Atmos. Chem. Phys. Discuss., 9, C2507–C2511, 2009
www.atmos-chem-phys-discuss.net/9/C2507/2009/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "UV aerosol indices from SCIAMACHY: introducing the SCattering Index (SCI)" *by* M. Penning de Vries et al.

Anonymous Referee #1

Received and published: 7 July 2009

The authors have put a great deal of effort trying to extract meaningful aerosol related information from a satellite measured signal that is quite likely affected by a series of factors unrelated to the aerosol signal they want to pull out. As discussed in my review the AI signal in the range +/- 1.0 contains the effect of improper instrumental characterization, background geophysical noise (unrelated to aerosols) and inaccurate radiative transfer calculations. Although they have developed a sound methodological approach, it is being applied to a data set heavily affected by non-aerosol related effects.

The Aerosol Index is a residual quantity that measures the departure of the measured near-UV spectral contrast from that associated with a simple model of the earth-atmosphere system consisting of a molecular atmosphere bounded at the bottom by a Lambertian reflecting surface of wavelength independent surface albedo.

The resulting residual quantity is not just the product of aerosol effects but it may also be associated with either geophysical phenomena unaccounted for in the RT calculations, or instrumental effects generally associated with instrument characterization.

Although most of the geophysical signal is associated with the presence of aerosols, non-aerosol related effects such as spectral dependence of the terrestrial surface albedo, specular reflection of the sun over water surfaces and ocean color effects (i.e., wavelength dependent absorption by pure water, chlorophyll, and colored-dissolved-organic-matter) are also detected by the residue. Sun glint effects are easy to screen out masking use of simple geometrical considerations. However, ocean color effects are widespread geographically and can only be accounted for by specifically including in the RT calculations the in-water absorption processes mentioned above. Near UV pure water absorption effects yield residual values in the range 0 to 1, whereas chlorophyll and CDOM absorption produce residues in the range 0 to -1. The interpretation over land is less complicated although issues associated with the inability to resolve topographic features may also result in non-aerosol related signal. In the absence of accurate RT, calculations one can screen out these effects making use of threshold values.

This is essentially the problem the authors are facing when trying to interpret residual data in the range -1 to 1 as aerosol-related without first accounting for the non-aerosol related effects. ONLY AFTER THE INSTRUMENT-RELATED EFFECTS AND THE NON-AEROSOL RELATED GEOPHYSICAL EFFECTS HAVE BEEN ACCOUNTED FOR ONE CAN CONFIDENTLY ASSOCIATE THE RESIDUE WITH AEROSOLS AND CALL IT 'AEROSOL INDEX'.

I do not believe the paper is ready for publication at this time. The authors should first improve the quality of the retrieved AI by properly accounting for the several instrumental issues they have documented in the manuscript. The authors should also recognize that at the background level non-aerosol related signal affects the retrieved AI. They should either explicitly correct for those effects or adopt reasonable threshold values to

separate the aerosol signal from other effects.

The paper describes an approach to extract information on weakly absorbing aerosols near the ground and purely scattering aerosols making use of the residual quantity better known as the aerosol index (AI). Except for infrequent cases of aerosol events of extremely high optical depth these aerosol types generally yield AI values of a few tenths that oscillate around zero. As stated at the beginning of this review the main difficulty in the interpretation of the AI signal at those low levels is that it is very difficult to separate aerosol-related effects from the noise (both geophysical and instrumental) associated with the measurements. In their analysis the authors assume that the entire range of AI values in the range -1.0 to 1.0 is solely due to aerosol effects and have neglected other non-aerosol related sources of the AI signal.

The authors mention a wavelength-dependent error that has been empirically adjusted. The sensor is also affected by the degradation of the UV channel and by an angle dependent error that require empirical corrections. Since calibration effects would affect the residual quantity, the authors should discuss the magnitude of these errors and the correction approach. It is apparent that there is enough uncertainty in the instrument characterization so that a noise level of at least 0.5 AI units should be expected (0.5 AI unit is equivalent to about 1% radiance error). Since the range of variability of the modeled aerosol signal (for weakly absorbing and non-absorbing aerosols) falls in that range one cannot accurately separate in the observations instrumental from geophysical effects.

Other comments:

Line 54: The literature review should include the paper by Torres et al [1998] where the physical basis of the AI in the presence of absorbing and non-absorbing (small and large particles) is discussed in detail. TOMS [Torres et al., 2005] and OMI [Torres et al 2007] algorithms retrieves AOD and SSA making use of the information content of the Aerosol Index.

Line 65: Torres et al [1998] discussed in detail the sensitivity of non-absorbing aerosols demonstrating that large size non-absorbing aerosols yield zero-residues. The main difficulty in the interpretation of the negative component of the AI is not clouds but the signature of ocean color effects. Terrain effects over land also yield negative residues.

Line 94: The statement that the negative part of the residue contains effects of clouds is not consistent with model calculations [Torres et al, 1998]. The scattering effects of large particles yield near-zero residues. Only small-size aerosols yield negative residues. Over the oceans ocean color also yields negative residues. The authors need to explain where the 'cloud signal' in the AI comes from.

Line 130: How are clouds treated in the residue calculation? In a highly reflective scene associated with clouds, how is the cloud treated? Where is the cloud located in the atmosphere?

Line 163: The authors should compare the global maps of the resulting SCIAMACHY's SCI, to global maps of aerosol optical depth by MODIS and MISR. If the SCI signal over the oceans is indeed aerosol-related there should be a reasonable agreement with MODIS-MISR in the geographical distribution. I also suggest that the authors compare the resulting SCI maps to global ocean color maps available from a variety of sensors.

Line 169: I assume the authors refer to the glint angle. A glint angle of 18 deg is too small to screen out sun-glint effects.

Line 194: Clouds do not change the spectral dependence. The statement by the authors contradicts without any proof previously reported analysis.

Line 225: The authors ignore the effects of ocean color in the residual quantities.

Line 232: The reported weak correlation coefficients (AOD vs SCI) with AERONET observations is not surprising. The signal separation (aerosol from non-aerosol) is less complicated over land than over the oceans.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 13569, 2009.