized by Chebyshev polynomials for EBCM T-matrix scattering calculations. This database has potential for broad application in passive and active radiative transfer from microwave through sub-mm calculations. Several useful relationships to radar-measured quantities are given and comparisons to spherical and spheroidal models are described.

Overall, this is a a nice accompaniment to the authors' previous work on non-spherical ice particle SSPs and demonstrates some practical advantages to using non-spheroidal models, particularly for zenith-pointing radar applications. I do have some concerns with some choices made in the demonstrations of the database, but these

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Discussion paper

can probably be considered minor corrections. The largest concern is the choice of equilibrium model. Why was this one chosen, and is the difference (in SSP) among different models smaller than the difference between them and the spheroidal model? I think some additional justification of this choice is needed. Otherwise, I don't see any problems in the actual calculations, and the results appear to be reasonable, so the SPP data should be considered ready for widespread use.

Minor Comments:

1. It may be confusing to use S_11 and S_22 rather than S_vv and S_hh because the definition of the scattering matrix in equation 1 uses h and v for the electric field components. Also, Bohren and Huffman use S_11,S_12,. . ., to refer to the phase matrix (rather than Z_11, Z_12,. . .) which could be confusing to some in the radar meteorology community.

2. The choice to use the Wang et al (2016) rain PSD seems arbitrary, and in any case, hides some details of the relationship between the PSD and integrated radar measurements. It would be more illustrative to use a general gamma form which is widely used in the radar and microphysics communities. For a given water content, to first order, the integrated SSP should depend on the mass-weighted mean diameter (Dm) of the distribution, with second order dependence on its dispersion, so providing these quantities and re-casting the plots in terms of Dm instead of R would be more helpful for interpretation.

3. The passive microwave radiometer simulations are valid, but perhaps not the most commonly-encountered scenario or one which would maximize the differences between the various raindrop models. It would be interesting to test a deeper rain column (up to 5km) and over a low-emissivity (calm ocean) surface. Another scenario would be from a radiometer on the ground looking up at a slant angle (the angle could be chosen to maximize polarization difference). With the results provided, I don't agree with the statement in the conclusions that these are significant discrepancies below 150 GHz.

Most spaceborne radiometers have an NEDT of 0.5-1K and after accounting for real variations in surface emissivity, and the rain PSD, it's hard to imagine a scenario where using the non-spheroidal model would provide an advantage. If anything, it seems that the spherical model is closer to the non-spheroidal model for passive microwave applications.

4. The limitation, mentioned in the final paragraph of the conclusions, that no drop oscillations were considered, should be mentioned earlier. This is important as readers may be tempted to compare the various plots of radar quantities directly to observations as confirmation of either raindrop model, but doing so would not be valid without accounting for such effects. Huang et al (2008) provide a parameterization of the raindrop canting angle distribution that may be useful if the authors wish to simulate these effects.

Huang, G., V.N. Bringi, and M. Thurai, 2008: Orientation Angle Distributions of Drops after an 80-m Fall Using a 2D Video Disdrometer. J. Atmos. Oceanic Technol., 25, 1717–1723, https://doi.org/10.1175/2008JTECHA1075.1

Technical corrections:

1. Page 8, Line 198: Fix citation style (remove parentheses)

2. Page 9, Line 203 (and references): Zrni should be "Zrnić"

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