Reviewer Comments

Manuscript ESSD-2020-109, Taurnigand et al., A multi-sensor satellite-based archive of the largest SO2 volcanic eruptions since 2006

The authors describe a new data archive that combines synoptic maps of SO_2 plumes, derived from UV and TIR radiance measurements, with estimates of plume heights and thickness derived from lidar profiles and radio occultation (RO). This archive will prove to be of great value to studies of gas emissions for the selected eruptions, as accurate knowledge of the height and thickness of plumes is critical to the estimation of gas concentrations. The authors have done a great service by collocating the RO products with the UV, TIR, and lidar data products, thus facilitating the incorporation of RO products into future analyses of the combined data record.

Unfortunately, this manuscript falls short as a description of the new data archive and showcase for the potential applications of the combined data records. With few exceptions, the descriptions of the data products are too sparse to be of much use to anyone but the most experienced remote sensing specialists. The exceptions to the sparse descriptions are focused on the RO products and, to a lesser extent, lidar profiles. Despite the attention paid to the RO data processing, the authors fail to discuss the basic relationships between the RO signals and volcanic plume phenomena. For example, what are the bending angles and bending angle anomalies (Sections 3.5, 4.1.2, and 4.1.3) and what do these anomalies tell us about volcanic plumes? Similarly, what is the relation between the RO refractivity and plume heights?

The processing of the CALIOP (lidar) data is discussed in the context of the RO data (Section 4.2.1), and the shortcomings outlined above affect the CALIOP discussion as well. The procedure for removing “unnecessary” information from the CALIOP images is confusing. How do the authors determine the “zones of interest” upon which to focus their processing? The practice of discarding CALIOP data corresponding to altitudes below 10 km seems short-sighted. If the RO data products are noisy for such altitudes, then shouldn’t the lidar data for low altitude (< 10 km) clouds be all the more important? Since the authors never explain the significance of the RO bending anomaly, relative to volcanic plume heights, it is difficult to appreciate why the low-altitude lidar data should be discarded. Similarly, the cloud aspect ratio is not explained, and the threshold value of 0.09 is not justified. What is the significance of a low aspect ratio? What are typical aspect ratios of volcanic plumes vs. meteorological clouds? Finally, the authors do not include CALIOP depolarization ratios in the archive. The CALIOP Aerosol Type (included in the Archive) does not identify volcanic ash or sulfates uniquely, while the depolarization ratios document variations in the size and aspect of particles within volcanic plumes.

In an effort to justify the creation of the archive, the authors make a number of problematic statements. The statement that "… not any archive is available at the moment to be used as background for future studies" (Line 17) is not true, as the authors demonstrate by citing the existing LaMEVE (Lines 68-70), OMI (Lines 92-93), and TOMS/OMI MSVOLSO2L4 (Lines 95-96) archives. In addition, the authors acknowledge the GVN archive at many locations in the text. The new archive may be the first to include RO data, but the potential contributions of RO to volcanology (see my previous comments) have never been discussed. Consequently, the unique nature of the new archive is not obvious.

The authors claim that papers describing individual eruption events "make it difficult to compare" the data sets (Lines 74-75) is disingenuous. The authors neglect to mention that the studies cited in this paragraph (Lines 74-90) The authors present no evidence for the claim that the volcanic clouds generated by the Merapi, Tolbachik, Kelut, and Calbuco eruptions were not studied "in depth" (Lines 87 – 90) What is the definition of "in depth?" The Calbuso eruption clouds, in particular, have been studied extensively, as this eruption had an impact of the evolution of the southern ozone hole.

The authors need to include at least one example of unique contribution of the new archive to plume studies. Figure 2 shows the locations of data points, but not the unique contributions to the study of plumes enabled by the new archive. For example, what are the levels of agreement between the UV- and TIR-based SO_2 retrievals? What are the variations in SO_2 retrievals relative to atmospheric conditions (principally temperature and humidity) and plume altitude? What are the levels of agreement between the IASI, CALIOP, and RO-based plume altitude estimates? Which altitude estimates have the highest level of confidence?

Examples of the potential contribution of the new archive to plume studies would help with the troublesome justifications for the new archive. The contributions would become readily apparent, eliminating the need for the current unsupported statements.