

Interactive comment on “Multi-mode retrievals for aerosol microphysical and optical properties” by Guangliang Fu and Otto Hasekamp

M. Mishchenko (Referee)

mmishchenko@giss.nasa.gov

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While this paper is neither exhaustive nor definitive, it can safely be called very useful as it adds valuable insights that should help instrument teams adopt alternative and potentially more appropriate retrieval strategies. I recommend publication after the few (mostly minor) comments listed below have been addressed.

1. The authors should make it maximally clear that the results of their study are likely to be heavily preconditioned by their choice of POLDER-like measurements (real or synthetic). The measurement accuracies selected for both intensity and polarization are hardly realistic. There is no discussion of what could happen if, e.g., an APS-type dataset were used, with its higher accuracy, more scattering angles, and wider spectral

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range (e.g., Mishchenko, M. I., B. Cairns, G. Kopp, C. F. Schueler, B. A. Fafaul, J. E. Hansen, R. J. Hooker, T. Itchkawich, H. B. Maring, and L. D. Travis, 2007: Accurate monitoring of terrestrial aerosols and total solar irradiance: introducing the Glory Mission. *Bull. Amer. Meteorol. Soc.* 88, 677–691). Furthermore, the paper is focused on what and how well can be retrieved without putting the outcome in the context of what and how accurately must in fact be retrieved (e.g., Mishchenko, M. I., B. Cairns, J. E. Hansen, L. D. Travis, R. Burg, Y. J. Kaufman, J. V. Martins, and E. P. Shettle, 2004: Monitoring of aerosol forcing of climate from space: analysis of measurement requirements. *J. Quant. Spectrosc. Radiat. Transfer* 88, 149–161). At least a short discussion of these important aspects is desirable.

2. As far as I understand, the BC aerosols are in the accumulation category and hence are treated as homogeneous spheres. If that's the case, the authors should at least acknowledge that this treatment can be exceedingly unrealistic (e.g., Liu, L., and M. I. Mishchenko, 2018: Scattering and radiative properties of morphologically complex carbonaceous aerosols: a systematic modeling study. *Remote Sens.* 10, 1634).

3. “All fine modes are assumed to have the same refractive index and all coarse modes have another refractive index value”. This assumption is highly artificial. Can its robustness be somehow checked by mixing BC and sulfate aerosols with their actual refractive indices and then performing a synthetic retrieval assuming that the refractive indices are the same? What would be the meaning and usefulness of such a retrieval?

4. The sentence “We use the Mie/T-Matrix approach of Dubovik et al. (2006) with their proposed spheroid aspect ratio distribution for computing optical properties for a mixture of spheroids and spheres” can be made factually more accurate. For example, “Nonspherical aerosols are modeled as a size/shape mixture of randomly oriented spheroids (Hill, S. C., Hill, A. C., and Barber, P. W., 1984: Light scattering by size/shape distributions of soil particles and spheroids. *Appl. Opt.* 23, 1025–1031. Mishchenko, M. I., L. D. Travis, R. A. Kahn, and R. A. West, 1997: Modeling phase functions for dustlike tropospheric aerosols using a shape mixture of randomly ori-

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ented polydisperse spheroids. J. Geophys. Res. 102, 16831–16847). We use the Mie/T-Matrix/Improved-Geometrical-Optics database by Dubovik et al. (2006) along with their proposed spheroid aspect ratio distribution for computing optical properties for a mixture of spheroids and spheres.”

5. “Number column” should be “column number” throughout.

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