Response to *anonymous referee #3*

Anonymous Referee #3
Received and published: 25 February 2017

In their manuscript "Continuation of long-term global SO_2 pollution monitoring from OMI to OMPS", Zhang et al. report on a detailed comparison between boundary layer SO_2 retrievals from the two satellite instruments OMI and OMPS. The same PCA algorithm is applied to both data sets and very good agreement in annual means, spatial correlation and temporal correlation is found for three selected regions without the need for radiance or column adjustments.
Satellite observations of pollution SO_2 are an important topic, and with the aging of OMI, continuation of the existing long-term time series by the OMPS instrument(s) is an important topic in order to sustain the ability to track changes in anthropogenic emissions. The detailed comparison of two satellite data sets presented fits well into the scope of AMT. The manuscript is clearly structured and well written and provides quantitative results in both figures and tables. I therefore recommend the manuscript for publication in AMT after addressing the questions and suggestions listed below.

General point
My only general concern with the paper is that while it provides detailed comparisons for annual means and shows many correlation plots, it does not show the type of figure which probably is the most important one for users of the data sets: direct comparisons of time series. I suggest that the authors add figures showing time series of OMI and OMPS for the three regions on annual, monthly and daily resolution. This enables the readers to judge how similar the seasonality of SO_2 in the two data sets is, how long-term annual trends will be affected by the change in sensor, and how similar the time series over the largest SO_2 hot spots of the world are for the two instruments.

We thank the referee for the detailed review and helpful suggestions that have helped to improve the manuscript. We have added direct comparisons of time series at a daily resolution from the two instruments for three regions. Each regional time series shows very good agreement of SO_2 mass between the two instruments. We didn't include the plots of time series on annual and monthly bases here, because we feel that the daily time series provide adequate information.

Detailed points
• *Please add the recent OMI SO_2 study by Theys et al. to the literature review in the introduction.*
A: We added Theys et al. (2016) to the introduction.

• *Page 4, line 13: Effective cloud radiance fraction of 30% - please give details on how that was determined in OMI and OMPS*
A: Effective cloud radiance fraction is one of cloud data products from both OMI and OMPS. It is defined at each pixel as the fraction of the measured radiance that is

scattered by clouds. The values are calculated and reported in the OMI and OMPS total ozone product. We have added this to the manuscript.

• *I do not understand why the authors choose to change the selection criteria between OMI and OMPS. They state that the results are very similar in OMI data but then why change the settings? Later, the difference in selection criteria is given as one of the reasons for deviations between OMI and OMPS SO_2 columns. I think that identical selection criteria should be used for both data sets or if that's not possible, a clear explanation should be given why the different treatment is necessary.*
A: The reviewer is referring here to the negative outlier check. As stated in the manuscript, this check is based upon computed standard deviations in the remote clean Pacific. These standard deviations are different for OMI and OMPS. We added in the manuscript that these values represent approximately a 2-sigma filter. Using the criteria setting of -1.0 for OMI versus -0.5 for OMPS produces very similar patterns of mean SO_2, but with slightly higher bias in SO_2 for the setting of -0.5.

• *Page 5, line 9: Smaller OMPS than OMI columns are explained by the lower spatial resolution of OMPS, but is that really expected at the gridding size of 0.5 degrees?*
A: OMPS large pixels may dilute SO_2 retrieved columns and thus decrease detection ability. This happens before we average the individual pixels to 0.5^o resolution. We revised our statements and please see page 6, lines 31-33.

• *Page 5, line 22: I do not understand why volcanic SO_2 should have different effects on OMI and OMPS – the boundary layer column is probably overestimated, but shouldn't that be similar for both instruments? Please explain.*
A: Both instruments should overestimate SO_2 similarly from the assumption of boundary layer height. We rearranged our statements to make our explanation more clear.

• *Page 7, line 20: Why do the authors expect an effect of the larger OMPS FOV on SO_2 columns over a background region? In my opinion, only the signal to noise ratio is relevant here. Please comment.*
A: Signal to noise ratio (SNR) is certainly highly relevant to SO_2 retrievals over clean regions and can be influenced by FOV size. "The OMPS large FOVs may also reduce errors generated by variability in observation conditions (by smoothing them out) that affect our simple fixed AMF assumptions, e.g., geometry, cloudiness, and surface conditions. We plan to reexamine this issue with future versions of the PCA algorithm that will have more detailed AMF calculations. " We added them in the revised manuscript.

• *Table 2: Why are the differences between the two linear regressions so large in some cases?*
A: As we explained in the manuscript, the reduced major axis regression assumes that there are errors in both y (OMPS) and x (OMI) axes. The errors are minimized by the *product* of the "y-distance" and "x-distance" of observations to the regression line, while for ordinary least square fitting, the errors are minimized by the "y-distance" of observations to the regression line.

• *Table 2: Please add what's on the x-axis and what's on the y-axis in your regressions as otherwise the slope cannot be interpreted. Please also add units to the values in the table. I also would prefer percentages for the number of values within 50 and 25%.*
A: We added the explanations of X and Y in Table 3; 'X presents OMI SO_2 and Y presents OMPS SO_2'

• *Table 2: Why are there more values within 50% than within 75%?*
A: We corrected 75% to 25%. Now they are consistent with Figures 3, 4, and 5.

• *Figure 1: In the figure caption, a bias correction is mentioned which is not discussed in the main text. Please explain and add to description of method.*
A: Figure 1 has no empirical bias correction and we have fixed the figure caption.

• *Figure 1: Shouldn't that read South Atlantic Anomaly?*
A: We fixed it. Thanks for pointing it out.

• *Although the manuscript is well written and the use of English is overall very good, I think that in some parts, another proof reading in particular with respect to use of articles could further improve the language.*
A: We revised the manuscript to improve the use of the language.