

## ***Interactive comment on “Analysis of properties of the 19 February 2018 volcanic eruption of Mount Sinabung in S5P/TROPOMI and Himawari satellite data” by Adrianus de Laat et al.***

### **Anonymous Referee #2**

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In the paper “Analysis of properties of the 19 February 2018 volcanic eruption of Mount Sinabung in S5P/TROPOMI and Himawari satellitedata” de Laat et al present a multi-sensor approach to determine the altitude of the volcanic ash cloud from the February 2019 Sinabung eruption. The results from different cloud retrieval algorithms applied to TROPOMi data are compared to volcanic ash heights based on CALIPSO data as well as from Himawari geostationary satellite data. Although the analysis is suitable for NHESS, some major changes to the text and figures are request, as described in the specific comments below.

Specific comments:

P3, L66: Missing word '(down to 2.5x7km<sup>2</sup>) of SO<sub>2</sub>'

P3, L70. The term "volcanic clouds" is mis-leading, since it can refer to clouds of ash, particles, trace-gases. Here you are clearly referring to volcanic ash clouds. You use this term very often throughout the text. Please describe at each occasion what you mean.

P3, L84: Calipso -> CALIPSO

P3, L85. Maybe add a short explanation about what the 'A-train constellation' is.

P3, L85. It is "13:30h local time"

P4, L118: Add here that the SO<sub>2</sub> product provides four different SO<sub>2</sub> VCDs for different SO<sub>2</sub> vertical profile shapes, since they are not known at the time of the measurement. For the rest of the paper it would be also good to know, which SO<sub>2</sub> VCD you have chosen. Here you might also refer to the paper of Hedelt et al. 2019, who has also studied the Sinabung eruption and retrieved SO<sub>2</sub> plumeheights for this.

P4, L123: Add a reference for the O<sub>2</sub>CLD algorithm (either paper or ATBD)

P4, L129. Consider also adding information about the cloud fraction from OCRA

P5, Sect. 2.5: I suggest to add more information on CALIOP, references and a description of what the 'attenuated backscatter imagery' displays, i.e. what it is sensitive to, etc. I also propose to also add the VFM, which shows the type of absorption feature as well as the BTM which gives information about the type of absorption.

P6, L163 You write the 'extend of the volcanic plume', but by means of what? SO<sub>2</sub> VCD or AAI or? Please specify.

P6, L166: Here it would be interesting to see what is the TROPOMI OCRA cloud fraction.

P6, L170 Please describe the 'clear differences' between FRESCO and ROCINN

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P6, L183 I suggest to rephrase the sentence, since the CALIOP data only shows an attenuation by clouds. As you write later on, there is no \*CLEAR\* detection of an ash layer

P6, L187: Add the CALIPSO overpass time here, such that the reader gets an idea about the overpass time difference btw TROPOMI & CALIPSO

P7, L193. The VFM classifies the volcanic cloud as 'cloud' and sometimes 'ash'. This is because fresh volcanic plumes are typically rich in water vapor (especially for tropical eruptions). The volcanic clouds also contain high concentrations of water droplets. Therefore, the classification in the CALIPSO VFM sometimes fails to pick up the volcanic ash or sulfate aerosol because of competing clouds. Another interesting feature which could be analyzed in this paper is the brightness temperature difference from CALIPSO which clearly shows the ash in the data

P7 L214-216. The description of the BTM should appear in Sect. 2.4

P8 L237: TROPOMI was launched in 2017. Given that we now have 2019, I wouldn't call it 'recently launched'.

P8 L225-226 Since the ash and SO<sub>2</sub> cloud are co-located there is certainly also an effect of the ash on the SO<sub>2</sub> VCD retrieval (and not only shielding). Might be interesting to study the effect of ash on the SO<sub>2</sub> VCD

## Figures

Figure 1 is clearly overloaded. Although it is interesting to see all results in one single figure, it is really hard to understand all plots. I would suggest to break down the figure into several figures (i.e. show FRESCO/OCRA/O<sub>2</sub>CLD cloud heights separately in a figure, as well as FRESCO/OCRA CF and SO<sub>2</sub>/AAI) before showing combined plots

Figure 2: Clearly a colorbar for the attenuation backscatter is missing. Also please add the AAI colorbar to this figure and not only refer to it. Please consider to show also the VFM, showing some ash classification in the cloud as well

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Figure 5: I would rearrange the plots and show the HIMAWARI vs AAI plots next to each other and clearly indicate the SO<sub>2</sub> threshold in the plot title. A color bar for each subplot would also be very helpful. Have you tried to display these results in a 3D scatter plot, with  $x=SO_2$ ,  $y=AAI$  and  $z=BTD$ ? Furthermore, why did you show the scatterplots for  $AAI < -0.25$  – they are not part of the volcanic ash cloud, as your AAI contours also indicate. For the SO<sub>2</sub> plot I suggest using a logarithmic scale. I also suggest showing horizontal/vertical lines at  $x=0$  and  $y=0$

Figures S1, S2a, S2b: Would it be possible to indicate the location of the volcano on the maps?

Figures S2: Would it be possible to add the AAI/SO<sub>2</sub> contours to the maps?

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