

RC1 - answers

General comments

Serena Di Pede et al. introduce the upcoming updates to L0–L1 reprocessing within the TROPOMI/S5P framework and describes the impact of adapting the new L1 product into the L2 ozone profile retrieval. The performance of the ozone profile retrieval is highly sensitive to the stability of radiometric and wavelength calibrations. In this context, the soft calibration applied to ozone profile retrieval may serve as a useful diagnostic tool for evaluating the quality of the L1 product and comparing the effects of the updated L0–L1 reprocessing. I believe this paper fits well within the scope of Atmospheric Measurement Techniques (AMT) and recommend its publication after addressing the following aspects.

We thank the reviewer for the comments and suggestions. We have addressed each point raised and, where necessary, adjusted the manuscript.

Major comments

1. **Introduction:** I think it is unnecessary to present the importance of ozone and the full history of space-based ozone monitoring in this paper, leading to some duplication in the companion paper by Keppens (2024). Instead, it is better to provide an important aspect on the history/current status of L1B and L2 ozone profile product. Like, the validation results and data application results. I believe there are companion papers that already address the importance of version updates related to stray light and background signal corrections and other calibration issues.

Thank you for the suggestion and for giving us the chance to improve the manuscript. We have updated the introduction section accordingly. There are more references to processor version updates and companion papers.

2. **Section 2:** Is the L0–L1 reprocessing planned only for the UV1 and UV2 bands? If not, please provide a brief summary of the updates across all spectral bands. If so, it would be helpful to clearly state that the reprocessing applies only to the UVN module.

The L0-L1 reprocessing updates are limited to the UVN module, no changes are applied to the SWIR detector (bands 7 and 8). The dynamic straylight correction is only applied to bands 1-2, the residual correction is applied to all the bands (from 1-6). In band 3, the so-called "sharp detector feature" is also applied.

Manuscript change: we clarified this aspect in the Introduction and Section 2.

3. **Section 4:** Are the updates to the version 2.9.0 ozone profile product limited only to the L1B data and its soft calibration? It appears that only three orbits per year are selected to calculate the soft calibration. I believe this sampling may be

insufficient, especially after filtering out cloud-affected pixels. Additionally, the ozone fields selected each year could be inconsistent, potentially affecting the robustness of addressing the temporally varying systematic biases.

Thank you for pointing out that this aspect is not clearly explained in the manuscript. Our work describes the updates in the L0-1B processing, and their effect on the soft-calibration correction. As we mention at the beginning of Section 4 (Improvements, in the updated version of the manuscript), there was no change in the soft-calibration procedure itself. The soft-calibration correction is computed per each year of the mission considering 5 orbits per year, always over the Pacific Ocean where the total ozone variability is low and to ensure consistency during the years. The orbits used for the forward model comparisons are always chosen in the same months of the year, specifically in January, March, July, September and November, to capture seasonality.

Manuscript change: We moved the text section in 272-279 to the procedure (Method section 3.3) to enhance clarity on the methodology.

4. **Figure 2:** Please take a look at <https://www.mdpi.com/2072-4292/17/5/779>. This paper also indicates the deeper degradation at Fraunhofer lines in UV1 band over time.

Thank you for the suggestion. Figure 2 of this paper shows in a clear way the degradation of the UV1 band over time, while the stability of the other bands.

Manuscript change: we added this work as a reference of the manuscript.

5. **Figure 13:** The OMPS-NP ozone profile product is similar to SBUV-type products, primarily designed for stratospheric ozone retrievals. However, the authors use it as a validation reference for the entire ozone profile, including the troposphere, which may not be appropriate. Additionally, the citation of Kramarova et al. (2017) is incorrect, as that reference pertains to the OMPS Limb Profiler product, not the Nadir Profiler. Moreover, for stratospheric ozone validation, OMPS-LP would be more suitable than OMPS-NP due to its superior vertical resolution.

The initial idea was to compare the ozone profile retrieved from two nadir-viewing instruments. However, we decided to replace Figure 13 with a new figure, motivated in the answer to question 7. We believe that the new figure is more consistent with the scope and analysis of the manuscript. The inter-satellite comparison will be discussed in another manuscript, when a larger dataset over the mission will be used to enable a more appropriate comparison of the two data versions.

Manuscript change: replace Figure 13, as motivated in question 7.

6. The impact of the L1B updates on the soft calibration is remarkably large (Figure 9), whereas the resulting impact on the ozone product is relatively minor—only a few percent (Figure 11). It implies that the implemented soft calibration works well for addressing the systematic biases existing in both versions of L1B product.

Yes, that is correct. The soft-calibration procedure is not changed and it should address well the systematic biases shown by both L1B versions. We would like to remark that Figure 11 shows the results of the retrieval of a single orbit (over the Pacific Ocean) which was also used to test the calibration results with different L1B versions (shown in Figure 9). We believe that the largest impact on the ozone retrieval will be visible when looking at the comparison of the two ozone product versions of an extended dataset over the whole mission. This comparison would enhance more subtle differences regarding, for example, the bias of the data or the drift compared to on-ground measurements.

Manuscript change: Building on this remark and connecting to questions 7-8, we replace Figure 11-12-13 using along-track averages and the across-track dependent anomalies metric to show the results on the ozone profile, as these metrics are more sensitive to the L1B updates presented in the manuscript. Moreover, the figures are based on a retrieval of a full day (15 July 2024) instead of a single orbit (22992).

7. To better emphasize the improvements resulting from the L1B reprocessing, I recommend comparing ozone profiles without applying soft calibration. This approach can reveal more substantial enhancements. For example, Bak et al. (2024) demonstrated improved OMI tropospheric ozone distributions using the Collection 4 L1B product without soft calibration, compared to results obtained with the Collection 3 L1B product where soft calibration was applied (see their Figure 8 vs. Figure 12). Reference: Bak, J., Liu, X., Yang, K., Gonzalez Abad, G., O'Sullivan, E., Chance, K., and Kim, C.-H.: An improved OMI ozone profile research product version 2.0 with collection 4 L1b data and algorithm updates, Atmos. Meas. Tech., 17, 1891–1911, <https://doi.org/10.5194/amt-17-1891-2024>, 2024.

Thank you for the suggestion and the opportunity to improve the analysis. We agree that the comparison of ozone profile retrievals without applying the soft calibration correction can be a useful diagnostic tool to reveal more subtle differences. We looked into this comparison using the ozone retrieval of a full day (15 July 2024) and replaced the figures 12-13.

Manuscript change:

- Figure 11 has been replaced by the retrieval results as a function of the across-track position (along-track averages). We believe that this metric is more consistent with the analysis of the manuscript as it enhances the effect of the across-track dependent calibration biases;
- Figures 12-13 have been replaced by the global maps and the across-track dependent anomalies of the total and tropospheric ozone column (the 0-6km ozone sub-column is in the Appendix E1). These figures also display the

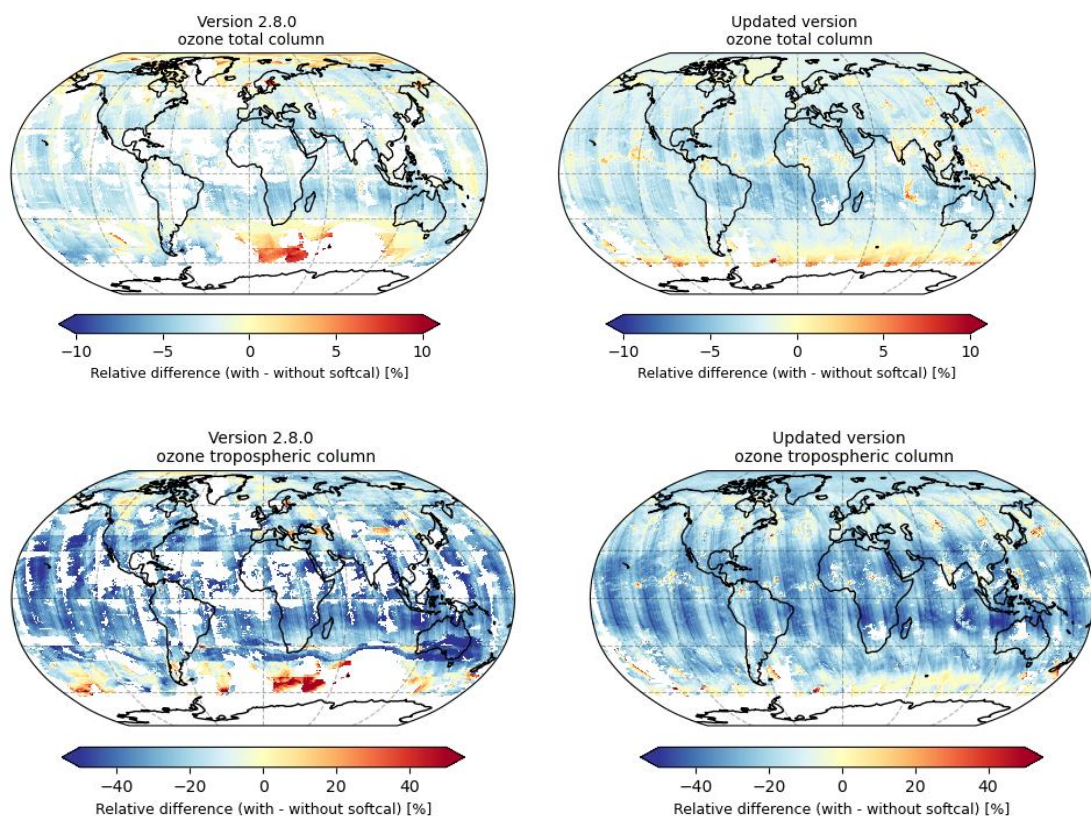
comparison with the two versions of the retrieval but without applying the soft-calibration correction.

The text has been accordingly updated.

8. Following previous comment, the impact of applying soft calibration on ozone profile retrievals should be significantly reduced between existing and upcoming versions, which could emphasize the improvements in both L1B and L2 products. Highlighting this reduction would help demonstrate the improvements made in both the L1B and L2 products. In particular, the decreased dependence on soft calibration is an important advancement worth emphasizing.

We agree that the impact of applying the soft-calibration correction on the retrieval should be reduced when using the updated version of the L1B data. If we indeed look at the difference between the retrieval, with and without soft-calibration (but same data version), we notice that the impact of the soft-calibration is reduced when using the updated version. This can be seen in the following global maps, showing the difference between the retrieved total and tropospheric ozone, with and without soft-calibration, for the same data version: version 2.8.0 (L1B 2.0.1) on the left, while the updated version on the right.

Manuscript change: the global maps in Figures 12-13 also show that the impact of the soft-calibration on the retrieval using the updated L1B data is smaller than in the previous version. However, we remark that it is not possible to perform a good quality retrieval without the soft-calibration correction.



Minor comments

1. Line 33: in (Singer et al., 1957) → in Singer et al. (1957)
Corrected
2. First line of page 5: from (et al.) → from et al.
Corrected
3. I think there are several unnecessary parentheses throughout the manuscript—for example, phrases like "(but on the same detector)", "(and, consequently, corrected for)", and "(and its uncertainty)" could be integrated more smoothly into the main text. Please consider editing these to improve readability and flow.
We agree with the reviewer, and we updated the text accordingly to avoid too many parentheses.
4. Figure 9. “residual” -> “background” in caption. Through the manuscript, the background term is used instead of residual.
Thank you for the comment. We updated the manuscript accordingly to use the term “residual”.
5. No availability section is provided in particular for validation reference (OMPS-NP) and the existing operational product, a plan for the upcoming versions.
After the implementation of the new L1 3.0.0 and L2_O3_PR (probably 2.9.1) data version, there will be more data available for validation, which we plan to address in another publication. We added this information in the Conclusions.