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Atmospheric Chemistry and Physics Discussions

Interactive comment on "SO_2 Retrieval from SCIAMACHY using the Weighting Function DOAS (WFDOAS) Technique: comparison with Standard DOAS retrieval" *by* C. Lee et al.

Anonymous Referee #1

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Review of

SO2 retrieval from SCIAMACHY using the weighting function DOAS WFDOAS) technique: comparison with standard DOAS retrieval

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General comments

Sulphur dioxide (SO2) is released into the Earth's atmosphere by a combination of natural phenomena and anthropogenic activities and it plays an important role in climate and ecosystems. Monitoring SO2 emissions and concentration is therefore important.

The current generation of satellite instruments provides possibilities to do this in near-real time.

The retrieval of SO2 concentrations from measurements in the UV wavelength range by e.g. GOME, SCIAMACHY, OMI, and GOME-2, suffers from a strong interference of the SO2 and the ozone absorption signals in the relevant wavelength window, in particular at high solar zenith angle and high ozone concentrations. When applying a standard DOAS approach, the interference problems can be countered in part by a background correction, based on the assumption that away from sources the background level of SO2 is on average zero. This, however, does not solve all problems of the interference.

The authors apply their WFDOAS method to try to better deal with the interference problems. Their method improves upon a standard DOAS method by taking into account the wavelength dependence of the ozone absorption, using appropriate weighting functions. The paper describes the role of the Ring effect (rotational Raman scattering) in this approach. And it compares standard-DOAS and WFDOAS results for two typical cases: one with background SO2 levels and one with relatively strong volcanic SO2 emissions.

The abstract of the paper states that the interference problems are solved by WFDOAS, but the reviewer feels that the paper does not merit such a strong claim. The paper does indicate that WFDOAS indeed improves the retrieval results, but not all problems are gone when using WFDOAS.

This notion may be due to the fact that in particular the section describing the results is not very well written and needs quite some improvements. In addition, there are rather a large number of linguage mistakes in the text – which is surprising, given that one of the co-authors is a native English speaker.

Specific comments

Some terminology is used in sections 1 and 2, and later comes back with some more

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description. This counts for example for 'Ring' (page 10820), later Raman is mentioned, and again later there is talk of the filling-in of Fraunhofer lines (page 10824). Another example is the South Atlantic Anomaly. It is in general better to have the explanation of a term when it is first used.

The Results section, as mentioned above, needs quite some improvements. It tries to say too much in too few words and thus creates confusion.

Lines 11-14 have the phrase "while they are decreasing ... in the SDOAS retrievals", but that is nowhere visible as SDOAS results are not shown in Figure 2.

Line 14 says that "the slightly decreasing offset over high latitudes is removed when using the OSRC." But this is not what Figure 2 shows: the SO2 with OSRC dreases slowly from left to right in the top panel.

Lines 15-16 state that the O3 column with OSRC is slightly lower: what is the consequence of that? is it important?

Regarding Figure 2

- The observation that the ORSC values in the top panel are more or less constant and around zero is quite crucial here; seeing that in the graph would be a lot easier if an annotated right axis is shown (something that actually counts for all panels of Figs. 2 and 3).
- BrO is not mentioned in the text or caption, and – remove that panel.
- What is the meaning of the ORSC value of about -0.05 in the middle panel?
- The colour coding of the two cases in the key at the top of the figure is very hard to see with such small symbols there.

Regarding Figure 3

- The colour coding of the two cases in the key at the top of the figure is very hard to

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see with such small symbols there

- The annotation along the axes could be in a bigger font, as in Fig. 2.
- Notes regarding the caption are given further down.

Section 3.2 (page 10827, lines 7-12) state that including BrO in SDOAS does not make an important contribution. Why then confuse matters by including BrO in the fit? And it states that the number of polynomial coefficients does not have an affect. Why then use different numbers?

And at the bottom of page 10827 the conclusion thus is that SDOAS+RSM does a better job than WFDOAS ... So why then use WFDOAS?

Other issues

page 10818

- line 7: "to solve" may be too strong a claim; see general comments
- line 10: proper English spelling is "Cartography", i.e. without an 'h' following the 'C' (it is "to chart" but "cartography"!)
- line 13: "demonstrates" – cf. "so solve" in line 7
- line 18: twice "aerosols" with an 's' at the end
- line 22: remove 'The' before SO2

page 10819

- line 3: "... trace gases, in particular SO2", i.e. without brackets since SO2 is here the main topic
- line 6: remove 'the' before 'climate'
- line 7/8: "... the estimates ... not easy to determine ..." is badly written. Try: "Neither the anthropogenic SO2 flux nor the flux due to volcanic emissions is easy to determine

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precisely, ..."

- line 12: starting a new paragraph after 'difficulties.' will ease reading and remove 'The' before 'SO2'
- line 13/14: twice TOMS is mentioned in a bad sentence. Try: "... 1983), and later using other satellite instruments ..."
- line 16: write "Cartography" (see note page 1, line 10)
- line 17-19: the number of references here, 11, is very large – perhaps limit it to a few essential references (3 or 4) "and references therein"
- line 23-26: again rather many references, 9
- line 26/27: since the next piece of text is rather important, it is perhaps better to start a new section here (either '2' or '1.1'), e.g. called "Problems with the standard DOAS retrieval"
- line 28: remove 'the' before GOME

page 10820

- line 8: add comma in "sector, which"
- line 10: add comma in "cross-sections, indicating"
- line 14: "its changes" sounds weird; use "these variations" instead
- line 20: "... interference from Ring but ..." is too cryptic; use "... interference with the Ring effect, but ..."
- line 22: add comma in "surfaces, such"
- line 24: write "The overall scatter in ..."
- line 25: write "... large impact in an area ..."

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page 10821

- line 2: another ’this’ is confusing; write "... but that reduces ..."
- line 2/3: again another important part begins, so start another section (’2’ or ’1.3’), entitles something with ’WFDOAS’ – this gives the reader a much quicker way of finding his/her around in the paper
- line 5: write "... and results were compared to ..."
- line 15: starting a new paragraph with "Such an approach" may improve readability
- line 21: write "... means that the SO2 cross-section ..."
- line 25: remove ’the’ before ’SCIAMACHY’
- line 25-27: write "... and SDOAS are described, the ... techniques are compared ... parametrisations are evaluated."

page 10822

- line 3: title of section is inadequate/incomplete; maybe "Measurement data and retrieval methods"

page 10823

- line 11: write "... applied to the retrieval of"
- line 14: there should be a reference here to Table 1
- line 15: start new paragraph here
- line 17: use present tense: "... 1997) is integrated ..."
- line 18: typo in "radiative"
- line 21: add ’the’ before ’BrO’ and before ’SO2’
- line 22: to improve readabiltiy, add brackets: "... cross-section (for all ... is applied)

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are included ..."

page 10824

- line 10: use present tense: "... closely matches the ..."
- line 17: write "... taken from the IUP climatology ..."

page 10825

- line 16/18: using ’in addition’ and ’further’ is too much; remove ’further’

page 10826

- line 14: write "... decreasing offset over high latitudes is removed when using the OSRC. ..."
- line 22: write "... detection limit, and another orbit covering a volcanic ..."

page 10827

- line 9: delete "which are" before ’summarised’
- line 9: the phrase "little difference in the difference polynomial ..." makes no sense; please re-write
- line 11: BrO "rarely" contributes – what does that mean?
- line 12: start new paragraph with "The constant ..."
- line 16: the words ’be obtained’ are weird; perhaps change for "occur"
- line 23: write "... the number of OMI SO2 data points ..." (not ’sets’)
- line 28: write "... to those of the SDOAS ..."

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- line 3: start new paragraph with "The seven day ..."

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- line 4-5: write "... level is in agreement with the RSM-corrected ..."
- line 6: delete "instrument" after 'OMI'
- line 20: write "Satellite measurements of SO2 can help to better identify ..."
- line 23: write "... due to strong interference with absorption by ozone, which..."
- line 26: add comma in "areas, which ..."

page 10829

- line 8: using 'demonstrated' seems a bit too strong, as explained above
- line 11: remove comma in "... 2006) and amient ..."
- line 16 "The retrieval of SO2 emissions" is nonsense: emissions are not retrieved, SO2 concentrations are; please rephase

pages 10830-10834

- reference list not checked

page 10835: Table 1

- The text first mentions SDOAS, then later WFDOAS, so it would be more logical to have SDOAS first in the table.
- Since the wavelength range for SDOAS and WFDOAS are the same, it does not need to be an entry
- The text says that the number of polynomial coefficients is not important; see remark above. Note also the remark above on including BrO.
- In the final format the table will look rather messy, with 2 entry lines and 9 footnotes. Why not make the table easier reable, e.g.:

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method	cross-section	remark
SDOAS	SO2	at 295K (Vandaele et al, 1994)
	O3	at 223K and 243K (Bogumil et al., 2003)
	...	
WFDOAS	SO2	...
	...	

page 10836, Fig. 1

- The text says that WFDOAS does not include BrO, yet it is mentioned in the "DOAS fitting" box. Make sure that the entries in this diagram agree with the text en Table 1

page 10837, Fig. 2

- See remarks above

page 10838, Fig. 3

- See remarks above
- caption, line 2: write "... and a volcanic eruption (b)."
- line 3: add 's' in "... background conditions were ..."
- line 4: write "Spectra of the volcanic ..."
- line 7: write "... are retrieved with the ..."

page 10839, Fig. 4

- The caption seems to say that the bottom-right panel is SDOAS+RSM, but that is not clear: above the plot it says 'diff' – what does that mean?

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- It may be more clear to refer to 'top-right panel' and such in the caption.
- caption, line 6-7: write "There are open areas ... due to lack of SACURA data ... due to cloud-screening."

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 10817, 2008.