

## **Summary:**

The authors use 7 PMIP3 simulations to investigate the ENSO teleconnection to the Indian Summer Monsoon during the Last Millennium. The Author use the present day period to evaluate the model simulations and compare their results to some of the existing proxy reconstructions. The authors claim that during the Medieval Climate Anomaly the frequency of El Nino events is enhanced whereas during the Little Ice Age La Nina events occur more frequently. Then, they discuss some non-linearity which is unfortunately not presented in an understandable way.

## **Overall judgment**

I see that the authors put a lot of effort to analyze PMIP3 simulations. However, the way how the results are presented and even more importantly the questionable content leads to the manuscript lacks a clear structure; the phrasing is inadequate, preventing the reader to understand the content. Furthermore, the main result of the study, that during the Medieval Climate Anomaly (MCA) the frequency of El Nino events is enhanced whereas during the Little Ice Age (LIA) La Nina events occur more frequently is questionable as detailed below. So, I recommend to reject the manuscript from publication in *Climate of the Past*.

## **Response:**

Dear Reviewer, we are grateful for noticing our efforts. The manuscript has gone through several revisions in light of comments from DR. Bothe, the first reviewer, and DR. Wenmin Man (who reviewed an earlier version, and the editor. We greatly appreciate your time in perusing our manuscript, and for the constructive comments. Considering these, and those from reviewer and the Editor, we will carefully revise the manuscript. In fact, as the comments from the reviewer 1, DR. Bothe, arrived a few weeks earlier, we have carefully revised the manuscript, among other things, for better clarity and understanding as also suggested by him. We shall also incorporate the suggestions from you soon, and now hopefully, the revised version would meet your requirements, and the standard of the *Climates of the Past*.

## **General Comments**

### **Comment GC1:**

I. The manuscript needs a serious proof reading by a native speaker.

## **Response:**

Thank you. This suggestion will be carefully implemented.

### **Comment GC2:**

II. The structure of the manuscript is not clear, e. g., section 3.4 contains again an evaluation part. Presenting ‘preliminary results’ in a manuscript makes no sense, either the results are solid and necessary or not (then they shall not be presented). The authors made no clear selection of figures. It looks like the ‘randomly’ selected eight figures (+5 tables) in the main part and put the rest of the analysis made in the appendix (which is 15 figures and 4 tables).

**Response:**

We are sorry for the confusion, which arose only due to the wrongly-formed title for the subsection 3.4. The results reported in this subsection are not preliminary at all. The section 3.4 contains dynamics such as large-scale convergence/divergence patterns and exploration of Land-Sea thermal gradient. To avoid confusion, we remove the words “preliminary analysis” from the title of sub-section 3.4.

We have already received a similar suggestion from DR. Bothe. Accordingly, we plan to move the relevant figures into the main text, and the supplemental information now only contains only 6 Figures and 5 Tables.

**Comment GC3:**

III. The manuscript builds on one main finding, namely an increase of El Niño events during MCA and an increase of La Niña events during LIA. The authors ignore the fact that they use the NINO3.4 index which by definition varies a bit with the global mean signal. Thus, if the global mean temperature due to external forcing is increase the Nino3.4 index will certainly be biased positive and lead to or El Niños (although the cause is a global signal and not a real change in ENSO). The authors already show in their results that ENSO is NOT changing from the MCA to the LIA as the standard deviation during the periods is the same (see page 10).

**Response:**

Thank you. we find that a majority of the PMIP3 models in this study indicate more El Niños as compared to the La Niñas during the MWP (and relatively less number less number of El Niños as compared to the La Niñas during LIA). This is notwithstanding the relatively unchanging standard deviation of the NINO3.4 index across the LIA & MWP (as shown Tables A2 and A4 of the submitted manuscript for discussion round).

We agree that the mean background changes in temperatures may modulate the relative strengths of El Niños and La Niñas (e.g. Federov & Philander 2000), thereby introducing a non-linearity in the relative strengths/frequencies of the warm & cold ENSO phases. In the revision, we shall mention this aspect as a possible cause for

more El Niños in MWP.

**Comment GC4:**

IV. All figures are of bad quality.

**Response:**

We have improved the pictures clarity.

**Technical comments**

**Page 1**

**Comment TC1:**

L20-21: Unclear sentence

**Response**

Revised the sentence for clarity.

**Comment TC2:**

L22-28: Awkward and unclear statements.

**Response:**

We modified the statements. Modified statements now it reads as “Interestingly, the percentage of the simulated strong El Niños associated with negative ISMR anomalies is higher in the LIA. Also, the percentage of strong La Niñas associated with positive ISMR anomalies is higher in the MWP. This nonlinearity is apparently important for the relatively higher ISMR during the MWP. Further, distribution of simulated anomalous boreal summer velocity potential at 850 hPa during MWP in models indicates a zone of anomalous convergence in the central tropical Pacific flanked by two zones of divergence. This suggests a westward shift in the Walker circulation as compared to the mean pattern of the 850 hPa convergence and divergence. The simulated 850 hPa walker circulation during the MWP is also prominent relative to the corresponding historical simulations.”

**Comment TC3:**

L28: divergence center of what??

**Response:**

Divergence center of anomalous 850 hPa circulation calculated using the zonal and meridional winds

**Comment TC4:**

L29: convergence of what??

**Response:**

Convergence center of anomalous 850 hPa circulation calculated using the zonal and meridional winds

**Comment TC5:**

L30: Connection between the two parts separated by a semicolon is not given.

**Response:**

Thanks. A semi-colon has been replaced by a period.

**Page 2:**

**Comment TC6:**

L6: IPCC (2013) is not an adequate reference here, please use more specific references

**Response:**

Thank you. In addition to the IPCC, we also cite the PAGES 2k Consortium (2013).

**Comment TC7:**

L7-9: Unclear statement

**Response:**

We modified the statement.

**Comment TC8:**

L11-15: Missing references of definition of time periods of MWP and LIA also for the variation of the periods you need to give references.

**Response:**

We modified the text. Now it reads as “Paleo-data based studies identify two

significant periods in the last millennium (LM), i.e. Common Era (CE) 0850-1849, prior to when the instrumental observations started. These two periods are, (i) a relatively warmer period known in literature as the 'Medieval Warm Period' (MWP, CE 950-1350), roughly followed by (ii) a relatively cooler period, the Little Ice Age (LIA, CE 1500-1850) (e.g. Lamb et al, 1965; Grove et al, 1988; Graham et al, 2010; Mann et al, 2009)."

**Comment TC9:**

L18: Be more specific about the regions you are referring to.

**Response:**

Paleoclimate reconstructions from various well-dated proxy data suggest that during the MWP, some regions experienced temperatures as warm as mid-20<sup>th</sup> century, whereas some others were as warm as the late-20<sup>th</sup> century (e.g. extratropics, southern hemisphere land region; Stockel et al., 2013).

**Comment TC10:**

Paragraph 3: There is no logical connection to the paragraph before

**Response:**

Thank you. The paragraph now reads as "Paleoclimate reconstructions from various well-dated proxy data suggest that during the MWP, some regions experienced temperatures as warm as mid-20th century whereas some others were as warm as the late-20th century (e.g., IPCC 2013, Fleitmann et al., 2007; Borgaonkar et al., 2010; Ponton et al., 2012). As can be seen, these studies do not report the conditions at a regional scale. Particularly, there are no proxy or modelling studies that have reported on the temperature conditions over the Indian subcontinent, which is a major hotspot of climate variability, largely from the perspective of the summer monsoon rainfall."

Now this paragraph connects logically to the next one, which reads as

"The Indian Summer Monsoon Rainfall (ISMR; June-September; JJAS) variability is manifested on intra-annual, interannual, decadal, centennial and millennial to multi-millennial time scales (Ramesh et al., 2010)....."

**Comment TC11:**

L33-34: Awkward sentences, please clarify.

**Response:**

We modified the sentence for better clarity. Now it reads as "Proxy records also

suggest that during the last millennium, ISMR was the higher during the MWP and relatively weaker during the LIA (Yadava et al., 2005)."

I stop here as the entire manuscript is like the first two pages.

These issues have been carefully addressed, thanks to Dr. Bothe, the reviewer 1, who had also kindly given many such suggestions on the complete manuscript.