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Interactive comment on "Microwave and submillimeter wave scattering of oriented ice particles" *by* Manfred Brath et al.

Manfred Brath et al.

manfred.brath@uni-hamburg.de

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Answers to Interactive comment on "Microwave andsubmillimeter wave scattering of oriented ice particles" by Manfred Brath et al.
Anonymous Referee #2

January 31, 2020

Reviewer:

The manuscript "Microwave and submillimeter wave scattering of oriented ice particles" is well-written, logically constructed, and highly impactful. Databases of such oriented particles, particularly with complete phase and extinction matrix information, are not available, so this dataset is expected to be groundbreaking for microwave, millimeterwave, and submillimeter-wave sensor modeling applications. The radiative transfer results are very encouraging, and show that the authors have done a good job of creating a useful dataset. After addressing some minor clarifying issues, this manuscript is ready for publication.

My biggest concern is the precision to which these calculations have been run (see lines 176-178; 283-285). I understand that these are computationally-

expensive calculations, so improving on these numbers is beyond the scope of this paper. However, the cross-polarization terms, i.e., Z12 and Z21, are orders of magnitude smaller than Z11, so these terms may be unreliable, and looking at the processed data, there seems to be a lot of noise that is of the same order of magnitude as the signal. Luckily these terms are small, and the largest expected contribution would be to radar polarimetric variables, especially LDR. I think the authors should make a note of this when discussion the precision relative to Z11 (and the other phase matrix terms).

Answer:

We have to admit that we forgot to address the accuracy of the database within the text. In the revised version, we do. Due to the high demands in view of computation time and the amount of data, we had to compromise in terms of the accuracy of the resulting scattering data, which we forgot to mention. Considering the measurement errors of existing and upcoming passive MW and SubMM sensors, which are in the order of $\mathcal{O}(1\,K)$, and the brightness temperature depression due to scattering of frozen hydrometeors, which is typically $< 100\,K$, we aim for an accuracy of the scattering database in the order of a few percent. We added a similar statement to the Section Basic setup and shape data and added it to the summary to clearly address this. Furthermore, we now relate the truncation of the spherical harmonics in Section Scattering calculations to the desired accuracy.

Reviewer:

The authors should make clear that the amplitude scattering matrix (equation 11) operates on the complex electric field terms.

Answer:

We added that the scattering amplitude matrix is a complex matrix and that it operates on the electric field, whereas the extinction, the scattering, and the Mueller matrix operate on the Stokes vector, which is a real vector.

Reviewer:

The authors should explicitly state that orientational averaging must be done incoherently, that is at the the Mueller (or Phase) matrix stage, due to the power terms in the top left block of the Phase matrix.

Answer:

We added to Eq. 2 and 3 a statement that we assume independent scattering and that therefore we assume incoherent scattering.

Reviewer:

When discussing mirror partners and mirror symmetry, please cite van de Hulst (1957) and Mishchenko (2002). There is a really nice explanation with stick figures in both publications.

Answer:

Done as suggested.

Reviewer:

Also in reference to mirror particles, for the RT simulations in section 6.1, were the particles averaged with their mirror partners (with respect to the incidence plane)? This is important for properly conditioning the Z12 and Z21 Phase matrix parameters for the target medium of preferential alignment with zero mean canting angle.

Answer:

No averaging of the scattering data of the particles with its mirrored version was done for the radiative transfer simulation. Due to the orientational averaging and the random structure of the large plate aggregate the effect of the non-mirror symmetry are so small, that we neglected it for the radiative transfer simulations. Particles like the plate type 1 atomatically fulfill this, as they are mirrorsymmetric. We added a similar statement to the text adressing this.

Technical corrections:

Reviewer:

There are minor typos throughout the manuscript that need to be fixed, but the document as a whole is very clear.

Answer:

Corrected them.

Reviewer:

There are a few symbols that did not render properly, one of which was the asymmetry parameter.

Answer:

Unfortunately, there were some problems with the font. This happened when the manuscript was uploaded to AMT. We are aware of this.