Anonymous Referee #2

General comments: In this paper the authors present a new algorithm for retrieving volcanic sulfur dioxide total columns from UV satellite instruments which is used operationally to process TOMS and EPIC data. It is also able to process data from current hyperspectral UV spectrometers. The algorithm has been applied to several volcanic cases and compared to a modified operational OMI & OMPS PCA algorithm.

The main advantage of such an algorithm is that it helps in assembling a long-term consistent satellite-based volcanic SO2 emissions climatology. Furthermore, this new algorithm is able to correctly retrieve SO2 even in the presence of aerosols using a 2-step procedure.

Overall, I think the paper is suitable for publication in AMT after some moderate revisions. The paper can be slightly shortened in my opinion - although sections 2.1 and 2.2 are very interesting to read, they can be shortened and only focus on how they relate to the new MS_SO2 algorithm (i.e. remove the 'history' part of the algorithms).

> *We decided to leave these sections in the paper. We feel that the historical connections of MS_SO2 to the development of the TOMS ozone algorithm and to the early development of the Krueger-Kerr algorithm are important to the heritage of our algorithm.*

What I am missing in the paper is a clear statement about the advantage of the new algorithm over e.g. the modified PCA algorithm the authors are using for comparison. Furthermore, a better description of how exactly the algorithm is working is required from my point of view (see below)

> *The MS_SO2 algorithm retrieves 4 parameters (SO2, O3, $dR/d\lambda$ and R) while the PCA only retrieves SO_2. The additional parameters provide more physical information about the eruption that can be used to better assess the quality of the retrieval. The retrieval of ozone and the aerosol index (using retrieval $dR/d\lambda$) are especially useful in analyzing results from MS_SO2. We will clarify this point in the paper's conclusion.*

Specific comments:

p11, line 20. . . in which large O_3 anomalies. . .. do you mean large SO_2 anomalies?

> *No. We meant large O_3 anomalies. Identifying O_3 anomalies inside of the SO_2 plume is a key step in the step 2 algorithm. The O3 and associate SO2 anomalies are anti-correlated (Fig. S1). The correction to the SO_2 comes about via a correction to the O_3 for a given FoV. For the O3 anomaly to be clearly distinguished (and subsequently corrected), the O_3 anomalies inside the plume have to be well above the regional O_3 variability outside of the plume (along with other corroborating criteria (SO_2 and AI)).*

On the next page you refer to either $SO_2 > 15$ DU ... or AI > 6. Please check for consistency.

Our selection criterion is designed to identify the SO_2 plume region (generally where SO_2 > 15 DU). Heavy ash loading of the column, however, produces a shielding effect that can result in an underestimate of the SO_2, causing some FoVs associated with the plume to be less than 15 DU (e.g., volcanic SO_2 around the boundaries of the plume where SO_2 ~15 DU). So, in addition to testing all FoVs where SO_2 > 15 DU, we also consider a second independent condition that selects FoVs with super-high ash concentrations (AI > 6). This loosens the strict requirement on SO_2 and allows for values less than 15 DU to be further tested. We first select FoVs meeting these two criteria and then decide whether or not to apply step 2 based on the size of the ozone anomaly for that FoV.

p 12, line 6. "Step 2" instead of step 2. Note the other cases in the same section where "Step" is not capitalized.

Fixed. We decided to lower-case step1 and step2.

p 18, line28. Tables 1, 2, and 3 do not exist.

These 3 tables were moved to the supplement. Should have been labeled S1, S2 and S3.

p 21, line11. delete “an” in "The no aerosol case confirms an unbiased SO2 retrievals...".

Fixed.

p 22, line22. Define SLER.

Defined Simple LER, assuming clouds are at the surface (no Mixed LER, MLER, that separates cloudy and clear regions of the FoV based on cloud fraction). The SLER was described in 2.1 but the acronym was not used and so we define the acronym in 2.1.

Appendix

P 2, line 10. Eqs. (15a, b) could not be found.

Fixed numbering of equations in the supplement.