Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-187

Anonymous Referee #1

Referee comment on "How volcanic eruption latitudes diversify surface climate responses" by Seungmok Paik et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-187-RC1, 2022

I recommend major revisions for this paper. It ignores some relevant research work on this topic, which needs to be addressed. And fundamentally, I don't see what is really new here. We already know, as can be seen in the many previous papers referenced here, that volcanic eruptions can affect ENSO and the polar vortex. What does using one imperfect climate model, and analyzing the results in detail teach us? Shouldn't the study compare multiple climate models? In any case, the analysis needs to be redone, considering the points below.

The climate model has not been evaluated for its ability to simulate observed El Niños, and its Arctic Oscillation climate. How well does CESM simulate El Niño? This has to be tested and documented before we can trust its El Niño response to volcanic eruptions. How well does it do this for the recent observational period?

The southern and tropical set of volcanic eruptions seem to produce the same forcing of the climate system. Are they really distinct, and why are they not considered together? The aerosol distribution (Fig. 1g) looks very much like the tropical one (Fig. 1a) with the largest loading in the Tropics. How can you justify considering these eruptions separate from tropical ones? Also the Fig. 6 results for southern and tropical eruptions are the same. They really should be combined in the analysis.

The figures need to be revised, removing the bogus horizontal lines and putting black dots on the insignificant results, not the ones that are significant, so we can actually see them.

The pdf you provided has a very small font and the text and figures only cover part of each page. I find this annoying. I advise you in the future to make it easy for reviewers – not hard.

You have ignored the work of Coupe and Robock (2021), who found that in general the CESM Large Ensemble did not correctly simulate the El Niño or the winter warming after the three most recent large tropical eruptions, but did correctly simulate the winter warming if SSTs were specified. You have to reconcile your results with these.

Coupe, Joshua, and Alan Robock, 2021: The influence of stratospheric soot and sulfate aerosols on the Northern Hemisphere wintertime atmospheric circulation. *J. Geophys. Res. Atmos.*, **126**, e2020JD034513, doi:10.1029/2020JD034513.

The paper continually refers to northern eruptions and southern eruptions, but does not define them until lines 97-99. The definition needs to be given the first time these phrases are used. If they are eruptions that occur in high latitudes in the respective hemispheres, above what latitude? And would the 1982 El Chichón eruption be a northern one, since the aerosols stayed in the Northern Hemisphere?

Figs. 3a and 3b have blue contour lines that are not explained in the caption. What are they?

Section 3.2.1 goes into detail about ocean circulation changes, but never explains why the El Niño after the volcanic eruptions is delayed for a year, in contrast to observations after 1963 Agung, 1982 El Chichón, and 1991 Pinatubo. If the model is wrong about this, how are we supposed to accept the results of the paper?

The figures are drawn with GrADS, but many have horizontal lines that should not be there. You need to remove all of them from the figures, and this can be done in several ways. Check the GrADS forum for the solutions.

I don't understand why 10 mb is chosen for analysis of stratospheric wind anomalies. This is typically 26 km, much too high to be of significance for tropospheric influence. I know this model has a peak response there, but is it correct?

Polvani et al. (2019) claim that even an eruption the size of 1991 Pinatubo was not large enough to produce a significant change in the AO. How do you reconcile your results with theirs, considering you used the same climate model?

Polvani, L. M., Banerjee, A., & Schmidt, A. (2019). Northern Hemisphere continental winter warming following the 1991 Mt. Pinatubo eruption: Reconciling models and observations. *Atmospheric Chemistry and Physics*, **19**, 6351–6366. https://doi.org/10.5194/ acp-19-6351-2019

In addition, the 23 comments in the attached annotated manuscript need to be addressed.

Please also note the supplement to this comment:
https://acp.copernicus.org/preprints/acp-2022-187/acp-2022-187-RC1-supplement.pdf