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Interactive comment on “Sensitivity of PARASOL multi-angle photo-polarimetric aerosol retrievals to cloud contamination” *by* F. A. Stap et al.

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This is an interesting paper and is generally well presented and carefully written. The fact that the goodness-of-fit plus cloud mask rejects cloudy scenes while retaining scenes with high aerosol loads that “the cloud masks based on MODIS sometimes misinterpret” is a particularly interesting outcome. In the following paragraphs are a couple of suggestions to improve the paper by providing more information and/or discussions of potential issues are given.

It would be helpful if the radiative transfer code/codes that is/are use for the cloud and aerosol synthetic scenes is stated. While Hasekamp and Landgraf (2002, 2005) are cited that code is not generally used for the simulation of clouds and it would be

helpful to the reader if a clear statement of how the synthetic scenes were generated was explicitly made. This should include information such as the effective variance of the cloud droplet size distribution since a narrow size distribution would give more opportunities for detecting clouds using secondary and/or supernumary bows.

In the test of cloud effects using synthetic scenes uncertainties of 1.0% relative error in intensity and an absolute error of 0.005 in the degree of linear polarization (DOLP) are used. Then in the retrievals on POLDER data a measurement precision of 0.005% for the intensity and 0.0035 absolute error on DOLP are used. The number for the intensity appears to be in error. Moreover the authors subsequently note that: “The extent to which a comparison can be made with the fraction of good fits of the synthetic retrievals is limited, since the COT is not known for most of the partially clouded PARASOL pixels for the different cloud fraction bins that are used for Figure 2. Furthermore, the retrieved $\chi 2$ values in PARASOL scenes are expected to be higher on average than those found in the synthetic retrievals. This is in part due to the higher measurement precision that is used for calculating the $\chi 2$, which gives differences between the model and measurement more weight.” This suggests that the measurement precision assigned to the POLDER data is unrealistically high. If the balance between prior and likelihood needs to be adjusted it would usually be preferable to adjust the prior, rather than having an unrealistically low likelihood. This would allow for at least qualitative comparisons between the synthetic study and the POLDER study. The authors should at a minimum justify a choice that, as they note, makes a comparison to the synthetic study almost pointless.

Some justification of Eq. (2) should be given. Zhai et al. (Zhai, P.-W., Y. Hu, C.A. Hostetler, B. Cairns, R.A. Ferrare, K.D. Knobelspiesse, D.B. Josset, C.R. Trepte, P.L. Lucker, and J. Chowdhary, 2013: Uncertainty and interpretation of aerosol remote sensing due to vertical inhomogeneity. J. Quant. Spectrosc. Radiat. Transfer, 114, 91-100, doi:10.1016/j.jqsrt.2012.08.006.) found that an optical depth weighted average of a bimodal size distribution was what their single mode optimal estimate scheme retrieved. Depending on the particle size the volume weighting is similar to an optical depth weighting, but not for coarse mode particles. This equation needs a little more discussion of its limits particularly given the problematic comparison of AERONET and POLDER retrieved real refractive indices. It might be worth noting, though this would perhaps be rather contentious, that the AERONET approach using a single refractive index in effect is impossible to validate since even closure with in situ observations would generally tend to separate any analysis of refractive index between fine and coarse modes.

The authors noted that “To filter out such clouds the MODIS filter based on 1.38 μm measurements is needed.” I would suggest including the words “or equivalent” after μm since there other choices that are possible including a 1.88 μm band that many would argue is as good, or probably better, than the 1.37 μm band for cirrus clouds screening – particularly over snow and ice.

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