

## ***Interactive comment on “The sensitivity of the ENSO to volcanic aerosol spatial distribution in the MPI large ensemble” by Benjamin Ward et al.***

**Anonymous Referee #1**

Received and published: 12 September 2020

The reviewed paper deals with a very hot and scientifically important research question of how ENSO responds to hemispherically symmetric and asymmetric radiative forcing caused by the three largest volcanoes of the 20th century, Agung, El Chichon, and Pinatubo. The authors test the hypothesis that the primary driving mechanism is ITCZ's shift that works for symmetric and asymmetric volcanic forcing. The study takes advantage of the unique 200-member ensemble of MPI-ESM 1.1 with a relatively low effective spatial resolution, 180 km x 150 km x 16 layers. The research topic is important, the methods are sound, the results are interesting, but the analysis has significant flaws. Therefore I suggest the authors conduct a major revision to enhance their analysis and improve the text.

General concerns: The analysis is based on calculating the ensemble average re-

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sponses to volcanic forcing. It is known that ENSO response to volcanic forcing is sensitive to the ocean preconditioning. The used approach averages out responses to individual initial conditions (El Nino, La Nina, or neutral), potentially removing the effect of the mechanisms that depend on preconditioning, e.g., ocean dynamical thermostat (ODT).

Nino3.4 index based on relative SST exaggerates the El Nino-like response. A comparative analysis with the regular SST is needed.

Both EL Chichon and Agung eruption happened before the spring predictability barrier when ENSO responses are unstable. So, the responses to these two eruptions are contaminated by stochastic ENSO behavior.

ENSO's response to the Agung 1963 eruption, which is a milestone in the authors' arguments, is not what they think. It is not La Nina like a response, as its spatial temperature pattern dislikes the La Nina one. The ocean cooling in the Southern Hemisphere caused by Volcanic forcing that expands to the Northern Hemisphere could explain it. It is why it takes three years.

Specific Comments:

Fig. 1: Is it AOD from the model? Is it prescribed? From what data set? The color bar is wrong. AOD is an order of magnitude larger.

L36 and L89: The eruption started in February. The major emissions happened in March. Please use the month of the eruption consistently.

L39-44: RSST enhances the positive signal. Please show the regular SST results for comparison.

L66: Please specify that you are talking about Pacific ITCZ.

L70: Khodry et al. (2017) do not say anything about Walker Circulation. They claim that the atmospheric Kelvin wave does the job.

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L121: Response on the 3rd year is too late even for ENSO responses driven by ocean Kelvin Wave propagation

L145-149: The response to the 1963 Agung eruption, as it is shown in Fig 2abc, is not a negative ENSO pattern. It is an ocean cooling but of different origin. It brakes the entire reasoning about the general applicability of the "ITCZ" mechanism.

L167: Why the reduction in precipitation should favor Rossby waves generation? Decreasing the release of latent heat should decrease the Rossby wave generation. Please clarify.

L185-186: For completeness of the analysis, it would be useful to have these experiments for this paper.

L210: In this particular model.

L225: Adams et al. saw the signal in two years after an eruption (year 0 and year 1).

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Interactive comment on Earth Syst. Dynam. Discuss., <https://doi.org/10.5194/esd-2020-63>, 2020.