

Geosci. Model Dev. Discuss., referee comment RC1  
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## **Comment on gmd-2021-219**

Anonymous Referee #1

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Referee comment on "Evaluating the assimilation of S5P/TROPOMI near real-time SO<sub>2</sub> columns and layer height data into the CAMS integrated forecasting system (CY47R1), based on a case study of the 2019 Raikoke eruption" by Antje Inness et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-219-RC1>, 2021

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The authors present the assimilation of SO<sub>2</sub> retrievals from Tropomi satellite observations in the global forecasting system used in CAMS for volcanic forecasting. As for other major centres, assimilating vertically-integrated information on SO<sub>2</sub> from space-borne sensors is a challenge which needs continuous improvement, as observational product and data assimilation settings can be refined or improved year after year. This paper is of interest to the community. I suggest it is accepted after modifications are made.

### **Scope and title**

The title is a bit misleading as the study presented in this manuscript is presenting assimilation experiments carried out in a different system than the near real time (NRT) CAMS system used for volcanic forecasting. Moreover, the present study mainly compares results obtained assimilating the new product proposed by the DLR including information on the SO<sub>2</sub> plume vertical extension, with several settings, to those obtained in the current operational setting with NRT Tropomi data disseminated by ESA.

In addition, the study described in this manuscript only focusses on a particular eruptive event, the Raikoke 2019 eruption, which injects SO<sub>2</sub> plumes at very high altitudes. No other event is assessed in this study. Eruptive events release SO<sub>2</sub> plume at a large range of altitudes, depending on the volcano and the given episode. The present paper does not provide any guidance for other eruptive events.

I suggest to change the title so as to reflect the content of the paper more closely, such as "Evaluation of the assimilation of the S5P-Tropomi SO<sub>2</sub> layer height product in the CAMS global system in the case of the Raikoke 2019 eruption".

### **Assimilation settings for the background / minimisation**

Section 3.2 (220-225)

In most of ECMWF's papers on satellite data assimilation, the horizontal resolution of the

model (both in forecasts and minimisation steps) is lower than the operational one. In this manuscript, the authors decided to use a finer horizontal resolution than the operational version. I would appreciate the authors elaborate a bit more on why they decided to use this increased resolution at that stage.

In the baseline configuration, the background error standard deviation profile is set up to enable a modification of the SO<sub>2</sub> 3D field only around model level 98. The authors say this corresponds to ~550hPa. This may be the case over ocean with sea level pressure around 1013hPa. But the cross section in Figure 14 shows that this altitude may vary a lot, depending on the actual surface pressure, as the vertical coordinate is hybrid sigma-pressure coordinate.

The choice for this setting, which is used in operations and in the baseline configuration, is not supported in the present article. In order to make it easier for the reader, I would suggest to add the explanation for this choice in the paper.

### **Assimilation settings for the observations**

#### Section 3.2.1 (235)

The authors describe the baseline configuration and say "SO<sub>2</sub> observations are currently only assimilated ... when the observed SO<sub>2</sub> concentrations are considerably larger than the atmospheric background values". I suggest the authors clearly state that criterion, instead of vaguely referring to "considerably larger".

I may have missed the description of the observation pre-processing in the paper. Can the authors state clearly how the mismatch between the observation resolution and the model resolution? Are data thinned? Is there a super-obbing step? What are the parameters of the pre-processing?

As the number of observations varies between NRT and LH SO<sub>2</sub> observations, a clear indication of the difference in the number of assimilated data should be clearly given.

No word is said on the observation errors, which are also important players in the game. The reader would benefit from a clear description on how the observation errors are handled.

NRT Tropomi SO<sub>2</sub> observations are provided with averaging kernels. Are these averaging kernels used in the baseline configuration? Are SO<sub>2</sub>-LH observations provided with averaging kernels? If present, are the latter used in the assimilation? I suggest the authors clearly state all these "details".

### **Minor comments**

line 397: data are gridded for comparison. What is the time step for this gridding: daily or hourly?

Figures showing timeseries are numerous and sometimes hardly legible (eg. 12, 13).  
Figures showing maps are sometimes a bit small (eg. 5, 9)  
Do the authors think showing evaluation for D+5 forecasts is relevant for such a study which shows the high sensitivity to the assimilation settings?