Authors' response to the reviewers' comments

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Title: Satellite remote sensing of Asian aerosols: A case study of clean, polluted, and Asian dust storm days

General comments:

Q. The methodology is not well described and cannot be easily followed.

A. The methodology is updated version of former method (Lee et al., 2004; 2007) and contains well-known techniques such as the dark target approach (Kaufman et al., 1997a,b), spectral mixed and separation techniques (von Hoyningen et al., 2003), and spectral shape matching (Lee et al., 2007). Detail description of each technique can be found from the references. Indeed, we added more description of overall data processing in the revised manuscript.

Specific comments:

1. There are several ambiguous and inconsistent statements in this paper. As an example let us consider the following two statements.

First statement: "A LUT is used for the aerosol retrieval in this study. The LUT contains several sets of the pre-computed reflectances for each of the MODIS seven visible channel wavelengths…" (page 2657, block 5).

Second statement: "LUTs were calculated by the SBDART code… For SBDART running, AOT at 550 nm, spectral aerosol extinction, SSA, and g are required." (page 2657, block 10).

Do you assume that the AOT is wavelength-independent?
How do you obtain the spectral aerosol extinction?

A. Revision was carefully done for removal of vague expressions.
Basically AOT is wavelength dependent and radiative transfer model can calculate spectral AOT with spectral extinction values by internal interpolation of extrapolation. Spectral aerosol optical properties could acquire from spectral interpolation or extrapolation. This explanation has been added on page 8.

"As an input data for SBDART running, τ_{550}, spectral aerosol extinction, SSA, and *g* are required for determination of aerosol reflection as a function of AOT. Spectral aerosol optical properties, were made use spectrally interpolated /extrapolated values from AERONET inversion products listed in Table 2 because of insufficient spectral information of aerosol."

2. Here is the related issue.

Figures 3 and 4 provide a link between AOT at 550 nm and Reflectance at 470 nm.
The AERONET-retrieved aerosol microphysical (Table 2) allows one to calculate aerosol optical properties (e.g., AOT) at several wavelengths.
Why do you use AOT (550nm) to calculate Reflectance (470 nm)?

A. LUTs have various aerosol reflection-AOT combinations (n = 1,272,348). Figure 4 shows, as an example, this relation at the same AOT550 because AOT550 can control aerosol intensity in radiative transfer calculations.

3. The authors determined "Total transmissions and hemispheric reflectance" (page 2659, block 10) without appropriate description and gave only one reference. Detailed description is needed.

A. Additional explanation on total and hemispheric reflectance has been added on page 11. "Total atmospheric transmittance contains direct and diffuse transmission for illumination and viewing geometry and is estimated from Rayleigh scattering and aerosol extinction which is performed at 0.47 μm. Because the blue channel has lower reflectance over dark surface, the influence of the hemispheric reflectance is less important. Detail description of the total transmittances and the hemispheric reflectance parameterizations is given in von Hoyningen-Huene et al. (2007)."

4. The estimation of surface reflectance (page 2659) is unclear. Please provide more details as well. Do you estimate the surface reflectance for each pixel (1km resolution), seven wavelengths and different viewing geometry?

A. The paragraph explaining surface reflectance determination has been revised as;

"An accurate estimation of surface reflectance is therefore required for aerosol retrieval from satellite data. A linear mixing model of vegetation and bare soil spectra (von Hoyningen *et al*., 2003) were used to estimate surface reflectance in according to the following expression:

$$\rho_{Surf}(\lambda) = w \ [NDVI_{SW} \cdot \rho_{Veg}(\lambda) + (1 - NDVI_{SW}) \cdot \rho_{Soil}(\lambda)] \quad (6)$$

where λ is the wavelength, $\rho_{Veg}(\lambda)$ and $\rho_{Soil}(\lambda)$ are the spectral reflectance of "green vegetation" and "bare soil", respectively. *w* is the weighting factor for the surface reflectance level at 0.66 μm, which can tune spectral surface reflectance.

$$w = \frac{\left(\rho_{TOA}(0.66\mu m) - \rho_{ray}(0.66\mu m)\right) \times slope + 0.0002 * \Theta_{sc}}{NDVI_{SW} \cdot \rho_{Veg}(0.66\mu m) + (1 - NDVI_{SW}) \cdot \rho_{Soil}(0.66\mu m)} \quad (7)$$

slope is determined by *NDVIsw* which is the vegetation index which represent the vegetation fraction in each 1km resolution pixel, Θ_{sc} is scattering angle. The numerator in equation (7) is from the collection 5 MODIS operational algorithm (Levy et al., 2007) and it is useful in surface reflectance determination because it accounts for the dependence of the surface reflection on the vegetation fraction and scattering angle. Therefore, surface reflectance at 0.47, 0.55, and 0.66 μm were determined by tuned by this."

5. Uncertainties of AOT retrieval. The authors claimed that "Uncertainty of 0.05 SSA can cause uncertainty in the retrieved AOT by as much as 0.8" (page 2664, block 15). The typical values of AOT over land are less than 0.8. If I understand correctly, these values are comparable with the uncertainties of retrieved AOT. Is it true?!

A. The value is not absolute AOT but % error of AOT retrieval. Fitting equation for this plot was changed to exponential form.
"This plot can be interpreted as a linear fit of dAOT(%) = 0.91043·exp(dSSA / 0.02269) - 1.001 (R = 0.99). Therefore, an uncertainty of 0.05 for SSA could cause an uncertainty in the retrieved AOT of 7.2%."

6. English usage. There are numerous places in the current version of paper with poor English usage. Here are just three examples:

"*A linear mixing model between vegetation and bare soil spectra estimates the surface reflectance (von Hoyningen et al., 2003) were used to estimate surface reflectance*" (page 2659, block 15).
"*We simulated with the assumed error range of the input parameter and compute*" (page 2660, block 25).
"*…the suggested method, even for clear sky or heavy aerosols in the atmosphere, was enough to be identified by this study*." (page 2663, block 25)
The authors have to improve English usage.

A. In revision, all typos and grammatical errors listed below have been corrected and carefully edited by native speaker. All suggested changes were implemented.

7. Equation (6). Should the right term take the square?

A. Corrected.

8. Change "Fig.4a. Figure 4b" by "Fig.7a. Figure 7b" (page 2663, block 15).

A. Corrected.