Atmos. Meas. Tech. Discuss., 4, C281–C287, 2011
www.atmos-meas-tech-discuss.net/4/C281/2011/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieval of stratospheric aerosol density profiles from SCIAMACHY limb radiance measurements in the O_2 A-band" *by* B. Ovigneur et al.

Anonymous Referee #1

Received and published: 7 April 2011

Review of AMT manuscript entitled

Retrieval of stratospheric aerosol density profiles from SCIAMACHY limb radiance measurements in the O2 A-band

by B. Ovigneur, J. Landgraf and I. Aben

General comments:

This manuscript presents a novel technique to retrieve stratospheric aerosol density (and extinction) profiles from limb measurements with SCIAMACHY on Envisat. The retrieval approach is based on several discrete wavelengths in and just outside the

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

oxygen A-band near 760 nm with the aim to separate albedo and aerosol contributions to the limb radiances. The wavelengths outside the A-band are sensitive to both albedo and stratospheric aerosols, whereas the wavelength in the A-band is insensitive to the surface albedo because of the strong absorption by molecular oxygen. The retrieved stratospheric aerosol extinction profiles are compared to co-located SAGE II solar occultation measurements showing agreement within 30 – 50% depending on the assumed particle sizes. This agreement is quite encouraging. The paper is generally well written and easy to follow, and I recommend publication after the following general and specific comments have been addressed.

I have three general comments:

I. Retrieval errors: Essentially nothing is said about the retrieval errors (apart from the brief statement that the retrieval noise level is less than 1 % on page 1804). What are other sources of error? Can they be estimated, at least roughly?

II. Sensitive altitude range: The abstract as well as the conclusions state that the aerosol profiles are retrieved in the 10 – 40 km altitude range, but the measurements are certainly not equally sensitive to stratospheric aerosols at all altitudes in this range. Fig. 10 only shows comparisons with SAGE II up to an altitude of 29 km. Can you provide a more robust estimate on the altitude range for which the retrieval is typically sensitive to aerosols, e.g. using retrievals of synthetic limb measurements?

III. A-band emission: as you mention, the A-band is also a strong emission feature starting to become important in the upper stratospheric limb spectra. Looking at Fig. 5, the emission already leads to a small local radiance maximum at 761 nm at a tangent height of 38 km, which suggests that the effect of the emission will be non-negligible probably already 10 km below that tangent height. The crucial question is what effect the emission will have on the aerosol retrievals. Can you provide an estimate on this effect? Neglecting the emission in the retrieval would produce a high bias in the retrieved aerosol densities and extinction coefficient at the upper levels. Is this seen in

AMTD
4, C281–C287, 2011

the retrievals when looking at altitudes higher than 30 km?

Specific comments:

Page 1798, line 4: 'The Improved Limb Atmospheric Spectrometer-II .. was successfully launched in 2002.' The sentence before this one suggests that ILAS-II was a 'limb-viewing' instrument and not a solar occultation instrument. However, I'm pretty sure ILAS-II was an occultation instrument as well. By the way, occultation instruments are also sometimes called limb-viewing instruments.

Page 1798, line 10: 'both launched in 2001.' This is not true, as Envisat was launched on March 1, 2002.

Page 1798, line 13: 'which is backscattered .. in nadir, limb and occultation geometry'. Radiation is not really backscattered in occultation geometry, is it?

Page 1799, line 23: 'as depicted in Fig. 1'. Shouldn't this read 'Fig. 2'?

Page 1800, lines 10 and 16: As Fig. 4 is discussed first in the text I suggest changing the order of Figs. 3 and 4.

Page 1801, line 9: 'requires a simultaneous fit of surface albedo and stratospheric aerosol abundances ..' It's perhaps worth mentioning that normalizing the limb radiances with respect to a higher tangent height will remove a significant part of the albedo sensitivity, but retains the sensitivity to stratospheric aerosols. You also indirectly note this when discussing Fig. 3.

Page 1801, line 17: 'Thus, an increase in stratospheric aerosol at tangent height causes an increase in the amount of light travelling this path'. Strictly speaking, this is only true, if the aerosol is optically thin along the line of sight. If it becomes optically thick then increasing the amount of aerosol may not necessarily lead to an increase in limb radiance.

Page 1801, line 22: 'This makes the simultaneous retrieval of aerosol particle density

AMTD

4, C281–C287, 2011

profiles and surface reflection from limb measurements at one particular wavelength in the longwave visible an ill-posed inversion problem.' I'm not convinced this statement is true. The inversion problem is certainly ill-posed in a general sense, and requires constraints. However, as the albedo sensitivity of the limb radiances is – to first order – independent of the tangent height, one can use the limb radiances in the upper stratosphere, where the contribution of stratospheric aerosols to the limb radiances should negligible, to estimate the surface albedo. In other words, use different tangent height ranges for the retrieval of surface albedo and stratospheric aerosols.

Page 1804, line 9: 'Since the launch of SCIAMACHY, there has been no major volcanic eruption with significant stratospheric sulphur injection ..' This is perhaps true for tropical and subtropical latitudes, but we had the eruptions of Kasatochi in August 2008 and the one of Sarychev Peak in June 2009, that produced significant and measurable amounts of stratospheric aerosols at northern mid-latitudes.

Page 1804, line 13: You write that the retrieval noise level is less than 1 %. Does this also apply to high southern latitudes, where the aerosol signature in the limb radiances is much smaller than in the northern hemisphere, because of the aerosol phase function? I assume this is just the statistical error originating from noise on the limb radiances used. But what about other sources of error?

Page 1806: Subsection 'Comparison with SAGE II' It would be good to state what the accuracy (at least the estimated accuracy) of the SAGE II aerosol extinction profiles is. Otherwise, it's impossible to tell, whether a relative difference of 30 % or 50 % is problematic or not.

Page 1806, line 15: 'Fig. 7 shows on specific example'. I'm surprised to see that the SAGE II extinction profile goes to zero at 25 km. This cannot be a typical case. If this is rather an exception I suggest showing another example.

Page 1807, line 16: 'The reduced aerosol sensitivity of the measurement for large scattering angles is also the reason for the little number of successful SCIAMACHY

AMTD

4, C281–C287, 2011

retrievals at the Southern Hemisphere.' It would be useful to provide some information as to when the retrieval is successful or considered successful. What criteria have to be fulfilled? Are – for the unsuccessful retrievals – aerosol profiles produced, but then rejected after the retrieval? This should be discussed in more detail.

Page 1808, line 21: 'aerosol density profiles are retrieved in the height range 10-40 km'. This suggests that SCIAMACHY provides information on stratospheric aerosols within this height range, which is most likely not correct. It's not clear what the upper limit of the sensitive altitude range is, or how important the neglected O2 emission becomes near 40 km. The emission is already clearly affecting the A-band spectra at 34 km, which must lead to a systematic effect in the retrieved aerosol densities.

Page 1808, line 24/25: 'SCIAMACHY density profiles' -> 'SCIAMACHY aerosol density profiles'

Page 1814, Fig. 1: I suggest increasing the font size of all legends in this plot

Page 1815, Fig. 2: It's not entirely clear what quantity is shown here. It's certainly not limb radiance in radiance units (photons / sr / s / m2 / nm). Also, the axis labels and legends are quite small.

Page 1816, Fig. 3: axis label font size should be increased

Page 1818, Fig. 5: Perhaps you can indicate in this plot what wavelengths are used for the retrievals (at least the wavelength within the A-band)

Page 1819, Fig. 6: Font sizes of axis labels and legends are too small.

Page 1822, Fig. 9: Please mention how the relative difference is defined. Is it (SAGE – SCIAMACHY) / SCIAMACHY or 2*(SAGE – SCIAMACHY) / (SAGE + SCIAMACHY)?

Typos etc.:

Page 1795, affiliation: ',Utrecht' -> ', Utrecht'

AMTD

4, C281–C287, 2011

Page 1797, line 2: ‘aerosols influences’ -> ‘aerosols influence’ or ‘aerosol influences’

Page 1797, line 20 : ‘three mission’ -> ‘three missions’

Page 1797, line 25: I suggest changing ‘SAGE III mission’ to ‘SAGE III instrument’

Page 1798, line 6: ‘after 10 month’ -> ‘after 10 months’

Page 1798, line 8: ‘.Still’ -> ‘. Still’

Page 1798, line 9: ‘spectrometer’ -> ‘spectrometers’

Page 1798, line 11: ‘is an grating’ -> ‘is a grating’

Page 1798, lines 25 and 27: I suggest replacing ‘Sect.’ by ‘Section’ as in the other parts of this paragraph.

Page 1799, line 13: ‘tome’ -> ‘time’

Page 1801, line 8: ‘Figure 2 and 3’ -> ‘Figures 2 and 3’

Page 1801, line 14: ‘characteristics light paths’ -> ‘characteristic light paths’

Page 1803, line14: ‘Medium- Range’ -> ‘Medium-Range’

Page 1804, line 19: ‘on this short’ -> ‘on these short’

Page 1804, line 19: ‘address this .. to the effect ‘ -> ‘attribute this .. to the effect’

Page 1805, line 3: ‘uncertainties on the’ -> ‘uncertainties in the’

Page 1805, line 17: ‘which are’ -> ‘which is’

Page 1805, line 19: ‘addressed to’ -> ‘attributed to’?

Page 1805, bottom line: ‘both albedo result’ -> ‘both albedos result’

Page 1808, line 5: ‘14km’ -> ’14 km’

References, Crutzen 1976, Deshler, 1992, Deshler, 1993, Hofmann, 2009, Hofmann,

AMTD

4, C281–C287, 2011

1983, Obereck, 1983, von Savigny, 2003, Wang 2005: ‘Geophys. Res. Let.’ -> âĂŽGeophys. Res. Lett.’

Page 1811, line 20: âĂŽONeill’ -> âĂŽO’Neill’?

Page 1812, line 14: âĂŽstratospehric’

Page 1813, Taha et al.: This paper already appeared in AMT

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 1795, 2011.