

Interactive comment on “Assessing the Impact of a Future Volcanic Eruption on Decadal Predictions” by Sebastian Illing et al.

Anonymous Referee #2

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General comments This paper investigates how much effect a Pinatubo like eruption would have on decadal climate predictions for a number of variables, and whether the phase of major modes of variability (PDO, NAO) at the time of eruption make a difference to the climate response. The authors find that a volcanic eruption does indeed affect decadal predictions of temperature, precipitation and sea ice, and that some aspects are dependent on the initial state of the climate system, particularly at regional scales. This is an interesting and relevant topic, since the occurrence of a volcanic eruption would likely have a large impact on climate on the timescale of decadal predictions. The authors explain the background and relevance of the research well. I feel that the methods are appropriate to address the question and that the conclusions are supported by the evidence shown. The presentation of figures is generally good.

C1

The article is within the scope of ESD and should be interesting to its readership. I feel that the article is worthy of publication, following the correction of some generally minor issues. My main suggested change relates to presenting ensemble spread to show how consistent results are between ensemble members, which will have implications for how predictable the climate response to eruptions is. Similarly, an indication of the extent to which modes of variability (particularly the NAO and PDO) remain in the same phase or diverge between ensemble members post eruption may shed more light on the differences between the two ensembles. My other suggestions mainly concern clarity in some places and English corrections.

Specific comments

Abstract - Mention that it is an ensemble of forecasts here.

Abstract, last line – which simulations have the negative PDO? The 2012 ones? Please make that clearer.

Abstract: “So the question emerges how predictable is the response of the climate system to future eruptions?” Looking at the ensemble spread would also help address this question- see also comments below. Whilst you may find a volcanic signal in the ensemble mean, the paper does not really give a feel for how consistent these signals are between ensemble members, and this would have implications for how predictable the climate response to volcanic eruptions is.

Introduction, first paragraph – is it worth mentioning briefly where the predictability comes from? E.g. is it from certain modes of variability? Or from SSTs? Etc. I assume this list of variables are the things that are able to be predicted rather than the predictors?

Pg 2 Line 20, also pg 8 line 20- and the south American monsoon e.g. Joseph and Zeng 2011??, Iles and Hegerl 2013;14

Pg 2 Line 21-22 – is this decade long sea ice response for the large eruptions that

C2

occurred around the time of the Little Ice Age, or for twentieth century ones as well?

Pg 4 line 32 – What is a “lagged-day method” ? Can you explain briefly?

Pg 5 first paragraph and throughout – I found the naming of the two experiments somewhat confusing (Pinatubo-2012 and Pinatubo-2014), because they are initialised on the last day of December in 2012 and 2014 respectively, meaning that the eruptions happen in 2013 and 2015 respectively, and that only one day of 2012/ 2014 is actually simulated. I wonder if they would be better off being called Pinatubo 2013 and 2015? Or at least make sure that it is clear that the eruptions happened in summer 2013 and 2015.

Figure 1a and pg 4 line 27 – is it possible to plot the observed equivalent of figure 1a if its not too much work?

Figure 1 b and c - Are the vertical lines showing the initialisation dates in the right place? They should be almost on the dashes for 2013 and 2015 on the x axis given the initialisation happens on the 31st December. - Could you indicate on the plots when the eruptions happen? - Could you explain explicitly why the hatched bars are different from the solid bars before the eruptions? – Is this because the initialised runs diverge from the assimilation run? How different is the phase of the NAO/ PDO between different ensemble members before the eruptions? Can this be shown on the plot? Also it would be interesting to see how the NAO and PDO indices evolve after the eruptions and how much this differs between ensemble members since this will impact the post volcanic climate response.

Page 6 line 2 “AS it would be issued by the Miklip project” – what do you mean? Is this how the Miklip forecasts are presented? Do you mean that they present things as 4 year means? If not, what is the rationale for presenting results as 4 year means when some aspects of the climate response to volcanoes e.g. the precipitation response over land, happen on a timescale less than 4 years?

C3

Page 8 : Please define what a “frost day” is. Also, I am not sure whether it is really a climate extreme – i.e. in cold regions every day might be a frost day, and that would be normal, not extreme.

Page 9 line 8/9: “ in most regions” I am not sure that a precipitation reduction can be seen in “most regions” in figure 9.

Figure2 - “Anomalies are based on the period 1981-2010” – is the climatology based on the assimilation run? - I assume these plots are showing annual means? - It could be interesting to show the ensemble spread as well. (Also for the other similar figures).

Figure 5: near-zero changes could be shown in white for clarity e.g. so it would be white where there is no sea ice all year round, or sea ice 100% of the time.

Figure 9 and related discussion (precipitation): -Is the difference in the Pacific related to the phase of ENSO? How does the phase of ENSO compare in the post eruption years between the two ensembles? (I know they started off in the same phase when they were initialised, but they may have deviated since) -Also, is the difference over Europe due to a different phase of the NAO? -I am also intrigued as to how similar or different the variability of modes like ENSO/ PDO/ NAO are within the members of each ensemble- i.e. the PDO and NAO start off in a similar phase, but how much do they diverge between ensemble members over time? -I also suspect that using a mean of the four post eruption years is not the most appropriate to look at land precipitation, because the response tends to last more like 2 years, unless presenting 4 year means is the standard for decadal predictions.

Pg 10 ENSO discussion: It would be worth mentioning that this influence of volcanoes on ENSO is debated.

Conclusions “We have shown that the global near-surface air temperature and precipitation decrease as a response to the volcanic eruption is independent of the initial conditions” – but only for the initial conditions that you have tested- this sentence cur-

C4

rently sounds as if you mean its independent of all initial conditions, including things you haven't tested (e.g. ENSO phase), which you obviously can't comment on.

Technical corrections

Pg 1 line 9/10 "So the question emerges how predictable is the response of the climate system to future eruptions?" Add a colon between emerges and how. Same for page 3 line 9 -> "the question arises: What would happen. . ."

Line 12: "among other things" – if I understand correctly, the only other thing was the phase of the NAO, so this could be said specifically.

Line 21: "than in the simulations initialized in 2014" – delete "than", otherwise it means the opposite!

Pg2 line6 MetOffice -> Met Office , (assuming you mean the UK one)

Pg2 line 1 "more and more attention is BEING paid"

Pg 2 line 16 "regionally, HOWEVER, warm anomalies are ALSO found. . ." ("although" is not the right word and changes the meaning of the sentence). Is it worth saying why? i.e. its related to the positive NAO pattern that often occurs after eruptions.

Pg 2 Line 18 " atmosphere AND ocean dynamics"

Pg 2 Line 19 "The last major volcanic eruptions followed a period" -> "The last major volcanic eruptions WERE followed by a period" otherwise it means the opposite. Also, what do you mean by "the last major eruptions?" The ones that occurred this century? Same for pg 7 line 10

Pg 2 Line 25 – are these studies about the NAO observation based or model based?

Pg 2 Line 31 "could demonstrate" -> "demonstrated"

Pg 2 Line 34 "volcanic future eruptions" -> future volcanic eruptions

Pg 3 line 10 "from the start year" -> "on the start year"

C5

Pg 3 line 13 "multi-yearly" -> "multi-year"

Pg 4 line 25 "in the order of 50 to 100 years" -> "in the order of ONCE EVERY 50 to 100 years"

Pg 5 line 7 "are in both experiments in a similar state" -> " are in a similar state in both experiments"

Pg 5 line 11 variables -> modes

Pg 5 line 12 "nowadays set up" sounds a bit strange. How about "present day set up" ?

Pg 7 line 8 "solar near-IR radiation BY the increased sulfate aerosol"

Pg 7 line 19 (and elsewhere) "reacts stronger" -> " reacts more strongly"

Pr 8 line 13 "Whereas in the Pinatubo-2014 experiment, the frost days increase most over the whole of North America, Scandinavia, Nordic Sea, and East Asia." I get the impression that this sentence should be joined to the previous one ". . . , whereas. . ." If not, the change "whereas" to "In contrast". "Whereas" needs both statements to be in one sentence. Also "Nordic Sea" -> "the Nordic Sea".

Pg 8 line 21 – " ~60% of the world's population" This statistic needs a reference.

Pg 8 line 30 "area" -> "are a"

Pg 8 line 31 "but it turned out that the precipitation changes are. . ." sounds too colloquial. "but the precipitation changes were. . ." is sufficient.

Pg 10 line 2 – delete "Therefore"

Pg 10 line 8 "are in both experiments in a similar state" -> are in a similar state in both experiments AT THE TIME OF INITIALISATION. (see also comments for figure 9)

Pg 10 line 28 "We could not find a clear link between the different initial states of the NAO and one of these changes." "one of these changes" -> "any of these changes" or just "these changes".

C6

Pg 11 line 8 “experiments will be conducted, where similar to our experiment, the impact” -> “experiments will be conducted where, similar to our experiment, the impact”

Figure 6 and 8 captions “other regions” -> “ different regions”

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