

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-58

Alan Robock (Referee)

Referee comment on "Volcanic stratospheric injections up to 160 Tg(S) yield a Eurasian winter warming indistinguishable from internal variability" by Kevin DallaSanta and Lorenzo M. Polvani, Atmos. Chem. Phys. Discuss.,
<https://doi.org/10.5194/acp-2022-58-RC1>, 2022

Review of DallaSanta and Polvani

This paper has a fundamental error, in that it ignores new work that shows that SSTs matter when it comes to winter warming. Coupe and Robock (2021) showed that indeed large ensembles using state of the art models do not produce robust winter warming when run with a coupled ocean model, as current models do not robustly simulate El Niño following large eruptions. But they showed that if SSTs are specified, then every ensemble member simulates winter warming after the three largest recent eruptions of the 20th Century. That's 60 ensemble members, and they all get it.

Lines 68-69: The authors ask, "if Pinatubo and Krakatau are not large enough, how large does an eruption need to be to cause wintertime surface warming at Northern mid-latitudes?" I think this is the wrong question. The correct question is, "What other factor is missing from all these previous studies that prevents them from simulating what was actually observed after past large volcanic eruptions?" As Coupe and Robock (2021) have shown, it is the confounding influence of El Niño. If there is no El Niño, then erroneous tropospheric forcing destroys the stratospheric circulation forced by the volcanic eruptions. Stratospheric forcing by itself is not enough, and the present paper just reinforces that, and is not a new result.

On line 162, they say, "to avoid unnecessary confusion, therefore, we solely focus here on ENSO-neutral eruptions." Rather, it seems that this also removes addressing an important scientific question.

The author's current results just replicate what Polvani et al. (2019) have already found. I recommend major revisions, which would involve using AMIP runs to see whether the new model they use can also simulate winter warming when surface forcing from inaccurate

SSTs is removed.

Lines 14-19: These lines in the abstract need to be qualified. They should include that the results depend on the SST specification, that is with no El Niño.

Lines 30-33: This is not correct. First, it does not matter how many papers there are. What matters is how they were done. Second, Zambri and Robock (2016) did find winter warming after large eruptions, and showed the errors of previous studies, such as by Driscoll et al. (2012). Third, the claim that Bittner et al. (2016) supports their claim is wrong. As Zambri and Robock (2016) wrote, "In contrast to the findings of Driscoll et al. [2012], however, Bittner et al. [2016] showed that for the largest eruptions, the CMIP5 ensemble does produce a robust strengthening of the polar vortex." Fourth, the authors have ignored the paper by Zambri et al. (2017), which also showed that past model simulations did produce winter warming.

Zambri, Brian, Allegra N. LeGrande, Alan Robock, and Joanna Slawinska, 2017: Northern Hemisphere winter warming and summer monsoon reduction after volcanic eruptions over the last millennium. *J. Geophys. Res. Atmos.*, **122**, 7971-7989, doi:10.1002/2017JD026728.

Lines 245-250: Please explain how the NAM index was calculated and how it can explain more than 75% of the variance. On what time scales? Are you talking about daily, monthly, seasonal, or what?

There are multiple cases of excess verbiage, e.g., "notice," "we remind the reader," "we draw the reader's attention to," "we note that." These should all be deleted. Every sentence should be important or it should not be in the paper. Does this imply that other sentences should not be noticed? Such writing style should be avoided in scientific articles.

Lines 410-412: "early claims of robust Eurasian winter warming for eruptions such as Pinatubo – and even smaller ones, such as the 1982 El Chichón or the 1962 Agung eruptions – simply cannot be reproduced with current-generation climate models: these have consistently failed to show any warming for such historical eruptions" is simply wrong. You have to qualify this claim by conditioning it on the models only being forced from the stratosphere. In AMIP runs, current models have done an excellent job.

The figures have multiple problems with erroneous and unlabeled axes and missing units:

Figs. 1, A1: What are the x- and y-axes for each panel? 0 0 0? 0 20 10? 0 45 0? Give

the variable and the units for each axis, and mark them with numbers that make sense.

Fig. 2, A2: There are no units given for temperature or wind.

Fig. 2, A2: What are the x-axes? 0 45 0? What does this mean?

Fig. 2, A2: What are the y-axes? They are missing the variable and the units.

Fig. 3a: What are the x- and y-axes? Give the variable and the units for each axis.

Fig. 3, all panels: What are the y-axes? They are missing the variable and the units.

Figs. 5, 6, 7, 8: What are the units for temperature?

Fig. A3: Fix the axis labels.

Please also address the 14 comments in the attached annotated manuscript.

Review by Alan Robock

Please also note the supplement to this comment:

<https://acp.copernicus.org/preprints/acp-2022-58/acp-2022-58-RC1-supplement.pdf>