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Atmospheric Measurement Techniques Discussions

Interactive comment on "Improved spectral fitting of nitrogen dioxide from OMI in the 405–465 nm window" *by* J. H. G. M. van Geffen et al.

Anonymous Referee #1

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The paper "Improved spectral fitting of nitrogen dioxide from OMI in the 405–465 nm window" by Geffen et al. presents various improvements of the spectral analysis of NO2 compared to the "OMNO2A" retrieval, which is so far the basis for the standard NO2 product (NASA) as well as DOMINO (TEMIS). The paper is well written and matches the scope of AMT. I recommend publication after dealing with the following items:

General remarks:

1. The authors present a lengthy comparison of OMI stratospheric column densities to other instruments. However, while the observed discrepancy between OMI and other measurements was the initiation for working on an improved spectral analysis, this part

(section 2.3, section 3) is not directly related to the topic of the paper and should be shortened. I propose to move most parts of the comparisons to the supplement.

2. The presented algorthm is going to be applied in a "forthcoming OMNO2A SC reprocessing". While the authors have clearly shown that the current OMNO2A has some shortcomings and present some clear improvements, I evaluate the presented data to be too sparse to be a sound basis for a reprocessing. The authors present the results of their new set-up for only one orbit, and test the other orbits of the same day for consistency. But no results are shown for other days (e.g., after the row anomaly). Effects like "striping", or the slit function, are very likely time-dependend. I thus urge the authors to include more days (different seasons, different years) in the analysis and check if the settings (optimized for 1 July 2005) work as well for other days, before starting a reprocessing of the complete OMI timeseries.

3. The authors anticipate that the algorithm changes basically remove the stratospheric bias. However, some of the changes might effect the tropospheric columns as well (e.g. the update of the H2O cross section). Thus, a map of the NO2 SCD difference has to be shown, and possible spatial patterns should be discussed.

4. In the new algorithm, some cross-sections are updated or added, while other absorbers (e.g. Glyoxal) or Pseudo-absorbers (e.g. Vibrational Raman; spectral signatures of sand (Richter et al.) etc.) are not considered. The authors should motivate their selection of the absorbers they have added, and check the effect of the others they are still omitting (or give reasons/references why it is justified to skip them).

Further comments:

Abstract lines 5-6: The SCDs of OMNO2A are not only used in the current DOMINO and NASA products, but in all versions before as well.

Abstract line 23-24: ... independent NO2 retrievals from other instruments ...

Abstract page 10620 line 28ff: This is a reasonable anticipation, but the authors should

check this (e.g. by showing a map of the difference in NO2 SCDs between the fit versions).

Introduction page 10621 lines 12&15: For very polluted places, the tropospheric column can be higher than 90% of the total column, and higher than 10e15 molec/cm2.

Introduction page 10621 line 15: Stratospheric columns can be much higher than 2e15 molec/cm2, in particular at higher latitudes.

Introduction page 10622 lines 13-22: Please extend this paragraph by adding some historical context: "Early satellite retrievals of NO2 focus on the dominant absorbers, i.e. the Ring effect, O3, and H2O (refs). During recent years, continuous progress was made by accounting for weaker absorbers (O4, liq. water, CHOCHO, vib. Raman) (refs) or pseudo-absorbers (e.g. sand, Richter et al.)."

2.1.2 page 10624 line 19: "The standard OMI NO2 SCD..." 2.1.2 page 10624 line 26: Refer to the updates you are going to introduce: "In the modified fit presented in this study, these standard settings are modified/exteded by ...; for details, see sect. ..."

2.2: Shift the equation more to the beginning of the section, and add references.

Page 10631 line 9: "a" -> "at"

Page 10632: For the discussion of differences in the solar spectrum and the cross sections, total differences are only of minor relevance. Much more important are differences of the high-frequent spectral structures, in particular for the solar spectrum. It would thus be interesting to add plots showing the difference new vs. old.

Page 10634 line 12: If the cross section is given with a spectral resolution below that of OMI, convolution with the OMI SF is not appropriate (rather than "not strictly necessary"), as this further smooths the - already too wide - absorption structures.

Page 10635 line 22: I do not agree with this statement; a squeeze/stretch can be regarded as a wavelength dependend shift. From table 4, there are clear indications of

a change of the shift with wavelength. Thus, it is not appropriate to assume the shift being constant over the whole wavelength interval, in particular for such large intervals as in wcF. The authors should thus test how far allowing for a squeeze/stretch improves the spectral calibration.

4.2.2: The authors discuss artefacts in the NO2 SCD for inaccurate spectral calibration. These effects have been discussed before (e.g., Stutz and Platt, Appl. Opt., 1996; Beirle et al., AMT, 2013). These studies should be referenced. The authors conclude that these findings "pose firm requirements on the accuracy of the wavelength grid" of future satellite missions. Please comment if the accurate, but very time-consuming wavelength calibration done for OMI is foreseen to be done operationally in future missions, e.g. for TROPOMI. A faster solution might be to account for the spectral structures caused by a small shift in the wavelength calibration by including a "shift spectrum" as pseudo-absorber in the fit (Beirle et al., 2013).

Table 1: I propose to add the updated settings to this table.

Figure 12: The liquid water is shown as global map. It would be interesting to have additional maps, in particular the NO2 SCD, the difference of NO2 SCD vs. the old set-up, and the fit results for all other aborbers (the latter probably in the supplement), in order to evaluate the fit performance and possible artefacts.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 10619, 2014.