

Atmos. Chem. Phys. Discuss., referee comment RC2
<https://doi.org/10.5194/acp-2021-260-RC2>, 2021
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Comment on acp-2021-260

Anonymous Referee #2

Referee comment on "Climate impact of volcanic eruptions: the sensitivity to eruption season and latitude in MPI-ESM ensemble experiments" by Zhihong Zhuo et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-260-RC2>, 2021

Review of: "Climate impact of volcanic eruptions: the sensitivity to eruption season and latitude in MPI-ESM ensemble experiments" by Zhuo et al.

General comments

This study investigates the impact of volcanic eruptions of Pinatubo magnitude at different latitudes (equator, NH, SH) and in two seasons (winter and summer) on the climate, predominantly on precipitation and the South Asian summer monsoon. The study overall is interesting, and its idealized design allows the mechanisms involved to be investigated systematically, which adds value. The overall novelty could be better signposted and some statements are overstated (see specific comments). More detail on why the summer and winter eruptions have similar impacts despite different forcing would be useful. In general the paper is well written, and the analysis is logical, but the use of parentheses throughout makes some sections difficult to read. I recommend that these are removed. Please also check the quality of figures – e.g. Figure 2 is pixelated and squashed. Overall I think the manuscript will be suited to publication in ACP once these comments have been addressed.

Specific comments

The title is very broad, but the focus is on the South Asian Monsoon, so it would be useful to clarify this. The abstract also refers to 'climate impacts' but it is unclear whether this is in reference just to precipitation. The abstract would also benefit from an overall sentence that highlights the implications of the results.

L28 - It is well known that the spatial distribution of volcanic aerosols affects the climate

impact, and these studies are not the first to show this.

L33 – There are many other studies that have highlighted the importance of season on the climate impact (e.g. Toohey et al. 2011; 2013; 2016a; Aquila et al., 2012; Stoffel et al., 2015). It would be useful here to state what Stevenson et al. (2017) found in relation to the role of season. What about studies that have investigated the importance of latitude?

L39 – What is the difference between extratropical and high-latitude here?

L40 – Satellite observations for tropical eruptions show this spread so I do not think 'believe' is the right word here.

L47 - 49 – I am not sure controversial is the right word. It also depends on what 'climate impact' is being investigated and this is specific to NH cooling.

L65 - It would be useful to introduce to the reader that you first explore the global forcing and climate response (sections 3.1 to 3.4), before focusing on the precipitation response in India (section 3.5)

L73 – Are there any implications of using a low-resolution version for looking at regional climate? Is this important?

L92 – It would be useful here to state that these are meteorological ensemble members or to introduce the 10 members only at the end of this section.

L98 – Why 23 control runs? Is there a reason behind this? Figure 1 is somewhat confusing with the branches at the bottom for the 23 control runs – is this necessary?

L104 – Six sets of ensembles not three?

L122 – This line seems to undermine the purpose of the study. If it is not an equal focus, then I recommend it be removed from the title or that both seasons are investigated equally, and the limitations added to the discussion.

L128 – Is it realistic that the global mean time series are the same? It would be useful to add to the discussion some of the limitations of EVA.

L135 – consider adding 'reflecting the large-scale transport of the Brewer Dobson circulation' or similar.

L154 – Also recently discussed in Marshall et al. (2020) for a wide range of eruption latitudes. What about the LW heating following these eruptions and the impact on stratospheric dynamics and also on cloud cover? It may be useful to look at the surface radiation changes.

L172 – It would be useful to state the number of months after the eruption when the max cooling occurs in addition to the date.

Figure 5 – please make the stippling lighter as it is hard to see the underlying temperature anomalies or stipple the areas that are not significant.

L177 – but these ocean changes aren't significant?

L190-201 – can you point out some of these numbers and highlight what the reversed responses are? I do not see the black box in fig 6 and a small scale is present under panel d.

Figure 7 c and d – Why is the control line different in panels c and d? Please label the y axes and indicate that the control line is not an anomaly and shown on the secondary y axis.

Sections 3.5.2 and 3.5.3 are very difficult to read with the parentheses. Why are the summer and winter responses similar despite different forcing?

L273 – not just the change in the cloud cover, but also the background cloud compared to clear-sky conditions? What about the role of surface cooling?

L310 – Stevenson et al. (2017) also looked at much larger eruptions with very different forcing.

L342 – Because the ENSO response is mentioned in the conclusion, this result should at least be shown in the SI.

L365 – What about other dynamical effects, such as aerosol heating and changes to the polar vortex and other circulation changes. Is this important?

Conclusions: some statements are fairly obvious, and I do not think necessary e.g. 'results confirm that aerosols reflect incoming solar radiation'. Limitations to this study are also missing from the discussion/conclusions. For example how would your results differ with a larger injection magnitude? Would season and latitude become more important? If EVA is tuned for a summer eruption how robust are these results for winter? The temperature response (e.g. Figure 4) is also different for winter vs. summer eruptions but the conclusion is very general in saying that season plays a minor role in climate impacts. It needs to be clear this is in relation to precipitation change.

Technical corrections

L3 – earth --> Earth

L39 - impacts

L47 – simulations

L102 – remove 'to be'

L241 – since --> because

L357 – tropics, extratropics

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