

Thanks to the referee for the very helpful comments and suggestions, which have allowed us to clarify and improve the manuscript. Below, the reviewer comments are italicized and black, and our response is bolded and blue. We have revised the manuscript accordingly.

General comments

This manuscript compares the retrieved AODs from CALIPSO and MODIS with the aid of GEOS-Chem-APM model. I found the main content of the manuscript interesting in general, but would like to see more scientific explanation of the difference between the two satellite products beyond its correlation with aerosol type and thus the source. The sampling issue between the two different satellite measurements needs to be discussed in the manuscript, and the number of data needs to be added where possible. For the figures from Fig. 6 to Fig. 9 in particular, the number of data points can be added as dashed line in the figures. For the dust, when the nonsphericity of dust particle is not considered in the MODIS retrieval, AOD can be underestimated, as the phase function of spherical assumption is higher than that of nonspherical for the backward scattering, i.e. the geometry for the satellite retrieval (Lee et al., ACP, 2012). Thus, with the same reflectance measured from the satellite, the current MODIS retrieval underestimates the AOD. Furthermore, near the source region of biomass burning, it has been observed that the strong biomass burning also lifts dust together. Thus, it is likely that the current MODIS retrieval algorithms may not select the proper aerosol model in such case. The difference in the correlation between the Δ AOD and aerosol type in between South Africa and South America could be due to the different burning type. In South America, the burning is more for the smoldering type, while in South Africa it is more for the flaming type. This can cause different aerosol type from the biomass burning. Lastly, this study relies on the assumption that the GEOS-Chem-APM model provides accurate information on aerosol type at least. Then, it is necessary to include such statement on the performance of the model with appropriate references.

We addressed the sampling issue in section 3.3., in which we discussed the possible impact of different sampling from CALIPSO and MODIS on the results. We examined the sampling days on which CALIPSO has observations from the monthly mean $2^{\circ}\times 5^{\circ}$ grid cells (Fig.10), and found there are normally 5-8 days in a month (Sahara, July 2007) that have CALIPSO observations. To reduce the uncertainty caused by this sampling issue, we used level-3 daily MODIS AOD in $1^{\circ}\times 1^{\circ}$ to re-compute MODIS monthly average, in which only those days that CALIPSO has observations are taken into account for the monthly mean. This way we will obtain the monthly average for both CALIPSO and MODIS from the same observational days. As shown in Fig.10, the modified MODIS monthly mean AOD, though there is a slight difference when compared to the original one, is still higher than CALIPSO AOD, which is consistent with our findings. To further investigate this issue, we applied this approach to all 4 regions as well as a complete year in 2007. The results shown in Fig. 11 compare the AODs from CALIPSO, MODIS, and modified MODIS over 4 regions. It can be seen that the sampling issue, while it causes slightly different AODs, does not affect the findings of this manuscript.

We have included more explanations and discussions on the difference between the two satellite products in the text (see track change). We also added a short description on model evaluation and validation with observations.

Minor comments

p.7:22-24 It is not clear to me how the frequency distribution of MODIS can differ between daytime and nighttime as shown in the box in Fig. 3 and 4 respectively, as the MODIS measurements are for daytime only anyway. Is this just a sampling issue?

It is true that MODIS measurements are for daytime only. To compare the MODIS and CALIPSO consistently, we only chose the grid points that have both CALIPSO and MODIS measurements, which is why the frequency distribution of MODIS can differ between daytime and nighttime.

Table 1 How significant is the difference in the global average AOD in this table, considering the uncertainty of the retrieved AOD products? Please add the uncertainty of the AOD products for both over land and ocean with references. The standard deviation should be included together in this table.

We have computed the standard deviation and included them in the table. The text has been modified accordingly. Also, we added the description on the uncertainty of the AOD products in the text, and the associated references are included.

Reference

Lee, J., J. Kim, P. Yang and C. Hsu (2012), Improvement of aerosol optical depth retrieval from MODIS spectral reflectance over the global ocean using new aerosol models archived from AERONET inversion data and tri-axial ellipsoidal dust database data, submitted to Atmospheric Chemistry and Physics, Atmos. Chem. Phys., 12, 7087–7102, doi:10.5194/acp-12-7087-2012.

Thanks.