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Interactive Comment

Interactive comment on "Temporal and spectral variation of desert dust and biomass burning aerosol scenes from 1995–2000 using GOME" *by* M. de Graaf et al.

M. de Graaf et al.

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General comments

Referee #3 is thanked for the review of the manuscript. The referee states that section 3.1 is repetition of results from the paper by Herman et al. (1997). However, in that paper TOMS AAI were presented from 1984–1989, while the manuscript presents results of GOME AAI form 1995 – 2000, for the same areas as Herman et al. and more. Not only are these new and unpublished data, it provides an excellent opportunity to compare results from different sensors and, moreover, analyse the trend of AAI over a longer period. In addition, the time series of GOME AAI were presented to provide evidence for the analysis on aerosol type classification in the manuscript. The presented AAI distributions are new data and interesting by itself. Furthermore, areas with typical aerosol characteristics were selected on the basis of these GOME AAI time series, to construct the type classification algorithm. Finally, the GOME AAI time series were used to illustrate the errors in areas where the final algorithm obviously fails (Figure 7).

Referee #3 suggests that section 3.2 provides an opportunity to study indirect aerosol effects. However, the presented relationship between reduced precipitation and high aerosol loading cannot simply be translated into aerosol effects on clouds, which is the second indirect effect of aerosols on climate. The precipitation in the chosen area is monsoon-controlled and the precipitation clearly has a profound effect on aerosol loading due to rain-out. The reversed effect, however, cannot be deduced from a simple graphic comparison shown in Figure 3. We agree that this is a very interesting scientific issue, however, the current data set is not sufficient for this process study, which needs in-situ measurements and field studies. Such a study is currently undertaken in the African Monsoon Multidisciplinary Analysis (AMMA) project and GOME AAI data could provide valuable extra information.

Answers to specific comments of referee #3

Pg 1322. The statement of the AAI being the longest record has been changed to state it is the longest record over both land and ocean.

Pg 1323. The statement that TOMS AAI were converted to AOT has been removed. The new manuscript now describes the derivations of both AAI and AOT from TOMS.

Pg 1326. The reason for the use of 380 nm as reference wavelength is more fundamental than indeed expressed by the word tradition. In previous papers (De Graaf and Stammes, 2005; De Graaf, et al, 2005) it was shown that the use of different reference wavelengths, as done for different TOMS instruments and different data versions (V7 and V8), can have a profound impact. Especially the switch of the reference wavelength from the longer to the shortest of the two wavelengths has nonlinear effects. As

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long as the reference wavelength is the longest of the two wavelengths and the interval between the wavelengths is not too large and in the UV, different AAI products can be compared linearly. Contrary to the statement of the referee TOMS V7 and OMI AAI are calculated using a reference wavelength that is the longest of the two, just as GOME (and SCIAMACHY) AAI. Only the new V8 TOMS AAI was calculated using a different wavelengths setting. All previously published TOMS AAI results have the reference wavelength as the longest of the two wavelengths and can be compared well with GOME and SCIAMACHY AAI. This is explained more clearly in the new manuscript.

Pg 1326. The comment that negative residues have never yet been investigated was removed, as the referee correctly remarks that some papers do indicate the relationship between negative residues and clouds and scattering aerosols.

Pg 1327. We agree with the referee that surface albedo effects can yield negative residues. However, no statement is made about the residue as an aerosol property. We clearly and consciously distinguish between the AAI (which is an aerosol product, but with clear difficulties) and the residue, which is radiance difference. Time series of residues are presented, because the AAI is a threshold value which produces difficulties when treated statistically. The residue is well-behaved mathematically and clearly defined as a logarithm of a reflectance quotient.

The interpretation of the residue is a completely different matter. It is controlled by aerosol abundance, but also, as stated in the manuscript, by surface albedo, clouds and other geophysical properties. The time series will be mainly controlled by changes in atmospheric composition (aerosol and clouds) and seasonal changes in surface albedo. Therefore, the time series are discussed in view of all these controlling mechanisms.

However, the referee suggests that a time series of AAI (only positive values of the residue) would eliminate the geophysical causes for negative residues. This is not true, only cases are selected where abundances of absorbing aerosols conceal the effects of the surface or clouds, destroying the statistical behaviour of the quantity. The inclusion of a ’spurious’ aerosol effect due to the wavelength dependence of the ocean surface is (more or less) constant over time and furthermore equal for time series of the residue.

Pg 1328. The residue increases with more intense dust blowing events during the summer when wind speeds are peaking.

Pg 1328. The reference, and the mentioning of the fact that this was the first ever derivation of GOME AAI, was inserted in the introduction.

Pg 1330. This is the same argument as above. The residue is more well-behaved mathematically and is controlled by the same geophysical factors as the AAI.

Pg 1332. The way it reads is correct. The separation of positive residues, as caused by absorbing aerosols, small residues as caused by clouds, and negative residues caused by scattering aerosols, as stated in the pioneering papers by Herman et al (1997) and Torres et al (1998) and adopted by the referee, clearly needs a refinement. The sign and value of the residue is controlled by all these effects and surface and instrumental calibration effects. When interpreting changes of the residue all these effects play a role and their relative effects determine the overall value and sign of the residue. In the current case the precipitation is accompanied by clouds that have a diminishing effect on the normally high positive value of the residue due to abundance of desert dust. Furthermore, the desert dust aerosols are removed from the atmosphere by the precipitation, also diminishing the residue. This was explained in section 3.2, Pg 1329. From Figure 3 it can be seen that the monsoon-controlled area has different areas with different mean residues. In the north the residues are positive year-round and ’negative residues’ should be interpreted as lower, but still positive residues. However, in southern Africa the residue can be very low and the removal of absorbing aerosols by monsoonal precipitation can yield negative residues, due to the occurrence of clouds or different surface albedo.

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Pg 1334. The references have been added.

Pg 1334. The remark of the referee is correct, the land-ocean difference between the spectra is mainly caused by the cloud cover. However, the suggestion of the referee that the differences are caused only by a brighter background due to aerosols moving over the persistent cloud deck is somewhat limited. In a following study (De Graaf et al. 2006), the scenes were analysed in more detail using the SCIAMACHY space-borne spectrometer, which revealed that the BBA are indeed most likely acting as cloud condensation nuclei and a cause for the clouds as much as influenced by them. These relationships were discussed in the manuscript and it is rewritten to make it even clearer.

Pg 1336. The section title was changed.

References

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