Response to Referee Comment 2 (RC2) from Anonymous Referee # 2 (*Referee comment in Italic*, response in blue).

RC2: 'Comment on essd-2024-168', Anonymous Referee #2

Review of the manuscript "Version 1 NOAA-20/OMPS Nadir Mapper Total Column SO2 Product: Continuation of NASA Long-term Global Data Record" by Can Li et al.

The manuscript entitled "Version 1 NOAA-20/OMPS Nadir Mapper Total Column SO2 Product: Continuation of NASA Long-term Global Data Record" describes the NOAA-20 (N20)/OMPS SO2 product, which aims at extending the long-term climate data record of OMI, SNPP/OMPS of SO2 column densities from both anthropogenic and volcanic activities.

The authors not only describe the new algorithm for N20/OMPS but also perform a comparison with the existing data record, showing the added value of this additional satellite product.

The manuscript is very well written and already in a very good state and require only minor revision, as detailed in the detailed comments hereafter:

We thank the referee for the detailed comments. We have carefully considered all suggestions and made changes to the manuscript accordingly. Below please find our point-to-point response.

Detailed comments:

Figure 1: Instead of showing arrows for each instrument that all end in 2024 it is perhaps better to show the planned mission timeline. Otherwise one gets the impression that all missions end in 2024 (except for JPSS3-4/OMPS). What is meant with "Direct readout only" for NOAA-21/OMPS?

Other than OMI, we are not aware of any planned ending dates for other missions. We have updated Figure 1 to clarify this.

Direct readout SO_2 retrievals (with limited areal coverage) from NOAA-21/OMPS are currently available from few ground stations that have the hardware and software to receive and process broadcast data from NOAA-21. This is for producing real-time SO_2 data (latency < 30 min from satellite overpass) for monitoring and mitigating volcanic hazards for aviation. We have clarified this point in the figure and added a reference for this application.

Section 2.2.1 Line 134: Perhaps mention which RT code is used for the calculation of AMFs

We use VLIDORT for RT calculations. This information has been added to the revised manuscript.

Section 2.2.1 Line 162: You mention that the pixels are subdivided into 3 subgroups based on their latitude. What is the latitude range of each subgroup?

In the revised manuscript, we have clarified that the subgroups (subsectors) are based on latitudes and solar zenith angles (SZAs) and provided details on how the threshold is calculated.

Section 2.2.2 Line 185: You are using two reference orbits to derive the PCs. Can you show or indicate the effect on your results when you use a different orbit/day, e.g. in 2024?

We expect that different reference PCs will lead to changes in the initial SO_2 estimates, and as a result, different pixels getting selected for PCA and consequently different final estimates of SCDs. We have conducted test retrievals for 1 April 2023 using two different sets of reference PCs (see Figure 1 below). For most pixels, we found minor differences in SCDs that are well within the typical retrieval noise (mean difference of ~0 DU, and standard deviation of the differences < 0.1 DU). There are larger differences for orbits that pass over SAA areas, indicating that retrievals for those orbits are more sensitive to initial SO_2 estimates owing to larger retrieval noise due to SAA. We have added this discussion to the revised manuscript (and figure to the supplemental information, Fig. S2).

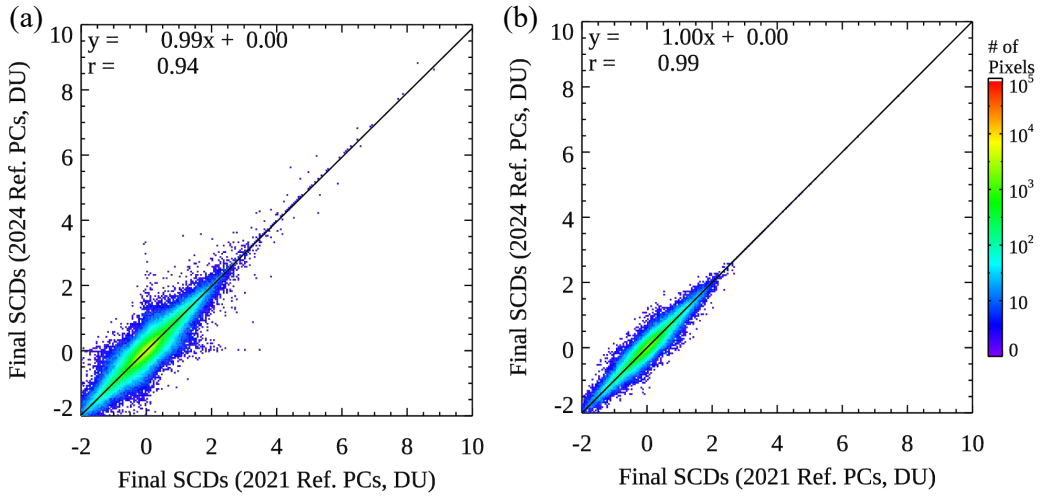

Figure 1. The density map comparing the final N20/OMPS SO_2 SCD retrievals using reference PCs from orbit 17460 on 1 April 2021 *vs.* those using reference PCs from orbit 33010 on 1 April 2024. (a) includes all orbits on 1 April 2023, whereas (b) includes orbits on the same day that are unaffected by SAA.

Section 2.3: I guess think this section should be moved to the end since it is out of context at this location and disturbs the readability.

We have moved this section to the supplemental information.

Section 2.4 Line 248. Typo "the the"

Corrected.

Section 3.1, Figure 2 and 3: From the figure you see an offset between the mean SO2 VCD of SNPP/OMPS and N20/OMPS. Where is this bias of SNPP/OMPS coming from? Maybe you should address this as well. Does a rebinning of N2O/OMPS have an effect on the mean SCD and associated bias?

The offset between mean SO_2 from SNPP/OMPS and N20/OMPS is likely due to different algorithm settings, especially the threshold for pixels that are assumed to contain SO_2 and excluded from PCA analysis. We have added the discussion to the revised manuscript.

Binning N20/OMPS is not expected to significantly change the mean SCDs. Indeed, this is confirmed by the results shown in the figure below.

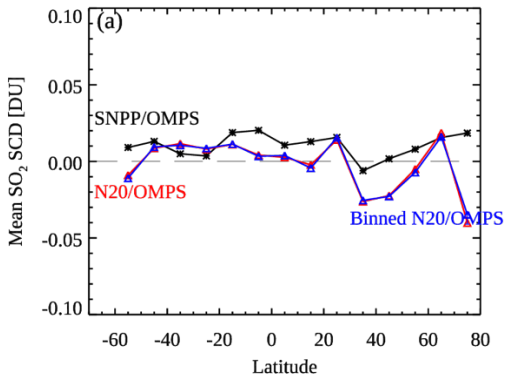

Figure 2. Same as Fig. 2a in the paper manuscript but with N20/OMPS mean SO_2 SCDs (blue) calculated after first binning the pixels to SNPP/OMPS resolution.

Section 3.2 Figure 4: Why do you see a stronger difference in mountain areas, especially in the South American Andes (negative) and Scandinavia (positive difference). Is this related to icy surfaces and related albedo effects?

In the paper, we have also noted larger differences over coastal areas (including Scandinavia). The reason for this is currently unknown. It is possible that there are terrain or surface related biases that are amplified in N20 retrievals due to its smaller

pixel size and the biases are not completely averaged out. This would be an interesting topic for future algorithm refinement studies.

Section 3.3 Third paragraph & Figure 6: The differences in the text and in the figure subtitles are slightly different, probably due to different rounding. E.g. for Norilsk a 8% difference is written in the text, but the figure title states 7% difference.

Yes, this is due to different rounding. We have updated the figure and the text so that the numbers are consistent.

Section 3.3 Figure 6. It is really hard to distinguish the three colored lines from each other. Maybe it would help if you show only the timeframe with N20/OMPS results, i.e. show the plot with data from 2018 onwards?

We elect to keep the time series unchanged in the paper, as there is also discussion on the long-term changes in SO_2 (e.g., over India and China). We have added a figure for the period of 2018-2023 (Fig. S5) to the supplemental information.

Section 3.3 Figure 7 Same suggestion as the two above: Perhaps show only data for 2018+ and check numbers in text and figure title.

We have checked the numbers and added a time series figure for 2018-2023 (Fig. S6) to the supplemental information.

Section 3.4 Figure 8. The x axis label of d and e are missing a "/" character, i.e. N20/OMPS instead of N20 OMPS.

Section 3.4 Figure 8d-f. Perhaps you find a better y axis label, since "OMI and SNPP ratio" is a bit hard to understand when only looking at the figure. Perhaps use "OMI emission/uncertainty ratio" or so.

We have updated the axis labels for Fig. 8 accordingly.

Section 3.5 Figure 10 Perhaps it would be useful to show the comparison with TROPOMI.

We have added TROPOMI data to Figure 10 (and Figure 11).

Section 4, This section should appear after the conclusions and then Section 2.3 should come after (see my comment above).

We use the template provided by the journal and the data availability section comes before the summary. We will check with the editorial office regarding the order of sections.