

***Interactive comment on* “Retrieval of tropospheric NO₂ columns from SCIAMACHY combining measurements from limb and nadir geometries” by A. Hilboll et al.**

Anonymous Referee #2

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The study "Retrieval of tropospheric NO₂ columns from SCIAMACHY combining measurements from limb and nadir geometries" by Hilboll et al. presents retrievals of tropospheric NO₂ columns from SCIAMACHY using either SCIAMACHY limb measurements or a CTM for the removal of the stratospheric column. While the procedure of the stratospheric estimation from limb measurements, as well as the key findings, are quite similar to Beirle et al., 2010, the extensive model comparison provides a clear add-on.

The paper matches the scope of AMT. It should be published after major revisions.

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General comments:

1. The paper is quite lengthy and sometimes lacks of a clear structure. The authors should try to shorten the manuscript, in particular for the parts which are not really new (e.g. that the reference sector method has problems at high latitudes in winter) and focus on the new results.
2. The authors point out that they use limb measurements corresponding to the respective nadir state for their stratospheric correction, and claim that this (in contrast to Beirle et al., 2010) results in a more accurate tropospheric product. This argument has to be strengthened by providing single-day results - preferably for a day shown in Beirle et al., 2010.
3. Both limb and CTM are applied for stratospheric correction, but have to be corrected for the reference sector first. Thus, there are different stratospheric datasets (with and w/o reference sector removal), and it was not always clear to me, which dataset is discussed or shown in the figures. So please make this clear, e.g. by defining abbreviations, or stating clearly that only the corrected datasets are shown.

Detailed comments:

Title: Two stratospheric corrections are discussed in this study, without a clear conclusion which should be preferred. This equality should be also reflected in the title.

5044, 13: see 2.

5044, 20-24: Given the high overall offset, I recommend to avoid to state "remarkably well agreement" before the offset is removed.

5046, 15: What does "originally" mean? "A widely used method was the relatively simple "reference sector method" "...

5048, 7: See 2.

5051, 24: add "e.g." in reference list

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5053: Try to clarify this section. I am confused by lines 19-20. What do you mean by limb state? In my understanding, all four limb line-of-sight directions belong to one limb state. What does "four distinct values for every nadir state" mean? Is the stratospheric correction for top left and bottom left pixels of the nadir state the same, or is there also a latitudinal interpolation applied within one nadir state? If not, systematic errors are introduced for states with strong gradients. Why is the across-track interpolation done linearly? What would happen if e.g. spline interpolation would be applied?

5054, 2/3: Interpolation is cubic in location and linear in time - why? What would be the impact of a different interpolation scheme?

5055, 6-8: please reword.

5056, 7: "originally"?

5056 13 "... by averaging all ..."

5057 23 "... observed for all ..."

Section 3.2.2:

- Refer to previous studies, which have reported the same phenomenon.
- Try to avoid repetitions on the reference sector method.

5060, 21: "in many regions": please specify. I don't see a striking global land-sea contrast. There are dominating "clouds" of positive as well as negative DVCD extending over land and sea. Thus, I cannot comprehend the following discussion.

5061, 15: How far does a cloud study improves our knowledge on surface spectral reflectance? This has to be discussed more in detail, and should also be listed in the error evaluation of the nadir column.

Section 3.2.4: I found this section hard to read. Fig. 9a shows uncorrected VCDs, 9b corrected VCDs, and 9c corrected VCDs for a different latitude - this is quite confusing.

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I suggest to

- move 9a into a separate figure, which could be shown in the method section as illustration for the need of offset correction.
- remove the unimportant parts of the caption (like "strat. AMF applied")
- label each subplot with the respective latitude range.

I would appreciate if the authors could focus the study of zonal variations to one or two months exemplarily. For each month, all latitudinal bands could be shown as subplots (top: northernmost) of a single figure. Other months could be added in the supplement.

5062, 5-10: A terrain effect or 3d effects would not only show up in October.

5062, 24: This should not be a problem any more after applying the offset correction?

5063, 9-20: Shorten.

5064, 1-12: This potential uncertainty has to be added to section 3.5.1.

Section 3.2.5: The 31-day running mean introduces artefacts after gaps. If the running mean would be calculated in opposite direction, i.e. starting on 31st December, running back in time, Fig. 15 would look significantly different.

The calculation of cv for limb is problematic, as the interpolated limb VCDs for each nadir ground pixel are not independent! The precision of the limb measurements should be derived based on limb data per state.

5066, 1-6: How does the stratospheric look like for the 60% deviation, and what is the SZA? Please add this profile to Fig. 5.

5068, 20: "delicate"?

5069, 10-18: I can see enhanced values in the marked area in the Indian Ocean for both products, so I can not comprehend this discussion.

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5074, 1: The "very accurate representation" has not been demonstrated on daily basis.

5074, 7: "agree surprisingly well" - after offset correction!

5075, 14-16: I don't see this point supported by Fig. 19.

5076, 8-9: Repetition.

Fig. 3: The colorbar has smooth transitions, but in the map, only 7 distinct colors are shown.

Fig. 19: The inclined rectangle shape of the strange patterns (in both subplots) close to the South Pole indicates that they are caused by single nadir states.

Supplement: It would make more sense to subtract the stratosphere from the total (=nadir) column; then the continents would look reddish, reflecting the tropospheric residue.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 5043, 2012.

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