Review of Fioletov, et.al., Version 2 of the global catalog of large anthropogenic and volcanic SO2 sources and emissions derived from satellite measurements.

General Comments

This paper describes a significant expansion of the 2016 OMI-derived global catalog of SO_2 emission sources enabled by the launch of new UV mapping instruments; OMPS on SNPP, the first operational instrument of this type, and TROPOMI, similar to OMI, but with much higher ground resolution. In addition, new retrieval algorithms for all three instruments offer significant improvements, such as lower detection thresholds. As a result, twice as many sources were found for this Version 2 catalog.

The introduction summarizes the history of UV SO_2 measurements from LEO since Nimbus-7 SUV/TOMS in 1978. TOMS, limited by telemetry bandwidth to 6 wavelengths (selected for total ozone determination), and relatively crude spatial resolution, given 1970s satellite technology, could measure large volcanic eruption plumes but had limited ability to observe surface sources of SO_2. GOME and SCIAMACHY similarly focused on ozone with its low spatial variability, but, with far more spectral information could detect some surface SO_2 sources. However, OMI addressed an essential factor for the detection of point sources of SO_2 with an 8-fold higher ground resolution than TOMS. The 2016 SO_2 catalogue of OMI data, updated annually and publicly available on a NASA website, discriminated four sources of large emissions; powerplants, smelters, the oil and gas industry, and volcanoes. This first-ever assessment of industrial SO_2 emissions from space showed the advantage of satellite monitoring as a uniform, independent source of information. The reference list is extensive and appears to be complete.

The satellite record of global sulfur dioxide emissions and the changes over time since 2005 is an important contribution to the assessment of air pollution and passive volcanic emissions. Having multiple, well-characterized, redundant satellite data Is a real asset in assessing errors. Fioletov and colleagues deserve praise for their efforts to produce best estimates of emissions from these somewhat diverse data sources. Analyzing the differences is a large effort considering retrieval algorithm changes, retrieval uncertainties, air mass factors, differences between coincident observations, quality control data selection standards, among other factors. Merging the data required difficult choices. The SO_2 total emission from each source is then calculated by combining the overpass sample of the plume mass with ECMWF reanalysis wind information and loss rate estimates. All of these considerations are documented in the text and figures.

The introduction of two additional satellite data sources offers new challenges as described in the text. Inevitable differences require explanations that should lead to a better understanding of the measurement and retrieval methods.

Specific Comments

Because the retrieval algorithms derive slant column SO_2 amounts an air mass factor is required to convert them to a quantitative geophysical measure, namely the vertical column SO_2 amount. The differences between the AMF choices almost suggest that this is a dark art. The authors make clear that the height of the absorbing layer is a primary factor affecting the AMF, although other factors such as partial cloud corrections also play a role. They chose to use independently calculated site-specific AMFs, similar to the original catalogue methods. The procedure is documented and referenced.

The need for arbitrary corrections (Ie, 22%) is disturbing. It's surprising that the TROPOMI data production group uses SO_2 absorption cross sections suitable for tropopause level air temperatures when a primary mission objective is to measure surface and low altitude plumes. Theys, et al. (2017) contend that this is "in principle accounted for in the AMFs". So why do we need a 22% correction?

It is concerning that the OMI data are empirically corrected by 10% to force agreement with the original catalogue results. Please explain the rationale for this correction. Are more ground-truth estimations now available since the first catalogue? A discussion of the ground truth analysis would be appropriate especially since the original catalogue had empirical corrections to "ensure agreement with reliable at stack emissions measurements…".

The procedures for merging the three data sets are well documented. The difficulties of multiple-source regions and the effect of ground resolution differences are described.

Lumping the former USSR countries together is no longer meaningful.

The reference list is extensive.

Technical corrections

Line 183 sp fund => find
Line 203 sp enshure => ensure
Line 275 ? "….and OMPS data do not produce a reliable fit. This may explain why OMPS-based emissions are biased low." This requires a bit of explanation.
Line 313. Repeat "that that"
L. 321, 322, 331: "Figure 5" is incorrect. Figure 6?

L 386 – 7. "The estimated emissions are about 40 kt y^{-1} but it is likely the combined emissions from the powership and the existing power plant in the area." Incomplete sentence.

L 431. increase => increased
L 456 typo weighed = > weighted

L 475 typo utilises => utilizes
L 498 “Can L” should be “Can Li”
I suggest running a spell check on the document. I doubt that I have caught all the errors.