

Comment on “Improved estimation of volcanic SO₂ injections from satellite observations and Lagrangian transport simulations: the 2019 Raikoke eruption” by Cai et al.

General comments:

Cai et al. describe an improved method to derive realistic time- and altitude-resolved volcanic SO₂ emission rates based on satellite observations of SO₂ and Lagrangian backward simulations. This study is the first application of the upgraded MPTRAC model in inverse modeling of volcanic SO₂ injections and transport. By considering varieties of SO₂ observations, adjusting the SO₂ mass and initialization method, and including an OH chemical module, the updated procedure provided a more sophisticated way to retrieve explosive volcanic SO₂ emission and achieved more promising results than their earlier version. The calibrations and sensitive tests make this study also a good tool article for the use of the MPTRAC model. The method described is of great potential in refining volcanic SO₂ emissions in climate models. This manuscript is clearly organized and well written, so I recommend this study be published after minor revision.

My specific comments are as follows:

Page 1

L1 are important

L10 The reconstructed SO₂ injection...

Page 3

L71 observed from the satellite

L78 since the beginning of operations

L89 compact SO₂ clouds

Page 4

L106 5 Dobson Unit (DU)

Page 5

Figure 1 caption: middle latitudes or mid-latitudes

Page 6

Figure 2: 24-hour

Figure 2: Are there gaps between tracks of AIRS and TROPOMI on the demonstrated area? If so, it would be easier for readers to distinguish between track gaps and areas with little SO₂ with the track gaps indicated.

L142 and hereafter, subgrid-scale

Page 9

Does the thick black solid line indicate the altitude of the tropopause?

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Figure 7: Although the cumulative SO₂ emissions (Fig.5) from TROPOMI and AIRS nighttime are similar, the magnitude of the differences in emission rates in Fig. 7(a) seems almost as large as the emission rate in Fig.3(a). Based on your current results, could you conclude the best practices (including a suite of satellite data and exterior winds) for the Raikoke case?

L255–256 short-term, long-term, longer-term

Page 15

L277 Would you please specify the source data of hydroxyl radical or how the profile of hydroxyl radical is set for the OH chemistry module in the model?

Page 25

Figure 15: I guess there is a mistake in the figure caption. Figure 15 shows the POD, FAR, and CSI time series of forward simulations initialized with TROPOMI observations, AIRS nighttime observations, and a constant injection rate when the detection threshold was set to 5.0 DU.

Page 26

L410–414: Did you fix the SO₂ column in a certain altitude level constrained by the altitudes of aerosols provided by CALIOP? Please make the altitude range clear, so readers do not have to search for and read Gorkavyi et al. only for the value of altitudes.

Page 27

L429 a constant potential temperature level/a isentropic surface.

Others

Please double-check the use of en dashes and hyphens between ranges of number and dates.