Dear Editors and Reviewers,

We thank the editor and two reviewers for their helpful and constructive review of our manuscript. During this review period we have focused on improving our manuscript by restructuring the introduction and discussion, clarifying and correcting statements in the text, and elaborating on the ENSO response by including discussion of the relative sea surface temperature response in comparison to the ensemble in Zanchettin et al. 2022.

It is our hope that the new version of the manuscript improves general readability, enhances comparison with previous studies, and will provide a valuable contribution to the community.

Sincerely,

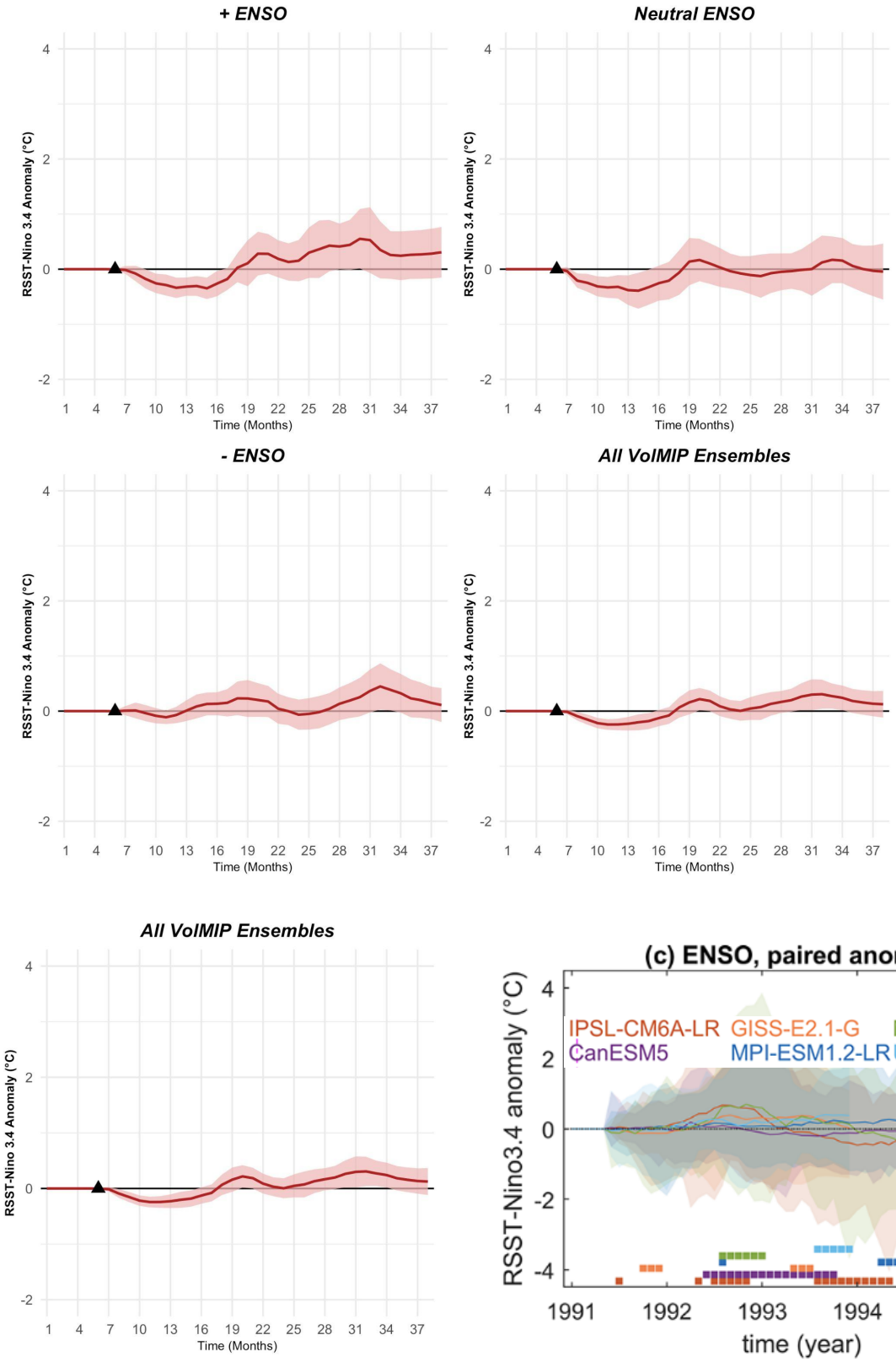
Helen Weierbach on behalf of all co-authors

Dr. Davide Zanchettin

We thank Dr. Zanchettin for his second review of our manuscript. As he pointed out, clarifying the Nino3.4-RSST response is essential for comparison to both previous and future studies. In response to his comments we have performed further analysis of the Nino 3.4 response using relative sea surface temperature anomalies and also performed a thorough read-through of the text to further polish and clarify the manuscript. Specific responses to Davide's comments are included below.

The authors addressed most of my comments on the original manuscript, and the manuscript has greatly improved, but it seems that there is one point that was not addressed, the one regarding ENSO. In my previous comments I wrote:
"Concerning the analysis of ENSO, the fact that the authors do not identify an El Nino-like response is very likely linked to the fact that the Nino3.4 index "as is" includes the volcanically induced cooling of the whole tropics, which must therefore be removed before investigating dynamical responses of ENSO. The most used approach is based on "relative SST" and is discussed in several papers, for instance Khodri et al. (2017) and Zanchettin et al. (2022). I strongly recommend the authors to revise the ENSO analysis to account for this. Note that using the relative SST method, Zanchettin et al. (2022) report the GISS-E2.1-G "showing a slight warm ENSO anomaly in 1992 in the ensemble-mean", so contrasting the result reported here in this version of the manuscript."
Since the authors still report a La Nina like response, and do not mention the calculation of relative SSTs, I feel my comment was not addressed. As already mentioned, Zanchettin et al., 2022, obtained different results using relative SSTs. I think this is a major point which should be addressed before the manuscript is published.

Thank you for pointing out this point which was not adequately addressed in our original responses. As pointed out, the analysis that we include for the ENSO response during the volcanic simulation which shows cooling of the tropical pacific does in include volcanic cooling of the full tropics. To address this point and enhance comparison between our study in the VolMIP community paper we have completed an analysis of the Nino 3.4 relative sea surface temperature anomalies (RSST- Nino3.4 Anomalies) for all ENSO ensemble groups (figure below with comparison to VolMIP community paper).



Comparison of ensemble mean
RSST-Nino 3.4 Anomalies for our study (left) and in the VolMIP community paper (right).

For the mean of our full ensemble (n=81), we see RSST anomalies consistent with the Zanchettin et al. community paper where in the first winter, there is consistently a negative anomaly, followed by positive anomalies for some ensembles. This is expected, since the model results used here are an expanded ensemble of the simulations that contributed to the Zanchettin et al. work. Because the RSST-Nino3.4 anomalies do not significantly change the results, we include the RSST-Nino3.4 results in the supplemental materials (S4). Furthermore, we have also decided to include the original seasonally-detrended analysis as it allows us to simultaneously visualize the ensembles for control and perturbed conditions, giving a more easily interpretable representation of how ENSO is changing including the response from volcanic cooling. To discuss the benefits of the two methods, we have additionally added sentences to section 4.1 to provide context and link interested readers to the RSST-Nino3.4 index who are interested.

Also, I have some suggestions for some further polishing of text/clarification that the authors may consider. Below are some examples from abstract, but I encourage the authors to go once more through their manuscript and double check the accuracy of their statements.
Line 3: what is a “regular” time scale? Maybe change to interannual or interannual-to-decadal. Then, it is not the “initial atmospheric and oceanic conditions” that “impact on climate”, rather atmospheric and oceanic dynamics contribute to generate intrinsic climate variability, or, initial conditions, or the climate system at a certain point in time, contribute to determine the evolution of climate in the following period.
Line 5: I would rephrase “simulations are sampled from possible initial conditions” as what is done is rather simulations being initialized from sampled conditions
Line 10: I don’t understand “with analysis coincident”, maybe just “coincident”?
Line 14: “neutral-phase” maybe change to “neutral ENSO”. Besides, this sentence reads unclear as it is not reported which sign the SST anomalies are, and if these are the same or opposite sign for positive and negative ENSO ensemble. Maybe it is worth detailing better here.
Line 15: this sentence is unclear, and it reads too vague. That initial conditions affect the response is known, so I would make this final statement more to the point.
Line 332: “show” maybe better “yield”?

We thank Dr. Zanchettin for his thorough comments for clarification from the abstract, it is a big help in finding places to clarify our wording and presentation. All examples included above have been improved and clarified, along with several other sentences throughout the paper.

Reviewer 2

We thank reviewer 2 for their thoughtful review of our manuscript. According to their comments we have significantly restructured the introduction, and renamed our discussion section "Discussion and Summary" to better reflect its contents as suggested by the editor.

This manuscript investigated the impacts of initial ENSO and NAO conditions on the responses to Pinatubolike forcing. Specifically, the authors focus on paired anomalies of different conditions and show that different initial conditions can lead to distinct volcanic responses. The research topic is interesting and crucial, but the manuscript is not well-constructed. Therefore, I do not suggest this manuscript to be published in Atmospheric Chemistry and Physics before the authors revise the manuscript to enhance the readability of the manuscript. Major comments (The line numbers are referring to the track-change file):

1. The introduction and model description and experimental setup are still too lengthy and include lots of information that is not related to the study. For example, in 1.2 ENSO response section, the authors should focus only on studies related to tropical eruptions like 1991 Pinatubo. Also, the authors discuss the different mechanisms that cause El Niño responses to volcanic eruptions but none of the mechanisms is mentioned in the results. Similarly, in the Model section, the authors discuss the difference between E2.1G and E2, which is not related to this study.
2. The discussion includes lots of summary of the results and does not discuss the possibilities of improvement or other points that usually have. The authors should rewrite the discussion section

To ensure our new "Discussion and Summary" section includes all relevant information we have added an additional few sentences which now discuss the consequences of our results, and agreement/disagreement with previous studies.

Other comments:

The abstract has been significantly restructured to account for these clarifying comments (1-5) and corresponding comments for the Davide. We hope that the abstract now presents a clearer summary of our study's findings.

1. Line 5-6, possible initial conditions? Why use "possible"? And the entire sentence is difficult to understand
2. Lines 8-11, this sentence is extremely long and is "with analysis coincident with" grammatically correct?
3. Line 11, what does it mean for "historical anomalies" and "control conditions"? Does it mean historical and piControl runs or something else?
4. Line 13, what does it mean for "relax SST toward baseline condition"? baseline condition of what?
5. Line 16, is "by initial climate conditions present at the time of the volcanic eruption" grammatically correct? And "at the time" is not accurate enough. Do the authors mean the following winter after eruptions?

6. Line 27, Timmreck et al. (2010)? Please make sure to use the correct format for citations throughout the manuscript. Same issue in Line 30.

Textual vs. parenthetical citations have been fixed here and throughout the introduction section.

7. Line 29-30, “largest volcanic eruptions in the last decade”? Or the authors mean “been widely studied in the last decade”? It is a bit confusing.
8. Line 30-32, any reference for this sentence?
This sentence was removed/combined with the previous when editing the introduction text.
9. Line 32, “a Mt.Pinatubo sized eruption”. A volcano can have multiple eruptions. Please use something like “1991 Pinatubo eruption” to indicate which event it is. And this issue happens throughout the manuscript.
Sentence now reads “a 1991 Pinatubo eruption”
10. Line 42, I don’t think Zanchettin et al. (2013) discuss the carbon cycle. Please make sure all the references are cited correctly.
Thanks for catching this. This citation was meant to refer to Zanchettin et al. 2016 and has been corrected. Other citations have also been checked to ensure they refer to the correct literature.
11. Line 45, only cite ENSO papers but not NAO papers?
ENSO citations are now accompanied by two citations to general information on the North Atlantic Oscillation.
12. Line 154, “The current CMIP6 model of E2.1-G ENSO representation”?
This has been changed to “The representation of ENSO in GISS E2.1-G for CMIP6”
13. Line 158, “Thus we note the model has larger variability in the NAO, likely linked to the model’s increased frequency in ENSO events” is this argument in Kelley et al. (2020)? I did not find it.
Thanks for pointing this out. The Kelley paper is an incorrect reference here and we have deleted this sentence. There has not (to our knowledge) been any formal discussion about a correlation between increased frequencies of ENSO events and NAO events. We instead only include information about the standard deviation of NAO in the GISS model from Orbe et al. and and corresponding variability in the NAO signal.
14. Line 181, “no correlation between ENSO and NAO states”? But in Line 158, the authors mention the NAO variability is related to ENSO events.
Thank you for pointing this out, as noted in the previous comment we do not have textual evidence of how increased Frequencies of ENSO may affect NAO frequencies. Thus we have removed the previous line and instead only discuss the lack of correlation present in our simulations.
15. Line 261, “we do not that”?
Thanks for pointing out this grammatical error. For some reason, this only exists in the trackchanges document, likely suggesting an error in the latexdiff package that was used to generate the file. The current text does not include this error.
16. Line 289, “(Miller et al.)”? “present and equivalent”?
Citation has been moved to the correct place at the end of the sentence reading “The MSU temperature metric is commonly used as a remotely sensed temperature data metric based on height, however here we present an equivalent modelled metric in E2.1 (Miller et al.)”

Editor Farahnaz Khosrawi

We thank Dr. Khosrawi for her very helpful and thoughtful feedback on our manuscript. We have significantly modified the introduction section with the help of her suggestions, renamed and added information to the discussion section, and additionally improved the readability throughout the paper, clarifying several sections throughout.

Dear authors,

please find enclosed two referee reports. While referee one has only minor issues (mainly one comment that has not satisfactorely considered/answered), referee 2 has some major issues on the introduction and discussion. I agree with the referee on the critics on the introduction which is indeed too long and too detailed. It is rather uncommon to have subsections in the introduction and the length should not exceed 1.5 pages.

However, the revision of the introduction can be easily done. I tried to rearange your text (see attached document) and could easily shorten the introduction to a reasonable length. The details on the processes like ENSO, the NH Winter Response could be put in a additional section. With some transitional sentences and references to the respective results sections these text parts could be easily put in a publishable shape.

I personally have no problems with your discussion section. However, to consider the critics of referee 2, one easy solution here would be to simply rename it in "Summary and Discussion" and if possible add some more sentences stating precisily the consequences of your results, agreement/disagreement with previous studies and/or future implications.

Additionally, I also compiled a list with technical corrections as follows:

P2, L27: References should be in parenthesis (\citep instead of \citet).
P2, L52: One closing parenthesis is missing (there is one, but it should be two).
P3, L79: space missing (between text and reference of Coupe et al.).
P4, L98: add “the” -> such as the 1991 Mt Pinatubo.
P4, L104: The Zambri et al. reference should be in parenthesis (\citep instead of \citet).
P4, L117: Same here with the references.
P5, L141: “degree” should be replaced by a degree sign.
P5, L141: “more” appears twice, one is obsolete and should be deleted.
P6, L156: spaces are missing after “December” and “January”.
P6, L159: space missing between number and unit.
P6, L160: Something missing here? Should it read “is done with” and is “as for other models”? Generally, the sentence seems to be not entirely grammatically correct. Please check.
P6, L173: add “the” -> the VolMIP protocol.
P6, L179: add/remove space around “=” so that spaces are used equally and use a mathematical “-“.
P8, L199: “…..and report and p-value…..” -> check sentence, something is wrong here.

P9, Figure 2 caption: Monthly -> monthly, Index -> index
P10, L239: something missing here? Significant? Should it read statistically significant? Otherwise it should read “statistic signal”.
P10, L242: Add comma before and after “however” and add “do” so that it reads “we do not do that…..”.
P10, L243: Second closing parenthesis missing.
P11, Figure 3 caption: 12:14 -> 12-14?
P11, L267: Temperature -> temperature
P12, Figure 3 caption: Equator-to-pole -> equator-to-pole and remove space between latitude and degree sign.
P12, L268: and -> an?
P12, L270ff: check appearance of degree sign. Either there is a space obsolete or it is written as “degree” instead of a sign.
P14, L301: …..conditions trend towards….. -> should it read “…..conditions have a trend towards…”
P15, Figure 7 caption: Boreal Winter Warming in small letters -> boreal winter warming.
P17, L373: Sentence incomplete?
P17, L379: What are “NINT aerosols”? For what is the abbreviation NINT standing for?
P18, L396: an -> a

Best regards, Farahnaz Khosrawi