

Review of the manuscript: "Version 2 of the global catalogue of large anthropogenic and volcanic SO₂ sources and emissions derived from satellite measurements" by Fioletov et al.

General comments:

The manuscript presents an update of the SO₂ emission catalogue based on SO₂ satellite observations. The new dataset includes updates in the retrieval algorithm, more accurate wind information and synergistic use of different satellite observations. Such update is very welcome since this emission dataset is quite useful for both scientific and societal applications. The method is scientifically sound, and I recommend publication after addressing the following minor issues.

We would like to thank the reviewer for his favorable comment.

Specific comments:

- Concerning the merging of the different emissions, it was not completely clear how the different instruments contributions are applied when you have only one or two instruments/estimations available. I mean before TROPOMI for example, are the estimates mostly based on OMI? And do you see a bias when introducing TROPOMI estimates into the merged estimates compare to OMI+OMPS only? Please clarify.

We added a paragraph that discussed this issue:

"Prior to 2012, only OMI data were available, and the weighted average was just OMI-based emissions. In 2012-2017, the weighted average of OMI and OMPS was used. Some sources in some years did not have enough data to produce estimates from OMPS and in such cases, the average was based on OMI data only. Although statistically significant annual emissions estimates for some sources can be obtained from TROPOMI data only, we nevertheless included OMI and OMPS-based estimates in the weighted average for such sources in the catalogue. Multiyear averages for such sources could be significant even prior to the TROPOMI measurements."

As for possible OMI/OMPS-TROPOMI biases, they are discussed in the manuscript: *"the difference is within $\pm 13\%$ for 50% of cases and within $\pm 28\%$ for 90% of cases"*. The biases are even smaller when summing sources over large regions (Figure 6). There are some sources, where the difference between TROPOMI and OMI are noticeable, and their possible causes are discussed in the text. We prefer not to adjust emission estimates for individual sources to remove a possible TROPOMI-OMI bias. Instead, we made estimates for individual satellites available.

- Connected to question n.1, what happens to sources you only detect with TROPOMI: do you have zero emission before the TROPOMI period, or do you attempt the fitting with OMI/OMPS anyways even if the detection limit is higher? For example, the two Russian arctic sites you mention have emission estimates in the database also before the TROPOMI period, even though you write that those are not reliable: can you clarify?

We added a paragraph that discussed this issue (see the previous comment). Annual emissions can be calculated even if the emissions are below the detection limit. It just means that such estimates would be within their uncertainties. However, such estimates could be useful to calculate multiyear averages, that could be above the uncertainties.

- Is there a chance to attribute some of the time series flattening in India to COVID- related issue?

We see small decline in Indian emissions in 2020 (Figure 5). However, we estimated annual emissions, while the most COVID-related decline likely occurred over approximately one season.

- Is there a reason you put together former USSR countries? Do for example trends in eastern Europe or Central Asia look the same than Russia? I would expect different policies in terms of emission regulation in these different countries.

We change that to “northern Eurasia” (Russia, Ukraine, Kazakhstan, and former USSR countries in Central Asia). To our best knowledge, no regulation to reduce power plant emissions was introduced in these countries. This makes that region different from, for example, Estonia where emissions have been reduced substantially since Estonia joined the EU.

Technical comments

Line 114 “epy”: what do you mean?

It was a typo. Removed.

L183 “fund” -> “found” or “find”

Corrected to “found”.