Atmos. Meas. Tech. Discuss., 3, C2519–C2528, 2011
www.atmos-meas-tech-discuss.net/3/C2519/2011/

Atmospheric Measurement Techniques Discussions

Interactive comment on "SCIAMACHY stratospheric aerosol extinction profile retrieval" *by* G. Taha et al.

Anonymous Referee #2

Received and published: 22 January 2011

Referee comments for the paper:

Journal: AMT Title: SCIAMACHY stratospheric aerosol extinction profile retrieval Author(s): G. Taha et al. AMTD 3, 5343 – 5374, 2010

1 General comments

In order to find out if the OMPS/LP algorithm is able to retrieve aerosol extinction profiles from the measured radiances (with the purpose of correction ozone retrievals), the authors have performed retrievals using (1) simulated radiances (for which the 'true

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profiles' are known) and (2) SCIAMACHY measurements. For both cases the retrieval quality is presented and is found to be acceptable. The conclusion is that the algorithm should be able to perform well.

Since the paper deals with the retrieval of aerosol extinction profiles from limb scatter measurements, a part of the process (measurement, data inversion) to obtain data that will be used later in scientific studies, I think that AMT is the right choice for the paper. The possibility of retrieving aerosol extinction profiles from the limb sounders SCIAMACHY and OMPS/LP is of course a new finding and worth publishing, since the obtained conclusions are substantial enough to have an impact on the future OMPS and SCIAMACHY data processing.

The scientific methods and assumptions that have been used are valid. Sufficient credit is given to related work by other authors, and sufficient papers have been cited. However, I suggest changing the title: it only points to the part of the paper that discusses the possibility for aerosol retrievals from SCIAMACHY. The possibility to do the same for OMPS is not mentioned, but this is the primary goal of the study.

The abstract sufficiently summarizes the study and the obtained results well. The overall structure of the paper is logic and clear. Concerning language, the paper is clear in general, but quite some typos and grammatical errors should be corrected. I have indicated the parts where I found the text not to be precise enough. Also, some abbreviations should be defined early in the paper.

2 Specific Comments

First a general remark: the wavelengths that are mentioned in the paper are not consistent. See for example fig. 8. The figure legend mentions 682 and 794 nm, while the caption mentions 692 nm and the text mentions 793 nm. Other errors can be found elsewhere. Please check and correct everywhere.

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Page 5345, line 14: the author mentions that no solar occultation instrument is currently active. Perhaps he can cite GOMOS on Envisat, a stellar occultation instrument that has been active for ten years now and that delivers aerosol extinction profiles.

Page 5346, line 20: 'The a priori vector is a set of mean constant extinction vertical profiles . . . '. This is not clear to me. Mean of what? Also, to me, a constant extinction vertical profile is a profile that doesn't change with altitude. This is probably not what the author meant. Please clarify.

Page 5346, line 21: 'The a priori aerosol size distribution . . .0,06 μm effective radius and variance of 1.73 . . . index of refraction of m = 1.448 + 0 i' and following. Please specify where these values come from and why they were chosen. Also, do these values correspond (through an optical model, such as Mie theory) with the a priori extinction mentioned above? Finally, a lognormal distribution is not expressed as function of effective radius, but as a radius that represents the median of the distribution (sometimes called a 'mode radius'). Please correct.

Page 5347, line 21: a normalization value at the altitude of 35.5 km is chosen, probably because the aerosol contribution is negligible there. Please mention this.

Page 5347, line 24: 'A median Angstrom coefficient . . .': I guess this means the median of the angstrom coefficients evaluated from the retrieved extinctions at the different wavelengths. Please specify this.

Page 5347, line 28: Please briefly explain what the RSAS channel is exactly.

Page 5348, line 1 – 4: Please give a citation to a paper explaining the method using the moments of a size distribution.

Page 5348, line 5 - 10: 'Figure 1 . . .' Please specify that this figure was calculated for SCIAMACHY as is mentioned in the figure caption.

Page 5348, line 15: 'This data set was generated by a forward model . . .': Is it the same forward model as the one used in the OMPS/LP retrieval algorithm? Please specify.

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Page 5348, line 17: '... over a one-year period'. Do you mean colocations were searched for within a one year period? Please clarify.

Page 5348, line 21: Surface albedo is assumed to be 0.15. Where does this value come from?

Page 5348, line 25 and following: discussion on Fig. 3. What is shown? True – Retrieved, or Retrieved – True?

Page 5349, line 14: 'To ensure maximum sensitivity towards aerosol, we use a very small aerosol a priori'. This doesn't make sense. The author probably means a small aerosol a priori weight, which corresponds to a large a priori variance. Please correct.

Page 5349, line 18: 'Aerosol modeling error contributed up to 2% of the retrieval precision ... since there was no attempt made to constrain SAGE II aerosol profile spectral behaviour by an aerosol size model'. How did the authors determine this error? For this one needs to know the 'true' spectral behaviour..

Page 5350, line 25: 'the proxy data set is evenly distributed around the globe'. Not really, no location can be found above 50°N and below 70°S.

Page 5351, line 7: 'evidence of straylight in the spatial dimension'. This sentence is confusing. I would suggest 'evidence of straylight at high altitudes'. Also: please explain why the contamination is stronger at long wavelengths?

Page 5351, line 11-16: The authors describe how they continuously alter the normalization altitude. I only would like to mention that this is a risky thing to do. Eventual bias in the retrievals will be dependent on whatever causes the straylight, and it will be more difficult to identify the cause of the bias because it changes all the time.

Page 5351, line 18 – 24: Discussion on retrieved aerosol extinction. What do you use as first guess for the iterations? Please specify. Also, elaborate some more on the retrieval limits. Are the retrievals not updated during the iterations outside these limits? How are the limits determined?

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Page 5351, line 25 and following. Explain why these two separate retrievals were performed (which purpose).

Page 5352, line 1-4: first only ozone is retrieved with aerosol fixed to climatology, then ozone and aerosol are together retrieved. So we have two different and completely independent retrievals, of which I don't see the point. There is probably something missing here. Do you use the first ozone retrieval as a priori for the second? Please clarify.

Page 5352, line 12: '. . . 513 – 682 nm interpolated results.' The retrieval is performed for 750, 793 and 1028 nm. One cannot interpolate these values to wavelengths outside this spectral range, the most we can do is *extrapolate* them. But this is probably not what is done. Probably the 513 – 682 nm values are *evaluated* with the Angstrom law, of which the coefficients are obtained from the retrievals. Please clarify.

Page 5352, line 14: 'dashed line': I don't see it on the figure? Also: '. . .interpolated SAGE II'. How was it interpolated. Linearly? Cubic? Spline? Please clarify.

Page 5352, line 19: 'SCIAMACHY aerosol profiles show a good agreement with SAGE II . . .'. This is a matter of taste. Personally I don't consider a bias of 25 % good agreement. I would prefer the term 'acceptable'.

Page 5353, line 8: '. . . 192-194 K' around the observed aerosol layers. Specify at which altitude. There are multiple layers visible. Also: 'the time, location, and temperature indicate that this layer is . . .'. The magnitude of the extinction is also an indication: a value larger than 10e-2 km-1 is much larger than what we expect from background aerosols.

Page 5353, line 11: '. . . to detect a secondary aerosol layer . . .'. Specify at which altitude.

Page 5353, line 21: '. . . a good agreement with SAGE II'. Also here I would prefer the word 'acceptable'.

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Page 5353, line 24: '. . . which reflects on the larger variability of the differences for the compared profiles'. I don't understand this sentence. What is the author trying to say? Please rephrase.

Page 5354, line 15: 'some of the observed differences were real, caused by instrument differences and . . .'. Once again, I don't understand this sentence. Why are the mentioned differences real while others aren't? Please rephrase.

Page 5354, line 27: '. . . high altitude biomass burning'. There is no such thing. There are however high-altitude clouds as a result from biomass burning. Please rephrase.

Page 5355, line 15: 'The 1-sigma uncertainty is very small compared to the standard deviation, mainly because SCIAMACHY reported errors were small'. What do you mean? Are they too small to be realistic? Also: natural atmospheric variability explains partially the difference between sample standard deviation and retrieval uncertainty.

Page 5356, line 2: . . . deviation better than 15 % for the altitude range of 15 – 30 km.

3 Technical corrections

3.1 General remarks

Latitudes should preferably be expressed in the known form ' xxx°N' or 'xxx°S', so: '81.2°S' instead of '-81.2°'. Longitudes should preferably be expressed in the known form ' xxx°E' or 'xxx°W', so: '30.2°W' instead of '-30.2°'.

Dates in English are expressed as September 9, 2004, so not 9 September 2004. Please correct everywhere in the paper.

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3.2 Specific remarks

Page 5344, line 2: . . . Suite *Limb* Profiler (. . .

Page 5344, line 3: . . . to retrieve ozone *concentration* and aerosol *extinction* profiles . . . Actually this is a recurring problem in the paper. An 'aerosol profile' doesn't mean anything, it can be a profile of total particle concentration, effective radius and so on. It is aerosol extinction that is derived here. Also: ozone concentration. Please specify everywhere in the paper.

Page 5344, line 23: again: aerosol *extinction* profile . . .

(from now one, I will not mention this anymore)

Page 5345, line 1: specify what the abbrev. SCIAMACHY means.

Page 5346, line 15: For *the* ozone retrieval ...

Page 5346, line 18: For *the* aerosol retrieval ...

Page 5346, line 25: specify abbrev. NCEP

Page 5346, line 26: . . . taken from *a* climatology . . .

Page 5346, line 26: specify abbrev. PRATMO

Page 5347, line 24: . . . *Angström* coefficient . . .

Page 5348, line 2: . . . *Angström* approach . . .

Page 5348, line 8: At shorter wavelengths, Rayleigh *scattering* dominates the signal.

Page 5348, line 23: Figure 2 *shows* the simulated events location map. The lower panel *is a plot of all events vs. latitude and time*.

Page 5350, line 11: . . . version 6.03 data *were* used, that *include* an improved . . . versions used *by* von Savigny et al. (2005).

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Page 5350, line 26: . . . with time, *allowing us* to study . . .

Page 5351, line 5: *The* initial normalization error is *chosen to be* 35.5 km.

Page 5351, line 18: . . . aerosol extinction *profiles* at 793 nm . . .

Page 5352, line 6: . . . are using the first set *of retrievals*.

Page 5352, line 14: The right panel is the *relative* difference (*percent*) between . . . *For the purpose of comparison*, SAGE II was interpolated . . .

Page 5352, line 20: . . . with a flat bias *of* 25

Page 5352, line 28: . . . may be the basic assumptions made in the . . .

Page 5353, line 5: *Figure 12 is another plot showing retrieved SCIAMACHY and SAGE II aerosol extinction profiles, similar to the Fig. 10 left panel, now for September 13, 2004*, . . .

Page 5353, line 10: For the second case *on the right panel*, . . . a secondary aerosol layer *that matches the SAGE II aerosol extinction profile shape*.

Page 5353, line 13: . . . background aerosol (Thomason and Peter, 2006). Although the agreement in *profile* shape . . .

Page 5353, line 15: *Nevertheless*, this example demonstrates . . .

Page 5353, line 18: . . . summary plot of the *relative* difference (*percent*) for all . . .

Page 5353, line 25: It also *includes* the real atmospheric variability . . . geo-locations of *the* SAGE II and SCIAMACHY *observations*. There were several events similar to *the ones shown on* Figs. 11 and 12, where *the* SCIAMACHY *retrievals exhibit the correct* aerosol shape, but not the absolute value, which can add to the large *bias* seen here.

Page 5354, line 1: . . . *Angström* coefficient . . ., which reflects the quality of the . . .

Page 5354, line 7: . . . which indicates *that* the *Angström* model . . .

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Page 5354, line 12: Lowering the normalization height *to avoid* the straylight can lead . . . (correct meaning?)

Page 5354, line 25: . . . algorithm to *deliver* good stratospheric aerosol . . .

Page 5355, line 1: . . . would *be beneficial for* the retrieval *by the* further understanding and *quantification* of the retrieval uncertainties. *Finally*, SCIAMACHY and future OMPS aerosol measurements *would* extend the *existing* stratospheric aerosol records *in a significant way*.

Page 5355, line 12: *The left panel shows that the retrieved ozone concentration profile (Vis) agrees well with the one from SAGE II*, . . .

Page 5355, line 14: The standard deviation for both *Vis*. and IUP . . .

Page 5356, line 2: . . . retrieval algorithm is *currently* being tested with . . .

Page 5360, fig. 1: add units to the x- and y- labels.

Page 5361, fig. 2: add unit to y-label (latitude: degrees)

Page 5362, fig. 3: add 'nm' to every wavelength in the legend. Also, correct x-axis (-50, -25, 0, 25, 50). Change caption: . . . aerosol extinction profiles for the 450 simulated radiances. Blue: 994 nm, red: 525 nm. The dashed lines represent the standard deviations.

Page 5363, fig. 4: add units to y-labels. Caption: . . . black to red in altitude-ascending order.

Page 5364, fig. 5: add units to y-labels. Page 5365, fig. 6: correct x-axis of left panel (-3, -1, 1, 3). Caption: . . . of the relative difference (percent) for all . . . Red is for visible, and blue . . . The right panel shows the standard deviation with the same color code. Dashed lines represent the retrieval 1-sigma uncertainties.

Page 5366, fig. 7: add unit to y-label. Caption: Location of the SCIAMACHY measure-

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ment subset (upper panel), and latitude vs. time . . .

Page 5367, fig. 8: add y-label: 'altitude (km)'. Change x-label: 'ymeas-yclean'. Add grid to figure.

Page 5368, fig. 9: add y-label. Add grid to both figures.

Page 5369, fig. 10: add grid to left panel. Caption: The left panel shows the retrieved aerosol extinction profiles for 750, 793 and 1028 nm (color asterisk). Colored lines: 513-682 nm interpolated aerosol extinction. Black lines: SAGE II profiles at 525 nm and 1020 nm. Dashed black line: interpolated SAGE II aerosol extinction profile at 750 nm. The right panel shows the relative difference (percent) between the retrieved aerosol extinction profiles and the ones from SAGE II.

Page 5370, fig. 11: add grid to left panel. Correct date, longitude and latitude in caption.

Page 5371, fig. 12: add grid to figures. Correct date, longitude and latitude in caption.

Page 5372, fig. 13: adjust legend to avoid overlap with profiles.

Page 5373, fig. 14: caption: . . . of the relative difference (percent) . . . with SAGE II (left panel). The right panel shows . . .

Page 5374, fig. 15: Caption: Histogram of all detected tangent height offsets.

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