**Climate
of the Past**

Open Access

Discussions

# *Interactive comment on* "Continental-scale temperature variability in PMIP3 simulations and PAGES 2k regional temperature reconstructions over the past millennium" *by* PAGES2k-PMIP3 group

**SJ Phipps (Referee)**

s.phipps@unsw.edu.au

Received and published: 2 August 2015

## Overview

This manuscript is a product of the joint PAGES2k-PMIP3 workshop held in Madrid in November 2013. It makes use of the PAGES2k Consortium continental-scale temperature reconstructions and a suite of transient climate model simulations of the last millennium, particularly those conducted according to the CMIP5/PMIP3 protocol. This dataset is used to fulfil three aims: to assess the consistency between the model sim-

ulations and the reconstructions; to investigate the links between different regions; and to assess the role of external forcings in driving reconstructed temperature changes. A range of state-of-the-art statistical methods is employed.

In the Northern Hemisphere, there is reasonable agreement between the models and the reconstructions. External forcings are found to be important in driving temperature changes. In the Southern Hemisphere, however, the models appear to over-estimate the response to external forcings relative to the reconstructions. As a result, the model simulations exhibit a greater degree of spatial coherence than the reconstructions.

Overall, the manuscript represents an impressive body of work. The analysis is thorough, and the presentation of the results is clear. By comprehensively comparing a multi-model ensemble with a suite of reconstructions at the continental scale, the manuscript represents a significant advance in our understanding of the climate of the last millennium. I concur with the statement by the authors that "our results for the Northern Hemisphere suggest a convergence of our understanding of climate variability over the past 1000 years, but there remain many open questions for the Southern Hemisphere". The manuscript is entirely suitable for publication in Climate of the Past, and I recommend that it be published subject to the following comments being taken into consideration.

In the interests of transparency, I wish to state that I was one of the participants in the PAGES2k-PMIP3 workshop. I saw some early versions of this manuscript, as these were distributed to the workshop participants. However, I did not make any contribution towards the writing or development of the manuscript, and therefore I do not see any reason why I should not act as a referee.

**General comments**

1. Length

The manuscript is relatively long: 73 pages (in the discussion format) plus a 28-page supplement. Generally, this length is justified by the scope of the manuscript. However, I feel that the clarity of the text could be improved by tightening it in places, particularly in Sections 1 and 3. I would therefore encourage the authors to edit the text for length.

In specific regard to Section 3, which is currently nine pages long, I feel that much of this information could be transferred to the Supplement. Rather than providing extensive descriptions of each technique in the main text, I suggest that Section 3 could be restricted to 1-2 paragraph summaries that briefly summarise each technique and the motivation for using it. The interested reader could then consult the Supplement for more detailed information.

The manuscript also contains some excessively long paragraphs. This can impede readability, particularly as the longer paragraphs can lack a sharp focus. As an example, the paragraph that runs from line 9 on page 2490 to line 4 on page 2491 discusses the Southern Hemisphere, modes of climate variability, inter-hemispheric linkages and finally the Northern Hemisphere. I am afraid that the point that this paragraph is trying to make is unclear to me, and I feel that much of it could simply be removed. The manuscript would benefit from abbreviating longer paragraphs such as these, or from breaking them up into multiple shorter and more focussed paragraphs.

2. PMIP3 versus non-PMIP3 simulations

The title and abstract of the manuscript states that it studies the PMIP3 simulations, and they are referenced as such throughout the text. The value of protocols such as

that developed by PMIP3 is that they enable the inter-comparison of model simulations driven by consistent external forcings. However, the selection criteria outlined in Section 2.2 differ somewhat from the PMIP3 protocol. In particular, orbital forcing is not applied as a selection criterion despite the fact that it is required by the PMIP3 protocol and can be an important forcing on the continental scales studied by the manuscript. Non-PMIP3 solar reconstructions are also permitted (particularly CESM1, which uses a solar forcing timeseries in which the amplitude of variations has been artificially doubled). While there is considerable uncertainty in reconstructions of solar forcing, this nonetheless strikes me as undesirable. Furthermore, some of the PMIP3 simulations that do meet the stated criteria are excluded from the manuscript.

The authors should provide further justification for their specific selection of models, including: (i) why they did not simply select models on the basis that they follow the PMIP3 protocol; (ii) why some of the PMIP3 simulations were excluded; and (iii) why the CESM1 and COSMOS simulations were included, but not other non-PMIP3 simulations such as those studied by Fernandez-Donado et al. (2013). In regard to (ii), I believe that there were valid technical reasons for this, such as excessive drift, incorrect application of forcings, or deviations from the PMIP3 protocol; this should be explicitly stated. If the authors wish to retain the non-PMIP3 simulations, they should also make appropriate changes to the text (for example, removing "PMIP3" from the title and refraining from referring to the simulations as "PMIP3 simulations").

**Specific comments**

P2486, L20-23: This sentence could also acknowledge that, because of computational constraints, models have limited spatial resolution and are deliberately incomplete (i.e. they can omit known processes, such as the carbon cycle or atmospheric chemistry).

P2488, L2: I think "cannot be explained by" should simply be "is due to" or similar; also,

remove "changes in", as "forcing" already refers to a change in boundary conditions.

P2488, L3-5: This sentence blends two distinct issues, and could distinguish more clearly between them: the fidelity of the representation of internal variability within a model, and the specific instance of internal variability within an individual simulation.

P2489, L1-2: Also PAGES 2k Consortium (2013).

P2493, L15: Please clarify what is meant by "They": procedures, uncertainties?

P2494, L13: The variable name "tas" is enforced by the Climate Model Output Rewriter, but the name was chosen by CMIP5.

P2494, L24-26: I'm not sure if this is strictly correct: when studying power spectra, for example, stochastic internal variability would not prevent perfect data-model agreement.

P2495, L1-6: It would be helpful if the authors could more clearly link the specific combination of methods chosen to the three aims of the manuscript.

P2496, L18-22: This sentence is unclear to me; please clarify. Section 3.1: Further to my comment on Section 3 above, this section is a good example of where a concise 1-2 paragraph summary would be better suited to most readers than an extended technical description. Most of this text could happily be transferred to the Supplement.

P2499, L14: Is this the correct reference? And, if so, why was this reconstruction used and not one or more of the reconstructions that were used to drive the models?

P2504, L5-6: This is not a genuine like-for-like comparison, as some of the reconstructions are land/ocean and some are land-only.

P2510, L16-17: "very high" is a value judgement; very high relative to what? It would be better to use a more neutral statement such as "higher than +0.5".

P2510, L27-P2511, L1: What is the basis for this statement? Visually, the correlations

for the full period appear to be only slightly higher than for the pre-industrial period. This suggests that forced variations during the pre-industrial period are the dominant explanation of the strong correlations.

Section 6.1: (i) I have doubts regarding the methodology used to convert the volcanic reconstructions into timeseries of radiative forcing. The authors apply an established scaling factor of -20 Wm$^{-2}$ to convert aerosol optical depth into radiative forcing. However, I believe that this scaling factor is only valid for global means. Regionally, the appropriate scaling factor will depend upon the shortwave radiative fluxes; a given aerosol optical depth will scatter a given fraction of shortwave radiation, but this will equate to a greater radiative forcing in the tropics than at the poles. I can see no obvious solution to this, and I suggest that the radiative forcing data simply be removed from this section. This would not prevent the data-model comparison, which does not depend upon the radiative forcings anyway. (ii) When comparing the regions, the authors should comment on the fact that some of the reconstructions are land/ocean and some are land-only. For example, Europe and Asia, which have the strongest volcanic responses, are land-only reconstructions.

P2523, L20-27: Agreed! From this perspective, it would be helpful if the manuscript could document the implementation of volcanic forcing within each model e.g. in Table 1 or Supplementary Table S1.

**Minor edits**

P2484, L9: Insert "the" before "time".

P2484, L16: latitudes -> latitude.

P2485, L3: Remove "the".

P2485, L4: Constraints on, and uncertainties in, external . . .

P2485, L9: places -> place.

P2486, L5: "observing" -> "evaluating" or similar?

P2486, L14: "univocal" -> "unequivocal".

P2486, L24: Remove "also" before "not"; insert "either" after "understood".

P2490, L6: Insert "that" before "there".

P2490, L8: "2014" -> "2013".

P2491, L8: Insert "the" before "PAGES".

P2495, L2: "as" -> "to".

P2495, L13: Insert "by the fact that" after "and".

P2495, L25: "exchangable" -> "statistically interchangeable".

P2496, L12-13: Insert "the" before "simulation" and "target".

P2496, L14: "too" -> "excessively".

P2497, L2: "exchangeability" -> "interchangeability"?

P2499, L1: "Untermann" -> "Unterman".

P2500, L3: Insert "a" before "tool".

P2501, L10: "in" -> "over".

P2502, L16: Remove one of the instances of "relative".

P2504, L4: "estimating" -> "calculating"?

P2504, L5: "control runs" -> "pre-industrial control simulations".

P2504, L12: Insert "the" before "CESM".

P2504, L15: "but" -> "and".

Interactive
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

P2504, L19: Insert "than the models" after "variability".

P2510, L20: Remove "already".

P2510, L22: "do" -> "does".

P2514, L19: "Unternman" -> "Unterman".

P2515, L22: "done" -> "performed".

P2516, L29: Remove "ensembles"?

P2517, L19: "hamming" -> "Hamming".

P2519, L8: "constrains" -> "constraints".

P2521, L4: Insert "the" before "regional".

P2521, L7: Insert "the" before "continental".

P2523, L3: "yield" -> "yields a".

P2523, L5: Insert "the" before "hemispheric".

P2525, L23: Insert "the" before "continental".

P2526, L2: Insert "a" before "significant".

P2526, L17: Insert "the" before "basis".

P2546, figure caption: Insert "the" before "full length".

Supp P1, L40: "Untermann" -> "Unterman".

Interactive comment on Clim. Past Discuss., 11, 2483, 2015.