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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelling light scattering by mineral dust using spheroids: assessment of applicability" *by* S. Merikallio et al.

Anonymous Referee #3

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This is a nice and comprehensive study on scattering properties of non-spherical mineral dust compared to measurements. I urge publication in ACP because the presented facts are worth knowing and of highly scientific interest.

I have some comments and questions listed below in detail which can be summarised as follows:

a) What about the possible influence of other types of size equivalence? b) What about the validity of the shape distribution applied? c) How do the polarisation and particle measurements a la Volten et al. really fit together?

Some statements with respect to these questions should be included in the paper (Section 6?). It seems to me that the spheroidal model is rather discredited, although not all

uncertainties related to the questions a) to c) are discussed or cannot be discussed in one (this) paper. I am aware that the spheroid model is only an approximation but it is the best we have (we are able to compute the scattering properties for most situations half-decently). On the other hand, this paper demonstrates clearly that we must not rest.

Detailed comments and questions:

1) Page 3978, Line 24/25: The size of the dust particles are important. As noted later in the manuscript size distribution measurements are difficult, e.g., to measure coarse mode particles.

2) Page 3979, Line 28: What is meant with 'larger'? 30, 50 or 150?

3) Page 3981, Line 13: Obviously, volume equivalence is assumed. However, this is only one possible assumption. I think that the quantity 'size equivalence' is an important free parameter. Applying another type differing results are obtained. It would be nice to see results for various kinds of size equivalence. But I suspect that this would mean too much effort beyond the results of this paper.

4) Page 3982, Line 10, Eq. 6: As I understood the expression, case n=0 means an equiprobable distribution. It would be interesting to get an impression of the functional relationship, e.g., by plots of shape distributions (typical for the paper) as a function of the spheroid axis ratio. How do these distribution fit to measurements, e.g., carried out recently during the SAMUM campaign?

5) Page 3982, Line 14/15: The database of Mr. Dubovik was applied which uses different scattering codes, since the Mishchenko code converges only for size parameters lower than approximately 50. The larger the axis ratio the less convergent the code, especially in the transition range (to other codes, e.g., of Mr. Yang/Liou) of the axis ratio of about 2:1. How well does the database map the transition from one to another scattering code? This is important since axis ratios up to 2.8 are applied. Beyond, as

I know scattering kernels are saved in the database. How are, e.g., the cross sections derived numerically from these kernels?

6) Page 3982, Line 20-23: Some literature to the values applied would be helpful to stress these choices of the refractive indices.

7) Page 3982, Line 29: As noted in 3), volume equivalence is only one possibility.

8) Page 3983, Line 11: 'corresponding size distribution'. I do not understand this. The size distribution is constant for the sample, right?

9) Page 3983, Line 14/15: Could the authors summarize the accuracy of the particle measurements? Were the size distributions measured parallely to the polarisation measurements to ensure that always the same sample was considered? The authors know about the diffuculties of size measurements. Couldn't it be possible that there are inconsistencies between both measurements? Can it be screened out that the polarisation measurements only 'saw' smaller particles due particle losses in the experimental setup?

10) Page 3983, Line 18-19 and Page 3984, Line 8-11: How representative are then the samples?

11) Eqs. 7 an 8; Page 3985, Line 2: The cross section of a spheroid is not Pi times r^2. How is the shape really be considered in size integrations? How is the integration performed with regard to the volume equivalence case? What size ranges were considered, e.g., what minimum/maximum particle diameter assumed?

12) Page 3986, Line 3: Here, one could also refer to recent results, e.g., from SAMUM.

13) First two paragraphs of Section 4.1: To define 'coverage', are here single spheroids considered, that is, no shape distribution? A more clear description would help the reader.

14) Page 3987, Line 3: 'spheroids' –> 'spheroid'?

15) Page 3987, Line 7-11, 16-20: Would it be possible that the measurement merely detected smaller particles and larger ones were lost?

16) Fourth paragraph of Section 4.2: Could the authors present (or refer to literature) a formula of the shape distribution (not only a proportionality as in Eq. 6) as a function of the weights?

17) Page 3988, Line 26: Shouldn't be the exponent outside the absolute signs?

18) Page 3990, Line 15-16: Couldn't it be possible that the assumed shape distribution is not entirely accurate? See also point 4). What about a shape distribution of log-normal shape centered at a typical axis ratio found by in-situ measurements reported in literature?

19) Page 3991, Line 10-12: Isn't it valid only for the shape distributions applied in this paper?

20) Page 3994, Line 6-8: This is true, but isn't it in contrast to the statement in the introduction (Page 3978, Line 25)?

21) Page 3994, Line 20-22: The versatility was 'only' tested for one type of shape distributions and size equivalence.

22) Page 3995, Line 3: Size equivalence is also an important free parameter which was not investigated.

23) Page 3997, Line 19: 'validity', see 21).

24) Page 3998, Line 6-10: See 15). If the measurements were performed in the presence of merely smaller particles, the respective effective refractive index might be different to that one of the total ensemble because chemical composition and hence refractive index may vary as a function of particle size.

25) Page 3999, Line 5: What is meant with 'simplified model shapes'? Single spheroids of one axis ratio?

26) Page 4003, Line 1: 'Press et al. (1992)' –> '(Press et al., 1992)'?

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