Reply to Comment on egusphere-2025-5836 by Anonymous Referee #1

Referee comment on "Improved NO_2 spectral fits for TROPOMI and OMI by removing wavelengths around 430 nm" by Jos van Geffen et al., https://doi.org/10.5194/egusphere-2025-5836-RC1

⟹ The referee report is copied below; the reply is preceeded by an arrow, like this text.

Apart from the changes resulting from the review process, we have carried out the following updates, which do not affect the conclusions of the paper:
– TROPOMI processor v2.9.1, which includes the "NO2-gap approach" of the paper, was activated on 22 November 2025; the text has been updated to represent this fact where appropriate.
– Since we now have a few months of v2.9.1 data, a quick comparison of results before and after the switch is added at the end of Sect. 4.2
– Fig. 2 in Sect. 2.2.2 is extended to include the year 2025; the figure caption was reformulated to improve readability.
– Fig. A1 in App. A is extended to contain the full year 2025.
– Meanwhile the OMI collection 4 NO_2 slant column data, named OMNO2A, are released by NASA; the URL of the download access is added to the "Data availability" section. NASA has assigned a DOI to both the dataset and the ATBD: https://doi.org/10.5067/AURA/OMI/DATA2433. Unfortunately, this DOI appears not yet activated; it should likely lead to a landing page such as the one for the collection 4 cloud data (OMCLDO2): https://doi.org/10.5067/AURA/OMI/DATA2407. Hopefully, NASA has activated the OMNO2A DOI by the time the paper is published.
– A few minor textual corrections were carried out.

The paper "Improved NO_2 spectral fits for TROPOMI and OMI by removing wavelengths around 430 nm" by van Geffen et al. describes the improvement of the DOAS retrieval algorithms for the TROPOMI and OMI instruments by disabling a part of the fit-window that reduces the impact of vibrational Raman scattering on the spectral fit quality. The study updates the TROPOMI NO_2 retrieval algorithm described in van Geffen et al., 2020 and 2022. The "NO2-gap approach" is analysed for land- and water scenes and the impact on the stratospheric and tropospheric NO_2 columns is discussed.

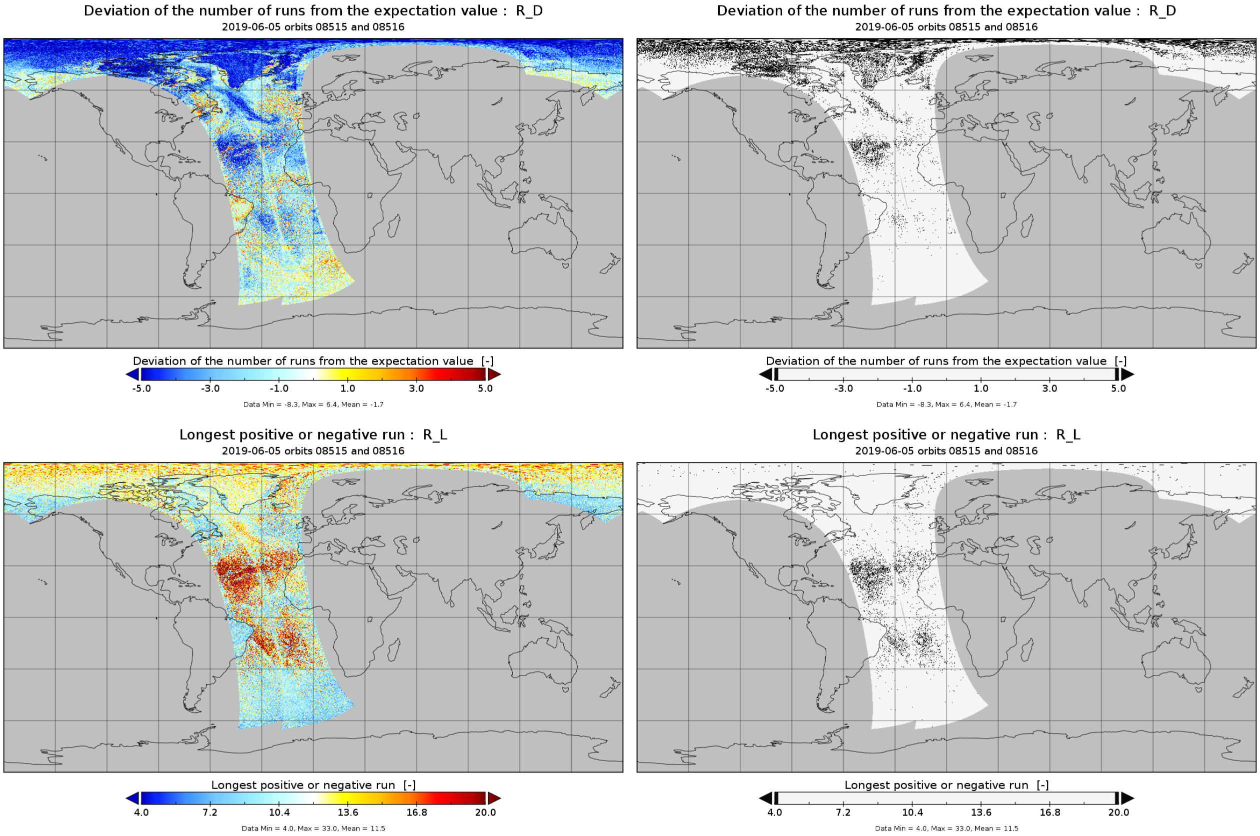
The topic of the manuscript is within the scope of AMT and it is of interest to the scientific community. It can be recommended for publication, if the authors make an effort to address the comments listed below, and improve the manuscript accordingly.

⟹ We thank the referee for these kind words.

Specific comments

Section 1
The authors explain that the remaining structures in the NO_2 fit residual around 430 nm for retrievals over clear-sky dry land indicate that the accounting for RRS effects (by including a Ring spectrum in the DOAS fit) may not be fully accurate. The possible effects of the RRS (besides the effects of VRS over water) are shortly discussed in Section 3. Could these RRS effects be further investigated by applying the TROPOMI DOAS algorithm on simulated reflectances calculated with a radiative transfer model with RRS (e.g. for some specific scenarios)?

⟹ It might be interesting to undertake such a study, but effect of the NO2-gap approach on the retrieval results is small, so that it is not clear whether such a study would provide additional information. In addition to that is will be a major effort since a lot of different circumstances are involved: land and water scenes, VRS (which is not easy to simulate, as it depends on aspects like the chlorophyll concentration as well as the viewing geometry), presence/absence of clouds, variation of the irradiance with solar activity, etc. In fact, using real data as done in the paper enables to have a close look at most possible cases without much effort, though of course it is then not possible to study the same case under irradiances at different moments in the solar cycle.



Fig_RC 1: Example plots of the runs test variables R_D (top row) and R_L (bottom row) using a colour scale between values considered to be tell-tale signs of possible problems (left column) and a black-and-white separation of the regimes (right column).

Section 2.1.1
Are there any other important algorithm improvements in the upcoming TROPOMI NO_2 processor v2.9.1 (besides the "NO2-gap approach" described in this manuscript) that are of interest to the reader and could be shortly mentioned here?

⟹ Processor v2.9.1 is operational since 22 November 2025; the NO2-gap approach is the only update implemented; the text at the end of Sect. 2.1.1 has been updated to mention this.

Section 2.2
P4 Please include the definition of the geometric AMF used in this study.

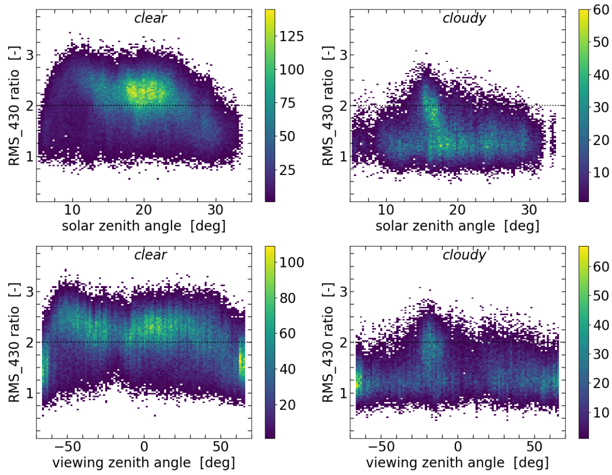
⟹ Done.

Section 2.2.2
The statistical DOAS uncertainty is derived from the standard deviation on the slant columns in 2°x2° grid cells. Since the SCD also depends on the viewing geometry, it might be better to use geometrical corrected slant columns (GCD). The question is if there are significant differences between the statistical uncertainties based on the SCD or GCD.

⟹ For consistency sake we have followed the same approach as used by Zara et al.,2018 (who refers to earlier papers regarding the adopted method) and average the SCD over 2°x2° boxes, which is OK as Zara et al. write "as long as the geometric AMFs within the box show little variability". And also following Zara et al.: "Boxes with relative AMF variability of more than 5% are discarded to prevent variability in viewing geometry influencing the results." A remark representing the latter has been added to the text. Also added is that boxes with less then 10 ground pixels in them are discarded as well.

Section 3 → 2.2.3
P9 Please include a global map of RD and RL

⟹ Such maps do not provide much information: depending on the scale used, they show a



Fig_RC 2: Scatter plots of the RMS_430 ratio (y-axis) as function of the solar zenith angle (top row) and viewing zenith angle (bottom row) for clear-sky pixels (left column) and cloudy pixels (right colomn) for the Atlantic Ocean orbit section of Sect. 3.1.

scatter of many points or hardly any points. Fig_RC 1 above gives an example using two orbits. Obviously, one could select boundaries between the regions other than $|R_D| > 5$ and $R_L > 20$ to indicate possible problems. As the text of Sect. 2.2.3 stresses both R_D and R_L are *additional independent* sources of information on possible problems with retrieval results: they do not on their own signal problems.
The plots of Fig_RC 1 are made using Panoply and the graphs are exported in the "Extra large" size; if you would like to see the individual graphs in PNG format, you can download them: `http://www.josvg.dds.nl/downloads/20190605_example_runs.zip` – that file will be deleted once the review process is finished.

Section 3.1
A possible dependence of the RMS_430 ratio on the viewing/scattering geometry is not really discussed in the manuscript. It would be useful to include scatter plots of the RMS_430 ratio as a function of solar-, viewing or scattering angles for clear-sky pixels over the Atlantic Ocean.

$\Longrightarrow$ There is no apparent relationship between the RMS_430 ratio and SZA or VZA, as Fig_RC 2 shows (VZA values for the left side of the track are shown as negative angles); a remark to this effect is added to the end of Sect. 3.1. (The "peak" in RMS_430 around SZA $\approx 15°$ and VZA $\approx 15°$ are related to a cloud complex in the Atlantic Ocean orbit section.)

Section 3.4
Fig. 6 Why are the RMS_430 ratios only plotted in black (> 2) and white (< 2)? A color map would provide more information, e.g. about the RMS_430 ratios over different water scenes. Measurements with cloud radiance fractions > 0.5 could be marked as well.

$\Longrightarrow$ The map of Fig. 6 is intended to show the areas where we consider the RMS_430 ratio to indicate problems and this is most clearly shown in this black-and-white version. Upon your request, a colour scale version of the map has been added in the new App. C, with separate maps for clear and cloudy pixels.

Section 4.1
Is there also a significant impact of the NO2-gap fit on the statistical SCD uncertainty? This parameter could be included in Tables 2 and 3 as well.

$\Longrightarrow$ There is indeed an impact on the statistical SCD uncertainty – this is discussed in Sect. 4.2 and listed in Table 4 on the basis of Pacific Ocean orbits from the two test months. As mentioned at the beginning, we've added to Table 4 also results of the first comparison of before/after the operational switch.

Section 4.2
Fig. 10 Please include a global map of the relative change in the NO_2 SCD as well. The scatter plot on Fig. 11 show small changes in the SCD for most pixels but there seems to be a fairly large

scatter in the SCD change as well.

⟹ There is indeed large scatter for the changes in GCD values, but the pattern is the same as for the SCD error shown in Fig. 10; upon your request a map has been added to Fig. 10.

Section 6
The authors discuss the unexpected large TROPOMI tropospheric NO_2 columns over the Tibetian lakes that are likely due to unreliable DOAS retrievals and they also propose an (experimental) approach to improve the spectral fit over small areas like the lakes. I agree that such an approach to construct the missing reference spectrum might not be suitable for global retrievals and operational use. However, a case study for the Tibetian lakes would fit in the manuscript and enhance the scientific significance of the paper.

⟹ Such a case study for these lakes would indeed be interesting but the same time complex to carry out, and was discussed in the context of the Labzovskii et al. (2024) paper. However, this is a research topic on its own and falls ouside the score of our paper.