Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
https://doi.org/10.5194/acp-2022-633-RC2, 2022

Comment on acp-2022-633

Qixing Zhang (Referee)

Referee comment on "Single-scattering properties of ellipsoidal dust aerosols constrained by measured dust shape distributions" by Yue Huang et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-633-RC2, 2022

This paper present a study of single scattering properties of tri-axial ellipsoidal particles with observationally constrained dust shape distributions. The calculated tri-axial ellipsoidal dust topics are compared with the spherical dust optics, spheroidal dust optics and the AGLSD laboratory observations. The major novelty of this work is using the observationally constrained shape distribution, both LWR and HWR, for tri-axial ellipsoidal dust optics calculation, and the results seems promising.

I believe that a perfect dust optical model should meet the requirement of both radiative effects estimation in global aerosol model and remote sensing retrievals. Usually the remote sensing retrievals need more detailed shape descriptors to reproduce the angle resolved observations. As mentioned in the paper, currently most remote sensing retrieval algorithms approximate dust aerosols as spheroidal particles with a shape distribution conflicts with observations. I think this is a good paper trying to solve this problem. The ability of the model to better reproduce the laboratory measured scattering matrices is convincing. Overall, the paper are well written and well organized.

Some comments:

1) The authors compared the calculation results with lidar field observation results. I am not sure whether the field observation meet the requirement of single scattering or not. Did the authors consider the multiple scattering effect when analyzing the results? And the aerosol mixing state? There are so many unknown factors in the field, it may be challenging to compare the model optics with field observation.

2) As mentioned in the paper, “more laboratory observations of the scattering matrices of atmospheric dust aerosols with simultaneous measurements of these samples’ microphysical properties, namely their size distribution, refractive index, and shape

distribution.” There are other laboratory measurement results of dust published (Liu, et al, JQSRT, 2019,229: 71-79, https://doi.org/10.1016/j.jqsrt.2019.03.010, and Liu, et al, AMT, 2020, 13, 4097-4109, https://doi.org/10.5194/amt-13-4097-2020), if possible, more comparisons between calculation results and laboratory measurement results are encouraged.

3) Line 205, “To obtain these weighting factors, we used Monte-Carlo sampling to randomly generate a large number of volume-equivalent …” Did the authors generate the particles for each volume-equivalent diameter D? The authors have already known the distribution of LWR and HWR, why need this Monte-Carlo sampling? Please clarify it.

4) Line 520, “they overestimate the lidar ratio (Fig. 7b) by underestimating the backscattering intensity by a factor of ~2”, and Line 535, “Kemppinen et al. (2015) added surface roughness to smooth particles with sharp corners and found that surface roughening can reduce the backscattering intensity.” From the results prsented in Fig 3-5, it seems that more detailed shape model will further widen the gap between modeled and measured backscattering intensity.

5) The optics database (Meng et al. 2010) was used in this paper. I am not sure whether this database is accessible or not. I suggest to give some information about this database in the part of Code/Data availability.