Review of Andrea Orfanoz-Cheuquelaf et al., Tropospheric ozone column dataset from OMPS-LP/OMPS-NM limb-nadir matching

The manuscript Tropospheric ozone column dataset from OMPS-LP/OMPS-NM limb-nadir matching by Andrea Orfanoz-Cheuquelaf et al. descripes the adaption of the LNM algorithm for SCIAMACHY (Ebojie et al., 2014) to the OMPS instrument. The errors are estimated and moreover the retrieved tropospheric ozone columns are compared to ozone soundings as well as comparable satellite data sets i.e. OMI-MLS and S5P CCD.

General Remarks / Questions

The total column is retrieved using a WFDOAS approach (or similar) here a view more details on the algorithm might be given e.g. is a stratospheric ozone profile necessary if so which one is used? As a reader we don't know all the details that might be obvious to the authors and have been presented in previous publications.

A: We prefer to do not blow up the manuscript with the details of the retrievals already published before as it might shift the focus of the paper, which is now on presenting the new product, expressing the issue newly identified in the Limb retrieval and a complete analysis of uncertainties.

Concerning the tropospheric ozone retrieval, are the total and stratospheric columns retrieved independent from each other, or are the retrievals linked? For example one might think of using the stratospheric profile retrieved from the limb observations in the total column retrieval, or constrain the stratospheric column by the total column as upper limit.

A: Now clarified in the revised version of the manuscript: “Both retrievals are completely independent of each other. For a consistency reason, they use the same ozone absorption cross-sections, Serdyuchenko et al. (2014).” (Lines 170-171)

Only cloud free pixels (cloud fraction less than 0.1) is used. Which cloud data are used here? If only the cloud fraction is used the VIIRS cloud fraction might be an option?

R: The cloud information is now detailed: “The cloud fraction information is obtained from the operational OMPS-NM L2 product V2.1 from NASA (Jaross, 2017). The retrieval of effective cloud fraction is made using the Mixed Lambert Equivalent Reflectivity model, using a weak ozone absorption wavelength, 331.2 nm for most conditions, and 360 nm for large SZAs and high amounts of ozone (Seftor and Johnson, 2017).” (Lines 104-107). Using the VIIRS cloud product might be an option but would introduce additional uncertainties from matching the footprints of both instruments (OMPS-VIIRS)

The authors discuss a very interesting issue in the OMPS profile retrieval over the Pacific Ocean around 10° N and attribute it to a possible cloud effect on the profile along the Line-of-Sight (p 16 l 335). I fully agree that clarifying this issue in detail might be worth a detailed study. On the other hand as a first check it might be worth to skip the profiles being affected by clouds some hundreds of kms north or south (along the Line-of-Sight) of the tangent point. This might give a first indication whether your hypothesis is correct, provided you have enough data. This effect is only observed over the oceans but not over the continents, even though or because the convection is stronger over the continents. Is this in agreement to the current hypothesis? Unfortunately there are no ozone soundings available in the most affected regions.

A: The effect is clearly observed when the instrument's line of sight crosses a persistent band of clouds which is always located at nearly the same geographical position and characterized by very high probability of cloud occurrences. Skipping all measurements affected by clouds at this particular location results in a loss of the statistical representativeness of the comparison because of a very small number of the remaining samples. The effect is certainly present both over the ocean and over land; however, it is much more difficult to detect anywhere else as the clouds appear statistically random at different locations along the line of sight, and the effect is strongly smeared away when calculating monthly mean values. However, the location of the ITCZ over the Pacific is fairly stable throughout the year, leading to a strong signal in yearly averages. In addition, the surface reflectivity gradient is strongest over the oceans, which typically have a lower surface albedo value with respect to land.

The tropospheric columns agree more or less with the data from OMI-MLS or S5P_CCD. All three retrieval approaches make use of the residual technique: TrOC=TOC - SOC. Can the observed difference to OMPS-LNM be attributes to the total column or the stratospheric column. For the drift relative to OMI-MLS (p 19 l 412) this might be of interest.

A: In the particular case of OMPS-LNM compared to OMI-MLS, differences between OMPS-NM WFFA TOC and OMI TOMS are lower than 2%, with OMPS-NM WFFA being higher than OMI TOMS. No drift was observed there. [Orfanoz-Cheuquelaf, 2023].

To address this question in more detail, we performed the comparison of SOC from MLS and OMPS-LP. The figure is now included in the paper (Fig. 7). It is observed that the patterns seen in the differences between OMPS-LNM and OMI/MLS originate from the SOC field.

Data from 2012 to 2018 are presented, however no reason is given why the following 4 years (2018- 2022) are not included, yet.

A: The reason is explicitly mentioned in the revised manuscript:

The OMPS-LP ozone profile time series based on L1 V2.5 data, which are used by both V2.6 and V3.3 retrievals, were found to exhibit a significant positive drift after 2018 (Kramarova et al., 2018). For this reason, only the data until 2018 are used to create the OMPS-LNM-TrOC dataset. (Lines 139-141)

A new version of IUP OMPS-LP profiles is being processed based on the improved L1 (V2.6) data that counts for the observed drift after 2018. Using the improved stratospheric data, the OMPS-LNM TrOC dataset will be reprocessed, extended to the present and will be subject of a later paper. (Lines 466-468)

Detailed remarks are listed in the supplement

Detailed remarks

Figure 1 is it possible to add a mean tropopause height to the mean profile deviations. Perhaps you can add an individual profile for both MLS and OMPS (V3-3) and the difference. Because, later on you are using individual measurements.

A: The mean tropopause height was added to the plot as suggested. We see no goal of showing a comparison for one single profile as the observed behavior might strongly vary from profile to profile and thus any selected example is not representative of the entire dataset.

p 6 l 145 -150: For long term time series based on SCIAMACHY and OMPS it is important to use the same definition of tropopause as in Ebojie et al.. However, this is not yet the focus of the study. Is the definition of the tropopause also consistent with the datasets used in the comparison section i.e. OMI-MLS?

A: This study uses the same tropopause definition as in Ebojie et al. (Line 159); OMI-MLS uses only the thermal definition (Line 191). Larger differences observed in the extratropics between OMPS-LNM and OMI-MLS might result from the difference in the TPH definition (text added in Lines 421-422)

p 6 l 152: Here some more details might given on the calculation of the tropopause. How are the data interpolated to the OMPS profiles / total columns.

A: The ECMWF ERA-5 data has a spatial resolution of 0.75°x0.75° and a temporal sampling of six hours. The data is linearly interpolated using the four data points around the exact given location for the two closest times to obtain the TPH at the precise time and place of every limb state. (Lines 162-164)

p7 l 184: "For the calculation .. (..below 0.1) are used." this is not fully clear. Assuming one of the three pixels has a higher cloud fraction, will all three be rejected or only the cloud contaminated one. How is the spatial resolution adapted in this case.

A: If a single cloudy pixel is detected, this one is neglected, and the average is performed. The entire matching is rejected in case of two or more cloudy TOC pixels. (Lines 197-198)

Figure 2 Unless the data are too cloudy the tropospheric columns are retrieved along the three central columns, right?

A: Three nadir pixels with the closest to the limb observation are selected and averaged to calculate tropospheric columns. They are not necessarily the central pixels of the nadir view.

Figure 3 One of the largest uncertainties in many satellite based trace gas retrievals are caused by the uncertainties related to the cloud fraction and altitude. Therefor the small error bars on the stratospheric ozone column with respect to the cloud data is a bit surprising. Even taken into account that only cloud fractions less than 10% are investigated the range shown here seems too optimistic.

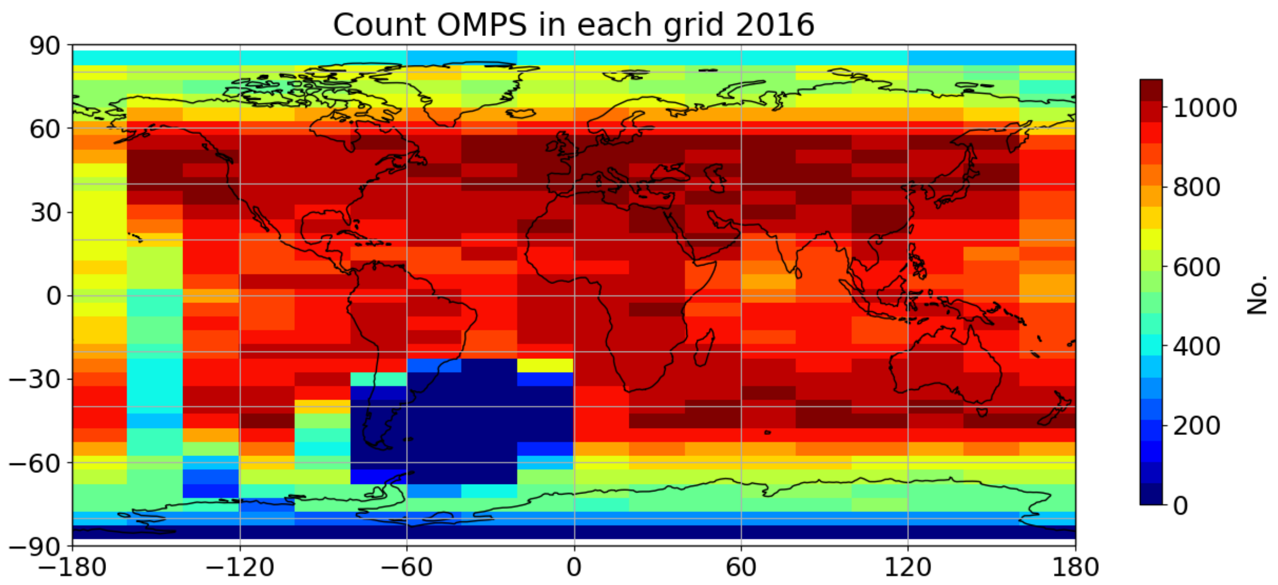
A: The estimate is based on the impact of clouds on ozone profiles, which is presented in Arosio et al. 2022, Figure 7. In that case, we tried to assess the contribution of thin unfiltered clouds on the ozone profiles, as a function of height and optical depth of the cloud. Assuming that only very thin clouds are left unfiltered, we then computed their contribution in terms of SOC, in particular considering the case of a low cloud with OD=0.1. One needs also to consider that the profiles used for the matching are cloud free above the tropopause, the cloud fraction less than 10% is referring to the nadir TOC.

Table 4: please add the percentile range as well. For some regions (over the tropical Pacific Ocean) the tropospheric column is as low as 20 DU (figure 4) so in this case 12 DU random uncertainty means ~60%. This is comparable to other tropospheric ozone products.

A: The paper's Appendix now gives a new table with percentile values for three cases, considering a tropospheric ozone column of 20, 30 and 40 DU.

Figure 4 The figure contains some orbital structures (over the Pacific Ocean), which is a bit strange for a 6 years mean. Is this caused by the sparse spatial sampling. How many data have been averaged for the specific regions?

A: The orbital structure observed over the Pacific Ocean results from a lack of coverage in the change of the orbit date, reducing the density of available data. This comes from an erroneous flagging of OMPS-LP L2 data. The following figure shows the amount of OMPS-LP profiles present in grid boxes of 20° Longitude x 5° latitude during 2016.



p 14 l 302 According to Cooper et al., 2009 Lighting NOx is an important ozone precursor over the southern US in summer and there fore contributes to the outflow over the Atlantic.

A: In addition to photochemical production, stratospheric intrusions (Škerlak et al., 2014) and lighting (Cooper et al., 2009) are important contributors during the summer. (Lines 317-318)

Table 5: as for table 4 add percentile deviations.

A: The table has been modified to include this information

p 19 l 392 OMPS-LNM has sparse spatial coverage, has this been considered in the comparison? Comparing S5P-CCD/OMI_MLS with OMPS only where and when both datasets are available.

A: Datasets are compared only in the grid boxes where both are available. (Line 412)

Refrences:
For your colleague Eichmann, Kai-Uwe the hyphen is missing in some references (e.g. Leventidou et al., 2018)

A: It was fixed

Cooper, O. R., S. Eckhardt, J. H. Crawford, C. C. Brown, R. C. Cohen, T. H. Bertram, P. Wooldridge, A. Perring, W. H. Brune, X. Ren, D. Brunner, and S. L. Baughcum (2009), Summertime buildup and decay of lightning NOx and aged thunderstorm outflow above North

America, J. Geophys Res., 114, D01101, doi:10.1029/2008JD010293

Orfanoz-Cheuquelaf, A. (2023). *Retrieval of total and tropospheric ozone columns from OMPS-NPP*, PhD Thesis, Universität Bremen, doi:10.26092/elib/2179.