

## Paper Title:

ClimeApp: Data processing tool for monthly, global climate data from the ModE-RA paleo-reanalysis, 1422 to 2008 CE

### Response to Report #1 and action taken:

(Comment / Response and action taken)

*Dear authors of the manuscript "ClimeApp: Data processing tool for monthly, global climate data from the ModE-RA paleo-reanalysis, 1422 to 2008 CE", I appreciate the substantial effort put into revising this manuscript. The current version is clearer and emphasizes the influence of the Tambora volcanic eruption effectively. However, I still have concerns about the scientific significance. Therefore, I suggest that the manuscript be accepted for publication after minor revisions.*

Thankyou very much for your comments and suggestions. We hope we have addressed each point, as shown below:

#### Main Comments:

1. *I recommend including at least one new finding or result regarding the Tambora volcanic eruption to highlight its scientific significance. For example, explain how to understand the warming after the Tambora volcanic eruption, which is not consistent with the simulated results.*

Accepted. We have added in a more detailed analysis of the possible non-volcanic temperature changes in 1816, supported by additional sea level pressure and 500 hPa geopotential height plots in the supplementary material.

See Section 4.1., lines 212-216, Section 4.3, lines 291-293, and Section 6, lines 383-385 in the revised track-changes document and Appendix C in the revised supplementary material.

2. *The ModE-Sim simulation does not consider the atmosphere-ocean coupling, which should be mentioned, since this may have a systematic error.*

Accepted. See Section 2.1, lines 70-73 in the revised track-changes document.

You are correct that there is no two-way coupling in the model, but volcanic signals may be implicitly (partly) contained in the SST forcing.

3. *Add a section in the discussion to explain the Tambora eruption for interdisciplinary research.*

Accepted. See Section 4, lines 186-196 in the revised track-changes document.

As mentioned in the introduction, the Tambora eruption is indeed a prime example for interdisciplinary research. This has been now better highlighted also in the main body

as scientists from all disciplines (such as history, climatology, aerosol science, geology, epidemiology collaborated to fully comprehend its mechanisms and impacts. This development has its roots already in the 19<sup>th</sup> century.

*Specific Comments:*

*1. Regarding the difference between ModE-RA and ModE-RAclim, can it be considered online assimilation or offline assimilation?*

Both can be considered offline, i.e. the simulations are run completely separated from the assimilation. The difference is prior/model ensemble before the assimilation is conducted. In ModE-RA this prior are transient model simulations, which are in agreement with external forcings. In case of ModE-RAclim the prior are random years and ensemble members, i.e. just physically plausible climate patterns but not necessarily in agreement with external forcings.

We have updated Section 2.3, line 97 in the revised track-changes document to hopefully make this clear.

*2. In the introduction, could you briefly outline the current issues faced in the study of Tambora volcanic activity, such as the lack of comprehensive interdisciplinary research?*

Accepted. See Section 1, lines 31-39 in the revised track-changes document.

There is an emphasis in the recent research for the necessity of interdisciplinary approaches looking at the impacts of the Tambora eruption. This has been highlighted in the introduction.

*3. Line 57: What is the specific meaning of "sea ice acting"?*

This refers to the fact that sea ice (and the sea surface temperatures) are used as boundary conditions for the simulations. We have edited this slightly to make this clearer – see Section 2.1, line 65 in the revised track-changes document.

*4. How do you distinguish the seasonal features using most of the proxy records with annual resolution?*

In the earlier period, where annual proxies dominate the input data source, the model fields are only updated/corrected in the site specific season, which each proxy represents (e.g. Alpine tree-ring width could best represent JJAS temperature). Details are described in Valler et al. 2024. Fortunately, at the time of the Tambora eruption there are many monthly resolved observations in Europe, so the reanalysis does not rely solely on these proxies

*5. Line 183: Specify that it is for summer (June to August, JJA).*

Accepted. See Section 4.1, line 204 in the revised track-changes document.

*6. Lines 219-220: A figure of direct comparison is a good idea to show the consistency between the results and previous reconstructions.*

Unfortunately, we were not able to include the original figures from Wegmann et al., 2014 or Brönnimann, 2015. However, we have now directly referenced the original figures to allow for easier comparison.

See Section 4.1, lines 249-252 in the revised track-changes document.

*7. Figure 8c: I am curious about what leads to the positive pattern.*

We believe this may be due to additional internal variation, not related to the volcanic eruption.

See Section 4.1, lines 216-222 and Section 4.3, lines 291-293 in the revised track-changes document for an updated explanation.

*8. Line 298: "though however" is not appropriate.*

Accepted. This now reads "however" - see Section 5.1, line 332 in the revised track-changes document.

*9. Line 309: "very latest reanalysis data in Climate Explorer" is not true.*

Accepted. We have edited this to only the ModE-RA data - see Section 5.1, line 343 in the revised track-changes document.

*10. In the conclusion, explain the new information about the Tambora volcanic eruption and highlight the significance of this APP for scientific research.*

Accepted. We have updated the conclusion to highlight the significance of the app and the case study, see Section 6, lines 380-388 in the revised track-changes document.