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Atmospheric Measurement Techniques Discussions

Interactive comment on "PHIPS-HALO: the airborne particle habit imaging and polar scattering probe – Part 3: Single Particle Phase Discrimination and Particle Size Distribution based on Angular Scattering Function" *by* Fritz Waitz et al.

Anonymous Referee #2

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Classification and phase discrimination of cloud particles, especially of mixed phase clouds, are of importance in a number of applications: modelling of the earth radiative balance and the clouds life cycle, interpretation of remote sensing data and so on. Phase discrimination and classification along with size estimation are usually performed using particles images. Several approaches and algorithms were reported in the literature and showed a good performance when applied to particles images. At the same time, based-on-images discrimination between droplets and quasi-spherical ice

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Discussion paper

particles is an extremely challenging task. It is well known that there exist significant differences between phase functions of water droplets and atmospheric ice particles. That fact was proved in a large number of modeling works. It was confirmed in experimental works where angular scattering intensities were measured in situ. The advantage of the PHIPS-HALO probe consist in the fact that a particle stereo-image and the corresponding angular distribution of the scattered light are recorded simultaneously. The synergy of those data provides significant improvement of the discrimination quality.

The work under reviewing addresses relevant scientific questions it is within the scope of AMT. I recommend that the paper be published in AMT after minor revisions.

Specific comments:

Figs. 1, 2 and 5; page 4 line 15; page 5 lines 11 – 14. Single spherical particles, the authors are dealing with, have the size parameter of 590 or higher. Phase functions of large spheres can be found in numerous textbooks and they differ much from "theoretical scattering functions" shown in Figs. 1-2. Mie calculations are mentioned several times in the text of the preprint before it is underscored (line 16 of the page 6) that "the calculated theoretical Mie scattering is integrated over the field of view of the polar nephelometer channels". Such important point should be underscored at the first mention of Mie calculations. And, I believe that the data from the light scattering databases by Baum et al. (2011) and Yang et al. (2013) were integrated over the field of view as well.

Fig. 1. It is written: "SOCRATES, RF02, #613, Spherical Ice". The particle shown in in Fig. 1b is not spherical; I would say it is quasi-spherical. Moreover, to my knowledge, there are no spherically symmetric particles that are able to provide such kind of the angular scattering function (ASF) as the red curve in Fig. 1c. The surface roughness and/or small internal inclusions cannot lead to an ASF that is increasing within the range [42 – 74] degrees. In my opinion, that ASF is the outcome of the deviation from

the spherical symmetry. If the authors can provide another explication, it would be useful to see it in the paper text.

page 5 lines 11 – 23. That part of the text should be revised. It is very difficult to understand how “the first discrimination feature f1” is computed even for an experienced reader. If I have understood correctly, the first step is the normalization of EVERY measured ASF by the ASF that corresponds to the spherical particle with the diameter of 100 μm. Next. What does it mean “the median over all channels”? How it is computed? Next. If the meaning of the “feature f1” is “the deviation of the observed ASF from the calculated Mie scattering”, why it has such high values for spheres as in Figs. 4a and 5a?

Figs. 4a and 5a Why the Gaussian fit of the feature f1 for droplets in Fig. 4a has the mean value (about 3.8) that differs much from the value (about 2.5) in Fig. 5a?

Section 3.2 The PHIPS-HALO provides ASFs for a particle that has random but fixed orientation in the space. To my knowledge, the databases from Baum et al. (2011) and Yang et al. (2013) provide scattering properties averaged over random orientations of particles. If so, Fig. 5 only shows that the proposed method is not in contradiction with properties of ensembles of ice particles.

Section 3.3 I would say that the calibration-and-verification approach, the authors used, is somewhat similar to methods of the neural networks. Of course, the choice of parameters in the work under reviewing is well grounded and corresponds to general features of scattering by spherical and non-spherical particles. At the same time, it would be interesting to see in future works comparison with performance of neural networks algorithms.

page 18 line 11. The HIAPER cloud radar is capable of collecting observations in a staring mode between zenith and nadir or in a scanning mode. Thus, it is worth mentioning in the text that the HCR beam was in nadir pointing mode for all Case Studies of Section 5.

Supplement (Fig. 9) In my opinion, the measured ASF differs much from the Mie calculation, especially in the range of [18 – 50] degrees. Nevertheless, the algorithm misclassified it. Thus, some improvements of the authors’ approach can be done in the future.

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