

Interactive comment on “Uncertainty and detectability of climate surface response to large volcanic eruptions” by Fabian Wunderlich and Daniel M. Mitchell

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We thank the reviewer for the in-depth assessment of our paper. The manuscript has been revised accordingly, with most points being taken into account as per the reviewer suggestions. In particular, we emphasized the main results of the paper compared to previous studies and we included a technique to remove the impact of ENSO to support the robustness of our results. We excluded the fingerprint analysis to get a consistent and clearer picture of our results. We therefore changed the title of the paper to: “Revisiting the observed climate surface response to large volcanic eruptions”.

C1

Major comments:

- The main new contribution seems to be the inclusion of the many reanalyses. However, I doubt how much additional information the reanalyses provide when we already have the observations of both surface temperature and pressure. If the models do not get the impact of the eruptions right then why should the reanalysis products which are based on models be better than the observations?

One major aim of the paper is to measure the uncertainty in the reanalysis products. This kind of direct comparison of the volcanic response between all reanalysis products and the observations has never been done before and will contribute to the S-RIP report. Reanalyses are used to build a complete picture of the atmospheric (and other components) system. Thereby forcing the stratospheric and tropospheric state to be in the direction of that observe during a volcano will filter through to land surfaces being better as well. So we would expect it to be better than models. Part of this paper is to identify the differences in the reanalysis so that researchers who use them know which ones to use, and which to avoid. We also provide a systematic comparison of reanalysis, obs and models looking at both radiative and dynamical response. By revisiting the widely accepted view of the dynamical and radiative response, we conclude that they are not as robust as often stated and show that identifying the effect of volcanic eruptions is still an issue.

- The Introduction is very brief. I think the authors need to discuss the difference between the tropical radiative response and the extra-tropical dynamical response already here. There should also be a more detailed discussion of previous work in these two separate areas.

The introduction was adapted to include the difference between radiative and dynamical response to volcanic eruptions. Also added a discussion of the novelty of the paper already in the introduction.

C2

Minor comments

- page 4, l24: Is Adams et al. 2006 the right reference?

Changed to Adams et al., 2003

- Fig. 5: I think this figure is hard to understand. It is said in the caption that the blue lines are for the winter after Pinatubo and El Chichon, but there seems to be more than two blue lines in the plot. I also wonder what the histogram tells us. Should it indicate the significance? But it is not for the same source as the other data so how can they be compared?

The caption of Figure 5 was changed. The histogram shows the distribution of the NAO index for the observations. This can not directly to the distribution of the reanalysis products but is very similar. Therefore the histogram acts as a measure of the strength of the NAO response after the eruptions.

- Fig. 8: The same here. Also, now it is said that the orange curves show the NAO signal. Should it be the TAS?

The caption of Figure 8 was changed. The distribution of TAS anomalies of the observations and reanalysis products are very similar. Therefore the histogram acts as a measure of the strength of the TAS response after the eruptions.

- page 7, l23: It would be interesting to see results when more weaker eruptions are included.

C3

The NAO response after weaker eruptions is shown in Figure S4 of the supplement. After the eruption of Fernandina in 1968, with a similar AOD to e.g. Fuego in 1974, a strong negative NAO was found. Therefore by including weaker eruptions still we would not find a robust NAO signal.

- page 8: It should be mentioned in the beginning of section 3.2 that this deals with the annual mean response.

Done

- page 9, l25. If the solar signal does not add anything why not begin the discussion with the two-signal ROF?
- page 10, lines 3-12: The discussion of the sampling of El-Nino events is unclear.
- Section 2.4: The description of the fingerprint method is very brief and impossible to understand without reading the references. In this way this analysis is different from the rest of the paper. Perhaps the fingerprint analysis could be deleted?

We excluded the fingerprint analysis.

- page 11: l14: Is there a cooling signal in Europe in summer?

There is a minor but in general not significant summer cooling in Europe following volcanic eruptions with a maximum over Scandinavia. This was not explicitly shown by our analysis but found by e.g. Fischer et al., 2007.

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C4