

Interactive comment on “Co-emission of volcanic sulfur and halogens amplifies volcanic effective radiative forcing” by John Staunton-Sykes et al.

Alan Robock

robock@envsci.rutgers.edu

Received and published: 28 December 2020

I would recommend to the Editor major revisions. Here are the main issues:

1. I don't understand how you carried out your simulations, and why you did them the way you did. Did you take an 11-year average of SSTs and sea ice, and then prescribe them, including their seasonal cycle, repeating the same average year for each entire simulation? Why 11 years? Do you understand that this removes all interannual variation in SSTs, and removes many surface feedbacks with the climate system? The 11-year period you are choosing, 1990-2000, includes the 1991 Pinatubo eruption. Was it included in the forcing for the coupled GCM you used? How did that affect the climate, and why are you averaging over its impacts. Furthermore there were a

C1

moderate and a huge El Niño in that decade. Did the GCM simulate them? Does your SST pattern have a permanent El Niño? How does that affect the climate response? And why did you use the Vidal et al. emissions for Cl and Br, but not for SO₂? They said Samalas emitted 158 Tg, but you several times say 56 Tg is representative of the Samalas eruption.

2. You need, in the introduction, an explanation of the ways volcanic eruptions affect stratospheric ozone, including before there were anthropogenic CFCs there and now. Since you are a chemist, chemical reactions would be useful. And dynamic processes also should be explained.

3. I see no discussion of the impacts of volcanic eruptions on stratospheric dynamics. How do changes in stratospheric circulation affect the ozone distribution and the aerosols? You say something about a lower branch of the BDC, but do not show what you are talking about, and how the circulation changes in response to the volcanic eruptions. How does the polar vortex respond, and how does this affect the size of the Ozone Hole?

4. All the time plots need an x-axis in years and not months, so that the seasonal cycles are easy to discern. Months since July 1 are confusing and obscure what is happening. You can start all your plots on January 1 of the year you injected the gases, so we can see what the variability was before the experiment started, too. The latitude plots need labels of 0°, 30°, 60°, and 90°, not 50 only. Climate scientists are used to looking at the different regions of Earth on the natural coordinates.

5. You use many acronyms without defining them. And you define some acronyms more than once.

6. All variables need to be in italics, and chemical symbols should not be in italics.

7. You use *r* for both correlation and radius, even in the same figure, which is very confusing. You can only use a symbol for one thing in a paper.

C2

8. You use a lot of global averages without showing the spatial and temporal patterns. A lot of what is happening depends on location and time of year. The specific processes are what is of interest. You can average the final result afterwards, but what is important is why things change and where and what time of year they change. This affects the climate response, as well as fluxes of UV. Global average UV does not harm anything, but local increases are important.

9. Why do you average results over three years? What is special about that? I would be interested in the winter and summer seasons for each year, which is where the chemistry and dynamics responses determine the patterns. Three-year averages do not address the processes.

10. You use VEI as an index for the size of volcanic eruptions that affect climate, but that is wrong. Please see the explanation of why in Newhall et al. (2018), for example. Mount St. Helens, for example, was VEI 5, but had not sulfur and no impact on climate. I also recommend reading the original Newhall and Self VEI paper, which explains that it is an index of explosivity, and stratospheric inject is used as one criterion to assign VEI, but it should not be done in the opposite direction.

11. You use a mixture of different styles of reference, and they all need to be in the same style.

12. There were no supplemental figures in the manuscript you provided.

I provided 105 comments in the attached manuscript, all of which I recommend you address.

Please also note the supplement to this comment:

<https://acp.copernicus.org/preprints/acp-2020-1110/acp-2020-1110-SC1-supplement.pdf>

Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2020-1110>,

C3

2020.

C4