

Interactive comment on “Assessing the impact of large volcanic eruptions of the Last Millennium on Australian rainfall regimes” by Stephanie Blake et al.

Anonymous Referee #1

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GENERAL REMARKS:

The manuscript “Assessing the impact of large volcanic eruptions of the Last Millennium on Australian rainfall regimes“ in consideration for publication in *Climate of the Past* investigates the impacts of tropical explosive volcanic eruptions on Australian rainfall regimes, ENSO and the Indian Ocean Dipole. The authors use a set of specific global climate model realisations to address questions about the importance of volcanic forcing power and timing of the above mentioned impacts.

Generally, the topic of the manuscript fits *Climate of the Past* and is a valuable contribution to the community, The study sheds light on volcanic climate impacts in the

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Southern Hemisphere, for which only few studies exist so far.

However, I feel like the manuscript lacks content in some important parts. In my opinion, the three main weaknesses are:

1) Experimental design: Since the study largely focuses on the IOD and ENSO, the authors should describe in detail how SSTs and evaporation over oceans is handled in the model. Is it an AMIP run? Is it coupled? Slab ocean? And if the SSTs are prescribed, can it be used at all? These things are completely disregarded in the manuscript at hand.

2) Model evaluation: There is NO effort made to convince me that this model is doing a good job in terms of precipitation. I would like to see a comparison between model and proxy data, or model and (PDSI) reconstructions.

3) Physical mechanisms behind the shown effect on ENSO and IOD: Although a lot of studies are cited as to show that there is agreement with previous work, I didn't find a proper physical explanation for the effects we see in the plots besides the paragraph in the introduction. I would like to see a discussion about the mechanisms in this specific model.

See below for specific remarks.

SPECIFIC REMARKS:

line 34: I would add here newer studies about precipitation like Iles et al 2013 or Wegmann et al 2014.

line 93: Not sure what exactly is unclear? Do you mean dynamic vs. radiative changes? Please explain further what gap your study is filling.

line 103: Here I really would like to see a thorough description of the ocean setting for this model (see above). What kind of SSTs are used? Is there a dynamic ocean? How is the volcanic signal supposed to show in the SSTs? Is it valid to use the model to

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investigate ocean surface changes? CMIP5 also had AMIP runs included, so I can't really infer if your model was coupled or not.

line 103: I assume CO2 forcing is done in CMIP5 fashion?

line 148: As I said before, I would like to see an evaluation for starters. How good is the model in terms of precipitation? The comparison doesn't have to be for Australia, but I want to be convinced that the model gets the broader precipitation response. Otherwise, the rest of the results is less meaningful.

Figure 2: Is this the annual mean? If so please indicate that fact. Maybe it would be nice to see DJF and JJA anomalies? Is the model able to do the NH winter warming? And if not, is there an argument to make that the model doesn't get the dynamics right (as is the case with many CMIP5 models)?

line 176: Again, I wonder about NH winter warming. Should counteract the summer cooling over the NH.

line 194: Indeed it suggests that. But how did it work? Where is the discussion of the physical mechanism? How is the signal transported in the model? Maybe show evaporation, heat content and other metrics to show the mechanism in the model.

Line 241: Okay, but how does this effect override the impact of IOD?

Table 1: It says strongest eruptions in the last millennium but I am pretty sure that Tambora was stronger than Huaynaputina as Figure 1 shows. In fact even the unknown 1809 eruption is bigger. Please adjust your Table description.

Figure 3: in fact 2xCG is not an ensemble and should be marked as such.

Figure 4: The 90th percentile of what? The ensemble members? If so, please adjust. (also for the rest of the Samalas & Huaynaputina plots.

Figure 10: Here it says Australian precipitation whereas Figure 9 says NW Australian precipitation and Figure 11 says SE Australian precipitation. I assume Figure 10 also

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is SE precipitation?

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