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Atmospheric Measurement Techniques Discussions

Interactive comment on "Sensitivity study on polarized aerosol retrievals of PARASOL in Beijing and Kanpur" *by* X. F. Gu et al.

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Dear reviewer,

Thank you for your comments on our manuscript, we appreciate your comments and suggestions very much, which are valuable in improving the quality of our manuscript. With reference to the problems you raised about our paper, we give the following explanations:

1. For assessment of PARASOL derived AOD at 865 nm, the coincident measurements and fine mode AOD at 870 nm retrieved by AERONET are considered for comparison. The quality index for all the PARASOL AOD estimates used for validation is greater than

0.5, a threshold suggested by Bréon et al. [2011] for PARASOL retrievals over land, with an average of quality index $\sim$0.80 and 0.87 for Beijing and Kanpur, respectively. As the Level 2.0 AERONET retrievals close to satellite overpass time were generally unavailable, Level 1.5 retrievals are used to ensure enough match-ups for comparison. Moreover, to keep the stable atmospheric conditions for comparing satellite and ground-based data, the closest AERONET retrievals within half an hour of satellite overpass time are selected in this work.

2. In the rest of the paper, we try to preliminary figure out, for fine/coarse combined aerosol type, the uncertainty of PARASOL aerosol retrievals arising from algorithm-assumed aerosol model and surface polarization model, respectively. It's of highly importance for improvement of the algorithm or development of new algorithm. In section 4.3 we conclude that the surface BPDF model overestimates surface polarization from about 20% to 50% at Beijing and Kanpur. This conclusion did not result from comparison against any polarized reflectance data, like ground-based or airborne measurements. We estimate the uncertainty in surface model from the equality of the two formulas detailed in the manuscript, given the total retrieval error and that arising from algorithm-assumed aerosol model obtained in Section 3 and Section 4.2,respectively.

The estimation is performed with the assumption that the uncertainty in the molecular contribution is ignorable in channels centered at 670 and 865 nm. Although neglecting multiple scattering can introduce error in these formulas, the influence is small and the analysis results is meaningful .In addition, this conclusion shows good agreement with the previous study by Waquet et al. [2007], which reported that the surface model overestimates surface polarization from a few to fifty percents.

3. The sunlight scattered by the aerosol is highly polarized, but only when particles are small. On the contrary, coarse-mode aerosols polarize very little. As a consequence, PARASOL algorithm over land only retrieves the fine mode optical depth, with no reliable information on the total optical depth. In the previous work by Fan et al. [2008] and Su et al. [2010], a 0.30 μm particle radius threshold for fine mode definition

was applied all over east Asia, while for AERONET retrievals which are used by most researchers to assess the performance of satellite derived AOD, the fine and coarse mode separation ranges from 0.439 to 0.992 μm. In this study we try to figure out the exact value of particle radius threshold for polarized aerosol measurement.

Given the seasonal mean aerosol model at both sites, the study analyzes how the TOA polarized reflectance (simulated using RT3 codes) changes with the cutoff radius threshold (r-cutoff) between 0.19μm and 0.43μm. When the difference between the TOA polarized reflectance related to the entire size distribution (0$\sim$15 μm)) and that related to the cutoff radius reaches the minimum and shows little change as r-cutoff increases thereafter, the corresponding r-cutoff is the sensitive particle radius for polarized aerosol measurement.

The analysis is conducted only for a certain imaging geometry with scattering angle of about 100 degree,as the aerosol polarized phase function at this scattering angle is representative (smaller than the maximum and much greater than the minimum), which is probably why this scattering angle was also used as a reference angle in the analysis of directional dependence of the polarized light by Deuzé et al. [2001]. The aerosol polarized contribution can get rather small at most of the other scattering angles. If the difference in TOA polarized reflectance mentioned above was accumulated over the 14 imaging directions of PARASOL instrument, it may be less sensitive to cutoff radius threshold as compared to that of our study, resulting in error in the sensitive particle radius.

We appreciate for Editor and Reviewers' warm work earnestly, and hope that the explanations will make the manuscript more understandable.

Once again, thank you very much for your good comments and suggestions.

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