Atmos. Chem. Phys. Discuss., 5, S1625–S1629, 2005
www.atmos-chem-phys.org/acpd/5/S1625/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "SCIAMACHY Absorbing Aerosol Index – calibration issues and global results from 2002–2004" *by* M. de Graaf and P. Stammes

M. de Graaf and P. Stammes

Received and published: 20 July 2005

General comments

The referee is thanked for the careful review of the manuscript. Below all points raised by the referee are discussed.

Answers to specific comments of referee #1

P3368

The definition of the residue needed more clarification, as pointed out by the referee. However, the introduction of the term residue has been postponed until section 2, the

theory section, because traditionally only the term AAI is used to indicate absorbing aerosols using the technique described in the manuscript. The residue is a quantity that is used to compute the AAI from, and is at the moment only a temporary computational "by-product". There is additional information in the residue, but that is not the subject of this manuscript, so it was removed from the introduction. The theory section has been extended with some of the methodology of De Graaf et al.(2005), as suggested in point **P3368, L27**, see below.

P3369, L7-9, L12, L14, L16, P3370, L23 All suggestions have been adopted. In L14 expected ranges have been given.

P3371, L7 and P3373, L25-27

The term "inversion process" has been removed. Instead some more theory has been included from De Graaf et al.(2005) to explain more clearly what is done: the surface contribution and the atmospheric contribution are separated using the assumption of a Lambertian surface and from this the surface albedo in Equation 2 is calculated.

P3372, L5-7, L9-10 The suggestions were adopted.

P3372, L23 The reference to "averaging window" as used in the technical reports referenced in the manuscript has been removed.

P3373

(a) The first two lines were rewritten to infer more clearly that the first major flaw is due to use of a scalar radiative transfer model, not the use of the LIDORT model, as suggested by the referee. After this the LIDORT model is still mentioned to keep a reference for the reader.

(b) The implication of neglecting polarisation in the LUTs is illustrated in a new figure, showing the residue in a modelled Rayleigh atmosphere where polarisation has not been accounted for, for different geometries. In a Rayleigh atmosphere the residues should be exactly zero. The errors in the reflectance in the modelled atmosphere

ACPD

5, S1625–S1629, 2005

(which are of the order of about $10-15\%$) yield residues of a maximum of -4 to 3.5.

Also in figure 1 in the manuscript the effect of neglecting polarisation in the LUTs is shown to be about 2.5 between west pixels and east pixels of an arbitrary orbit.

The effect on the residue of a reflectance offset of about 10 to 20 percent (as found for SCIAMACHY) is about 2 to 4. So the absolute values of both effects are comparable. They are probably not decoupled because the reflectance error might be dependent on geometry, like polarisation is. However, the error due to the neglect of polarisation is easily removed by replacing the LUTs and this is still highly recommended for the operational SCIAMACHY AAI. See also the remarks on the correction factors (point **P3380 L16 and L7-8**) below to see that the LUTs are the actual show stoppers.

P3374 L14 The sentence was dropped.

P3375 L1, L18, L19-24 The suggestions were adopted and most of the paragraphs have been condensed into descriptions of the facts.

P3376 L21, L26, P3377 L29 Textual changes have been made. Symbols are now defined in the theory section.

P3379 L9-10, L14, L16 As stated in the manuscript the sensitivity of the TOMS AAI has changed since the introduction of version 8 data. This fact is not very widely known, but has quite large implications for the interpretation of the index. Here the different definitions are given and the differences in sensitivities of the V7 and V8 TOMS AAI will be highlighted.

Two wavelengths in the UV are used to calculate the AAI (see Equation 1 in the manuscript). In the definition of the V7 TOMS AAI (also used for SCIAMACHY), the reference wavelength λ_0 is the largest of the two wavelengths (360 nm for TOMS and 380 nm for SCIAMACHY). In the definition of the V8 TOMS AAI this has changed and the reference wavelength is the shortest wavelength (331 nm for TOMS). This has increased the sensitivity of the index. This is shown in a new figure, where the monthly

ACPD

5, S1625–S1629, 2005

averaged TOMS AAI V8 is compared to the monthly averaged TOMS AAI V7. The V8 AAI is about 1.5-2 times as sensitive as the V7 AAI. Also the V7 AAI was valid only from 0.7 upward, to indicate the presence of absorbing aerosols. In V8 this threshold has changed and all values larger than zero are sensitive to absorbing aerosols according to P.K. Bhartia (pers. comm.).

The majority of the points are on the line where V7 TOMS AAI is zero, which in the V7 definition meant that there would be no absorbing aerosols. In the new V8 definition these points have an AAI greater than zero and are now indicative of aerosols.

The reason for the increased sensitivity is the larger optical thickness at the lower wavelength (about 40% larger at 331 nm compared to 360 nm). In the AAI method all atmospheric scattering and absorbing effects are modelled with an adjusted surface albedo under a Rayleigh atmosphere. At the lower wavelength the atmospheric effects are relatively larger and the retrieved surface albedo is affected more strongly.

The relationship between the V7 and the V8 AAI is also nonlinear, because the reflectivity at the reference wavelength is a nonlinear function of geometry and atmospheric conditions. This was also found by De Graaf et al.(2005). Note that all TOMS AAI data from 1978 to present are reprocessed according to the V8 definition. So all the data presently available on the Internet are 1.5-2 times as sensitive as those published in papers so far. The definition of SCIAMACHY AAI is the same as the original TOMS V7 AAI, so the results from SCIAMACHY (and also its predecessor GOME) are comparable with the results of the TOMS AAI published in the various papers referenced in the current manuscript and the paper that explains and investigates the sensitivity of the AAI (De Graaf et al.,2005).

Also note that the sensitivity of the TOMS AAI changes with the different TOMS instruments since some instruments have different channels than others. Currently, EP/TOMS uses channels in the UV at 331 and 360 nm. Before this, TOMS instruments had channels in the UV at 340 and 380 nm. The same is true for GOME and SCIA-

ACPD

5, S1625–S1629, 2005

MACHY; for GOME the wavelengths used were 335 and 380 nm and for SCIAMACHY the wavelengths were 340 and 380 nm, but as long as the reference wavelength is unchanged the relationship is linear.

The figure showing the relationship between the V7 and V8 data and the above discussion were added to the manuscript.

P3380 L16 and L7-8

The error in the reflectances might be improved if the calibration of SCIAMACHY is improved, but using constant correction factors is not such a "course correction" as suggested by the reviewer. Because the AAI is dependent on the slope of the reflectance spectrum, the AAI is shifted linearly when the quotient of the correction factors of two wavelengths changes.

A new figure was created to replace Figure 6 in the manuscript. This figure shows that the SCIAMACHY residue is about 0.2 lower than the TOMS V7 and about 0.4 lower than TOMS V8 AAI (see also answer to referee #2). From this we can conclude that the quotient of the correction factors is too large, producing smaller AAIs than expected (i.e. the threshold where absorbing effects and scattering effects are separated is smaller than that of TOMS, probably even negative). Either the reflectance at the smallest wavelength (R_{340}) after correction is about $0.5 - 1\%$ too low or the reflectance at the highest wavelength (R_{380}) after correction is about $0.5 - 1\%$ too high, or any offset for both yielding the same slope in the reflectance.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 3367, 2005.