

Paper Title:

ClimeApp: Opening Doors to the Past Global Climate. New Data Processing Tool for the ModE-RA Climate Reanalysis

Action taken in response to reviewer comment RC1:

(Comment / Action)

Summary: The manuscript presents software to access data sets that may be interesting for researchers of the paleoclimate of the past centuries. This data set comprises three 'reconstructions' of seasonal climate fields based on climate simulations and an off-line assimilation scheme that merged the output of these simulations with natural proxies and long instrumental records.

Recommendation: I have some recommendations to improve the clarity of the text. In some instances, the text is indeed rather unclear, for instance, in the description of the differences between the three different data sets. To really understand these differences, I needed to look up the Valler et al. (2024) paper, and I think that this manuscript should provide enough clear information for the interested reader without the need to look up the original publications. Other than these recommendations, I think that the manuscript and the software are a relevant contribution to palaeoclimate research, and it will facilitate the use of these data sets by other groups.

1) Title: I found the title too 'literary'. This title would be fine for an internet site or a press release, but not really for a research paper. In its present form, it is not informative, and it should include specifications of the time scale, type of tool, and spatial extent of the data. I suggest including ModE-RA Climate Reanalysis, webtool, global, past centuries, and seasonal in the title and keeping the title technical.

Addressed. See lines 1 & 2 in the tracked change document.

2) 'ClimeApp allows access to the ModE-Sim climate simulation, which is the basis of ModE-RA before assimilating early instrumental, documentary and proxy data.'

Actually, ClimeApp allows access to all three data sets. This sentence may confuse the reader.

Addressed. See Abstract, lines 18 – 21 in the tracked change document.

3) 'ModE-Sim is a climate model experiment'

ModE-Sim is not really a climate model experiment, and this terminology can be confusing for an average paleoclimate reader - Please, keep the expected reader in mind (!). ModE-Sim is an ensemble of global climate simulations driven by external forcings.

Addressed. See Section 2.1, line 70 in the tracked change document.

4) *Originally designed to form the physical basis for ModE-RA,*

This sentence may be unclear to the average reader. Observations also form 'a physical basis', so it can be argued that ModE_Sim and the observations both are the physical basis for ModE-RA

Addressed. See Section 2.1, line 70 in the tracked change document.

5) *'The ModE-Sim ensemble mean used in ClimeApp represents the average over a set of climate states (the "ensemble members") that the model assumes to be realistic given the external forcings and boundary conditions.'*

Consider a clearer version of this sentence, for instance: Each member in the ModE-Sim ensemble represents a possible climate state that is compatible (from the model's perspective) with the external forcing). The ensemble mean is the average over all ensemble members.

Addressed. See Section 2.1, lines 75-77 in the tracked change document.

6) *'Averaging reduces temporal variability in the ensemble mean, compared with observations, but retains and highlights signals caused by variations in the forcings and boundary conditions, e.g. the climate's reaction to a volcanic eruption.'*

Averaging over the ensemble members also reduces the spatial variability, not only the temporal variability. The original sentence is, in my opinion, correct, but it may mislead the reader. Also, consider replacing boundary conditions by specifying SST and sea-ice. This will help the average paleoclimatologist.

Addressed. See Section 2.1, lines 79-81 in the tracked change document.

7) *'ModE-RA it can also help climatologists identify how observations affect the final reanalysis.'*

This sentence, and actually the description of ModE-Clim is rather cryptic.

Addressed. See Section 2.1, line 92 and Section 2.3, lines 118-124 in the tracked change document.

8) *'with observations increasing exponentially through time. Starting from a few thousand natural proxies and historical documents in the 15th century, by the late 19th century approximately 100000 mostly instrumental measurements are assimilated each year.'*

Exponentially? I do not think this is the case. Probably, the authors mean increasing very rapidly - until they reach saturation.

Addressed. See Section 2.2, lines 100-102 in the tracked change document.

9) *'this allows accurate reconstruction of the autumn, winter and spring seasons, in addition to the widespread tree-ring based summer reconstructions.'*

In principle, the setup allows for a seasonal reconstruction. Whether or not the reconstruction is accurate is another matter.

Addressed. See Section 2.2, lines 105-108 in the tracked change document.

10) ' The current resolution for ModE-RA is 1.875° (longitude) by 1.865° (latitude)'

spatial horizontal resolution

Addressed. See Section 2.2, lines 113-114 in the tracked change document.

11) ' This means that in ModE-RAclim, the externally forced signal in the model simulations is removed from the ensemble and only added back if it appears in the observations. '

As noted before, I found the description of Mod-E-RAclim rather confusing, and I needed to go back to the original paper by Valler et al. to really understand the difference. If I am not mistaken, the difference between ModE-RA and ModE-RAclim is the construction of the prior. For ModE-RA, the prior is constructed from the time-aligned ensemble members of Mod-Sim, i.g. the prior for the year 1800 is constructed from all simulated states for that particular year. For ModE-RAclim the prior is constructed from temporally non-aligned simulated states, e.g. the prior for 1800 includes all years of the ensemble ModE-Sim, regardless of the simulated year. Is my interpretation correct? If so, please spare a few lines to describe it more clearly. If not, please consider describing the ModE-RAclim in a much more detailed manner.

In my interpretation, the model error-covariance (spread) for ModE-RAclim is generally larger than for Mod-RA. For this reason, the impact of assimilating observations in ModE-RAclim is stronger. Please confirm if this is correct.

Addressed. See Section 2.3, lines 118-124 in the tracked change document.

Action taken in response to reviewer comment RC2:

(Comment / Action)

Dear authors of the manuscript titled "ClimeApp: Opening Doors to the Past Global Climate New Data Processing Tool for the ModE-RA Climate Reanalysis", the development of ClimeApp is a significant advancement in making paleoclimate reanalysis data more accessible. The application adeptly bridges climatology with humanities and other non-climatological disciplines, fulfilling a crucial interdisciplinary need. The manuscript commendably elucidates the technical underpinnings and functionalities of ClimeApp, offering a detailed exposition of features such as anomaly mapping, compositing, and statistical analyses. Additionally, the use of the Tambora eruption case study effectively showcases ClimeApp's utility in deriving new insights from historical climate events, thereby demonstrating its practical application and value.

However, the manuscript could be enhanced in the following ways:

Comparative Analysis: A comparative study between ClimeApp and other existing tools in paleoclimate research would enrich the manuscript. Such an analysis should highlight ClimeApp's unique features and advancements, further substantiating its contribution to the field.

Addressed. See section 5.1, lines 369-391 in the tracked change document.

Methodological Detailing: The manuscript could benefit from more detailed explanations in certain sections to enhance reader understanding. Specifically, a more comprehensive description of how ClimeApp differentiates between external forcing and internal variability through its statistical or computational methods would be beneficial.

Addressed. See section 2.1, lines 77-81 and section 2.2, line 109-111 in the tracked change document.

User Experience Documentation: While the paper provides an in-depth description of ClimeApp's interface functionalities, it lacks empirical data from user feedback or usability studies. Including findings from beta testing or initial user interactions would lend credence to the claims regarding the app's user-friendliness and effectiveness.

Partially addressed. See Appendix 4, lines 491-499 in the tracked change document.

Future Development Roadmap: The discussion regarding future enhancements and the expansion potential of ClimeApp is intriguing yet lacks specificity. Detailing forthcoming features, enhancements, and a clear development roadmap, particularly concerning scalability issues like handling larger datasets or increased user traffic, would provide a clearer picture of the app's growth prospects.

Addressed. See Appendix 3, lines 487-489 in the tracked change document.