

Comment on “Stratospheric aerosol layer perturbation caused by the 2019 Raikoke and Ulawun eruptions and climate impact” by Kloss et al.

General comments:

Kloss et al. study the change of the stratospheric aerosol layer after the eruption of Raikoke and Ulawun in 2019, and also try to address the climate effects of the eruptions. The main data sources are satellites and several in situ AOD measurements. And they used the CLaMS model to study the transport of the “hypothetical” volcanic plume, and they used the WACMM model to estimate the radiative forcing possibly produced by the two volcanic eruptions. Generally, the manuscript is nicely structured and the study may provide useful information for researchers interested in volcanism and stratospheric aerosols. I can see the authors have done a lot of work, collecting comprehensive data and running multiple models, for this study. However, the manuscript seems to be composed in a rush and many technical corrections are needed.

Also, I have a few questions that need to be addressed before the manuscript could be published.

My general questions are as follows:

1. The title.

I see the WACCM model results provide TOA radiative forcing. However, TOA radiative forcing does not equal to “climate impact”. To be accurate and avoid misleading information, I would prefer to use “radiative forcing” instead of “climate impact” in the title.

2. The IASI based  $D_{SO_2}$ .

Did you verify your definition of  $SO_2$  concentration in a previous study? If yes, please cite it. If no, please verify the definition and comment on the performance before use.

3. The LOAC data.

Why are the uncertainties explained here different from and worse than the uncertainties in Section 2.3 in Renard et al. (2016)? I assume you used a newer model of LOA

I assume you calculate stratospheric AOD (sAOD) from the LOAC data above the tropopause to 23 km. But you did not make it clear in the manuscript.

4. I would suggest you move section 3, the introduction of the two eruptions, to a more appropriate location, before the CLaMS and WACMM model setting, because it is better to know the date of the eruption, plume height,  $SO_2$  volume, etc. before the model set. After moving section 3, please also check the texts and remove the overlapped information of the eruptions in section 3 and in the model setting section.

5. The CLaMS simulation of the dispersion of volcanic plume.

The authors know it very well that the initial plume box for the CLaMS simulation is not accurate, so the simulation results are only suitable for a rough estimation. But this rough assumption would also make the simulation not very necessary.

In about half a month after eruptions, the  $SO_2$  concentration and  $SO_2$  plume height would be a nice proxy for volcanic plume dispersion, as you showed in Fig. A3. Or as

in <https://iasi.aeris-data.fr/so2/>. For a longer time after the eruptions, the error of trajectories accumulates and the results are even more unreliable. Are the CLaMS results in Fig.5 supported by the OMPS in Fig. 3 or WACCM simulations in Fig. 4? If not, it would be better to only keep reliable results.

#### 5. Figure 2

There are very small Dso2 values in the figures, such as in Fig.2a, bottom left corner in Fig.2c, and bottom right corner in Fig.2d. They are probably not SO2 from Raikoke. They may be removed if you only show data with large signal/noise ratios.

#### **Specific comments and corrections:**

Please make the font of the manuscript uniform.

Please read the manuscript multiple times to correct typos. I list some of them but not all of them here.

#### **Page 1**

L1 a moderate stratospheric eruption;

L4 short-wave length, high northern ...

L6 evolution of what?

L14 RF. Please spell it out when you use the abbreviation for the first time.

#### **Page 2**

L21–22 please unify the format of brackets (all half or all full).

L28 Brewer-Dobson circulation

L31 jets

L42 “0.7-2.2” (and many other places in the manuscript): please find out the differences between hyphens and dashes and use them right.

L46 Fromm et al. ... This sentence is very confusing, please try to rephrase.

#### **Page 3**

L58 setup

L69 “1.5 (Rault and Loughman, 2013).”

L71 )) Please add reference to MERRA2 data here.

L72 Are the OMPS AOD data contaminated by ordinary clouds?

L74 L81 dataset

L82 +- --> ±

#### **Page 4**

L109 “nm” is not a unit for wavenumber. I guess you may want to say “cm<sup>-1</sup>”.

#### **Page 4**

L85 “marked added-value” Can’t understand.

L95 “The Dust RGB product performs better for volcanic plumes than the Ash RGB product at large viewing angles.” Please add a reference here, or explain it if a reference is not available.

#### **Page 6**

L150 “- the” L153 “- The” L154 “- The”: I do not understand the usage of hyphens.

L152 “Mid-latitude”

**Page 8**

L238 moving

L239 usually

**Page 25**

Please put Fig. A1 together with other figures in the appendix.

Please put brackets around “ $10^{-3}$ ” in Fig.A1b to make the X label format uniform.

And add (km) as Y label for Fig.A1b.

The font size of figure titles is not the same.

**Page 26**

Please add a latitude range for Fig. A2c–d.

Please put the acknowledgement together with other texts.

**Page 28**

Please double check the format of your references ONE BY ONE to make sure they are in the ACP reference format.

**Page 30**

Please avoid citing a paper that you are not sure whether it is finished or not.