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Reply on CC1

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Author comment on "Total ozone column from Ozone Mapping and Profiler Suite Nadir Mapper (OMPS-NM) measurements using the broadband weighting function fitting approach (WFFA)" by Andrea Orfanoz-Cheuquelaf et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-61-AC4, 2021

Dear Dr Seftor,

Thank you very much for your careful reading and commenting. We conclude from your comments that our explanations are not clear enough and can result in some misunderstandings. We shall address these misunderstandings in the revised version of the manuscript.

Please note that we do not claim there are any issues with OMPS-NM calibration or data. We apologize for the confusion. To rectify the situation and clarify what we have done, we plan to add an appendix that addresses the issue.

The issues discussed in this manuscript are specific to the retrievals of total column ozone, O3, using the Weighting Function Fitting Approach (WFFA), a modification of the Weighting Function Differential Optical Absorption Spectroscopy (WFDOAS) technique. The WFFA has evolved from WFDOAS; both determine the total O3 column in the O3 Huggins bands.

WFDOAS, which uses the spectral window 325-335 nm, has been developed to work with measurements with relatively high spectral sampling and resolution and worked successfully with data from the GOME, SCIAMACHY and GOME-2 instruments.

The nature of the problem using WFDOAS on OMPS-NM data is the instability of the retrieval resulting in unrealistic behaviour of the results across the instrument FOV. We illustrate this effect in the appendix of the revised manuscript. Figure A1 shows more than 5 DU of differences between adjacent across-track FOV. The WFFA algorithm avoids this obstacle by reducing the weight of the differential absorption structure of ozone in the retrieval and by increasing the weight of the broad-band spectral signature of ozone. This is done by extending the spectral range to 316 to 336 nm and subtracting a lower order polynomial (constant) instead of the cubic one in WFDOAS. As a result, most of the instabilities has been eliminated, but some of them remained. Subsequently, we further analyzed the retrieval results obtained using only selected spectral points from the retrieval spectral window. It was concluded that the retrieval instability is most probably caused by the correlation between the weighting function of ozone, weighting function of the temperature and Ring spectrum included in the fit. The spectral sample with every second spectral point was found to have a much weaker dependence on the temperature, making the WFFA retrieval more stable. New plots providing more details on this topic are added to the revised manuscript (Figure A2).

In the original version of the manuscript, we referred to the spectral points in the selected fitting window as “readouts”, which seems to result in confusion. The term “readouts” is not used in the revised manuscript anymore. For our retrieval, we select the odd-numbered spectral points in the selected window. For clarity, in the revised paper, we include a table (Table A1) listing the wavelengths contained in the even and odd wavelength samples. The justification of the wavelength sample selected is rather empirical. Our investigations have shown that the retrieval using the odd wavelength sample is less sensitive to the temperature as compared to all other considered samples. This is why the odd-numbered spectral points have been preferred. We have included explanations regarding this topic in Appendix A2 of the revised manuscript.

As mentioned above, the identified issue is very specific to the ozone column retrievals with WFDOAS type methods and plays no role for other retrievals cited in your comment.

The inclusion or rejection of some spectral information does not provide a measure of the algorithm quality.

Concerning the aerosol effect in the retrieval, as discussed by Coldewey-Egbers et al. (2003), “WF-DOAS Algorithm Theoretical Basis Document” (DOI: 10.26092/elib/381), “the effective albedo by the Lambertian Equivalent Reflectivity (LER) approach near 377 nm represents a first-order correction for non-absorbing aerosols (…) total ozone could be underestimated by 1% if visibility is reduced to 2 km by absorbing aerosols”. We repeated this analysis with WFFA for different boundary layer aerosol types assuming a strong aerosol load (visibility of 2 km) and in addition for an extreme volcanic aerosol load in the stratosphere. We found that the WFFA TOC retrieval errors are highly dependent on the solar zenith angle. For small SZAs (about 30 deg), the TOC might be overestimated by about 3 % in the presence of weakly absorbing aerosols in the boundary layer. For strongly absorbing (urban) boundary layer aerosols, retrieved TOC is about 1 % higher. In the case of an extreme volcanic loading in the stratosphere, ozone might be overestimated by about 8 %. For high SZAs (about 60 deg), the error is below 0.5 % for weakly absorbing boundary layer aerosols and increasing to about 1% for strongly absorbing boundary layer aerosols and extreme volcanic aerosol loading in the stratosphere. This topic is included in the revised manuscript, Appendix A3.