

Comment on gmd-2021-109

Anonymous Referee #2

Referee comment on "Incorporation of volcanic SO₂ emissions in the Hemispheric CMAQ (H-CMAQ) version 5.2 modeling system and assessing their impacts on sulfate aerosol over the Northern Hemisphere" by Syuichi Itahashi et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-109-RC2>, 2021

This study investigates the degassing volcanic SO₂ emissions to global sulfur budgets using a Hemispheric CMAQ. The sensitivity simulations were conducted with and without the volcanic SO₂ emissions. The model simulations have been verified by the surface sulfate measurements during 2010 around the world. This study indicated that the degassing volcanic SO₂ emissions are an important source impacting airborne sulfur budgets and should be considered in air quality model simulations assessing background sulfate levels and their source attribution. Overall, this is a nice piece of paper with clear objectives and methods. Before considering publication in ACP, major revisions should be made. Some comments and suggestions are listed as follows:

Specific comment:

- In model verification, only the measurement of surface sulfate concentration is not enough. Since this study aimed to the sulfur budgets, the observation of deposition as well as VCD from satellite are needed.
- Since the atmospheric sulfate is connected with nitrate as well as ammonium, analysis on these two species are also needed, especially considering the long-range transport over the remote areas.
- The conversion from SO₂ to sulfate should also be discussed, since their different deposition characters (dry deposition velocity, wet scavenging). I would suggest the authors focus on the total S instead of the sulfate only.
- P4, L10. The global SO₂ emission is described here. What about the other species, such as NO_x, NH₃, etc? Since the conversion from SO₂ to sulfate, dry and wet deposition as well as atmospheric transport should be controlled by the reactions with the other species.