Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
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# Comment on amt-2021-32

Anonymous Referee #1

Referee comment on "Ozone profile retrieval from nadir TROPOMI measurements in the UV range" by Nora Mettig et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-32-RC2, 2021

General comments:

With this work on "Ozone Profile Retrieval from nadir TROPOMI measurements in the UV range" Mettig et al. provide an extensive first account of a Tikhonov-type retrieval of TROPOMI nadir ozone profiles and its overall performance. The research is presented clearly and exhaustively, and is of high interest to AMT. Only minor corrections and clarifications are requested, together with some improvements on internal and external referencing.

Specific comments:

Line 5, 142, 159, 439: Using "accuracy" as a synonym for a quantifiable total or systematic uncertainty (to be clarified by the authors) is misleading. Rather use one of the latter.

Line 52: Rather use "space-borne" than "at the top of the atmosphere" because the latter means different things in different applications (e.g. about 100 km for atmospheric modelling)

Line 81: "In the future, an operational TROPOMI Ozone Profile L2 product will also be provided." Please specify by whom and/or provide a reference.

Lines 126-127: Provide a reference and possibly some interpretation of the numbers for the statement that "For the ozone profile retrieval, all ground pixels are used which do not

have an error flag above 15 for "measurement_quality" or a "ground_pixel_quality" flag greater than 32."

Line 143: Please be more specific on "Version 4.23" Does this refer to the L2 product or processor? Which L1 version does this correspond to?

Line 167: Please be somewhat more specific on the collocation criteria: "100 km maximum distance and 24 hours time difference" Are all pixels within these criteria considered, or only the 'closest' or the one with some best retrieval parameters? As TROPOMI has daily global coverage, why not take the single pixel that spatially overlaps with the sonde launch site at the day of the sonde flight, or with (the majority of) the sonde trajectory?

Lines 180-181: The term 'matching' is rather vague. It is recommended to stick to the 'collocation' terminology throughout the text.

Eq. (3) and following: x_a should be explained upon first use, as well as its replacement of x_0

Table 1. The "Tikhonov 0th order parameter: 11.11" is not explained in the text.

Lines 236-237: "These errors are largely mitigated if the forward model is run by using the angles (viewing, solar zenith and azimuth) at the surface rather than those at the top of the atmosphere" Is this the case in this work then? Please clarify.

Lines 240-241: "These spectra are then convolved with the TROPOMI instrument response function (ISRF)." Please provide a reference for this.

Line 244: Would you have a reference for the "shift and squeeze correction"?

Line 255: "the Tikhonov regularisation has been proved." This statement is rather brief and hence not very clear.

Lines 325-326: "Consequently, the retrieval seems to be nearly independent by the a-priori." This is a quite strong statement that does not straightforwardly follow from the previous sentence. It should be quantized either here or with reference to the later

analysis.

Lines 347-350 and Figure 3 middle panel (C): The authors mix the use of 'averaging kernel' and 'averaging kernel matrix' and of their abbreviation. Line 367 introduces "AK" as the abbreviation of "averaging kernel matrix" but later "AK" is used to indicate the individual averaging kernels. Please clearly distinguish between both for clarity, and use separate abbreviations, e.g. AK and AKM, respectively. What is shown in Figure 3 panel (C) are individual averaging kernels and not the averaging kernel matrix as a whole, so please correct the label of the horizontal axis.

Lines 362-363: "The noise retrieval error calculated in the linear approximation by using the Rodgers formalism" Please provide a formula of reference with formula number.

Figure 2: Why do the second and third rows of plots not have green shaded areas showing dispersion, as the top row for the profiles has?

Line 380: "The best vertical resolution is obtained at the smallest angles (blue)." Please briefly explain why this is the case.

Line 384: "A measure for the mean vertical resolution…" Possibly, briefly note whether this indeed corresponds to the vertical averaging of the previous (or not exactly)?

Lines 430-431: And what about latitudes beyond 50° north or south? These are shown e.g. in Figure 11, but not mentioned here.

Figure 6, caption: Please describe the meaning of the grey area in the right plot.

Line 451: "convolved with the TOPAS averaging kernels" Possibly refer to Eq. (9) for clarity?

Lines 452-453: "The differences vanish in the altitude range where the retrieval is less sensitive." This may sound counterintuitive, so please clarify.

Figure 8, 10, 11: Add note on different (colour) scales.

Lines 517-519: “For most of the altitude layers, an across-track variation of the retrieved ozone number density is noticeable at some locations with higher values on the east side of the swath and lower values on the west side. This issue shall be a part of future investigations.” This is not clear for all latitudes in Figure 11. Depending on the location within the orbit (especially within 40° north to south), one could say that ozone values often look artificially constant within each swath, resulting in stepwise meridian behaviour between orbits, especially for plots (B) to (D), so possibly somewhat extend this discussion.

Line 538: “as the precision of MLS data significantly decreases” Please provide reference.

Line 576: A resolution of 9 km is mentioned in the main text (line 387).

Lines 600-603: Refer to MLS drift / degradation studies to assess how the TROPOMI soft calibration would be affected.

Line 605: TROPOMI L1b, WOUDC, and SHADOZ data are obtained from third parties and should be mentioned separately.

Technical corrections:

Throughout: “ozonesonde(s)” can be written in one word.

Line 51: “stratosphere” instead of “stratospheric”

Lines 108-109: Mention abbreviation of “signal-to-noise ratio” upon first use.

Line 133: Replace “by” by “using”

Line 173: “laser” instead of “lasers”

Line 217: The reference to Eq. (8) should be Eq. (7)?

Line 220: Double period.

Line 298: Add comma after closing bracket for readability.

Table 2: Remove double ‘with’ in “European background with with polluted boundary layer”

Line 342: Add comma after “Figure 2”

Line 464: Double ‘the’

Line 486: “positive”

Line 595: Replace “small” by “smaller”