

## ***Interactive comment on “The origin of the European “Medieval Warm Period”” by H. Goosse et al.***

### **Anonymous Referee #2**

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### Summary

An analysis and comparison of local and regional proxy records and global climate model simulations is presented detailing the long-term evolution and potential forcings of winter and summer temperatures in Europe. Whereas the proxy-derived estimates reveal summer warmth during medieval times were similar to the temperatures recorded in the late 20th century, analysis of model simulations and forcing cocktails indicates that this temperature course largely results from land-use changes and the combined effects of GHG and aerosol forcings. For winter, less warmth is seen at the beginning of the past millennium, and stronger warming towards the end of the 20th century due to GHG forcing.

Overall this is a very interesting analysis compiling recent proxy evidence from Europe and utilizing state-of-the-art techniques to attribute temperature variations on this regional (European) scale. The significance of land-use changes to European summer temperatures seen in the model output is of broad interest. The analysis certainly fits in the scope of 'Climate of the Past' and should be published after some minor revisions mostly related to text/wording changes. These include mentioning the large uncertainty and simplistic estimation of land-use changes over the past millennium, and the uncertainty and limitations of regional model output from global simulations, which I believe should both be stressed in the abstract of the paper (see detailed comments below).

#### Detailed comments

Introduction (p 2, first paragraph, lines 4-5): Cite some attribution studies instead.

Introduction (p 2, first paragraph, line 8): Jones and Mann 2004 is a review paper. I suggest citing papers presenting reconstructions (e.g., Jones 1998, Mann et al. 1999, Esper et al. 2002, D'Arrigo et al. 2006, etc.).

Introduction (p 2-3, second paragraph): I didn't like this paragraph, and in fact believe that it is somewhat misleading. I suggest replacing "By contrast" with "Similarly" (first line), since most - if not all - large scale reconstructions indicate warmth during medieval times. The uncertainties in both the large scale and European scale reconstructions (Guiot et al.?) are too large for such a conclusion to be used in the introduction, and do not justify referring to "contrasting" trends. Also, referring to a "conundrum" certainly overlooks the current state of knowledge of past temperature variations in Europe and the Northern Hemisphere.

Model and forcing description (p 4-6): Detail potential weaknesses/uncertainties of employing a global model while utilizing regional output (Europe and below). This should also be mentioned in the abstract.

Model and forcing description (p 4, first paragraph): Referring to "T21, 3-level, Ę" is

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certainly not "convenient" for non-modelers as proposed in the previous sentence.

Model and forcing description (p 5, first paragraph): The different sets of forcing time-series should be shown in a figure. Similarly, a plot of the ensemble members together with the ensemble mean should be shown in a figure (albeit the uncertainty range indicated later in the ms and figs). This would greatly improve the understanding of the model component of the study.

Model and forcing description (p 5, second paragraph): The land-use forcing timeseries applied (both the linear record from 1000-1700, as well as the alternative scenario including a stronger crop fraction increase at the beginning of the past millennium) are indeed rather "strong simplifications", and thus require a note in the abstract. The simplicity of this forcing timeseries certainly limits the conclusions detailed in the body of the paper and highlighted in the abstract. This suggestion also holds for the "group H" scenarios.

Selection of best pseudo simulation  $\checkmark$  (p 7, first paragraph): Avoid mixing "European scale" with "large scale". The latter term should be limited to NH records. Luterbacher et al. and Guiot et al. should be introduced as "European" or "continental" or "sub-continental" scale.

Selection of best pseudo simulation  $\checkmark$  (p 7, third paragraph): Include some details on the implications of this selection procedure of best-fit pseudo simulations, and address potential (statistical) consequences of over-fitting model output.

Selection of best pseudo simulation  $\checkmark$  (p 8, second paragraph): "This technique [the best-fit pseudo simulations] is used here to show first that it is possible to find one member of the ensemble that is consistent with the proxy records for any period". This is not really surprising, given that a large number of simulations are available for selection, and considering the short period (1-50 yrs.) utilized in this procedure. Further, avoid the term "reconstruct" when referring to model simulations.

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Selection of best pseudo simulation Ǻ (p 8, third paragraph): Here and later in the ms it is relevant to consider the data overlap between the proxy-based reconstructions (see also next point).

Selection of best pseudo simulation Ǻ (p 8, fourth paragraph): When assessing the proxy network, data overlap between the continental scale and local records (e.g. the inclusion of local records in Luterbacher et al., for example) needs to be considered. Since the winter season Luterbacher et al. data contain a large fraction of documentary data during the first half of the past 500 years, it is not surprising that the correlation for the winter mean is 0.66 (and higher than for summer). Not to mention the inclusion of instrumental data in the more recent periods of both the documentary records and Luterbacher et al.

Climate of the past millennium Ǻ (p 9, third paragraph): "Those model results are in very good agreement with a land area European Ǻ temperature reconstruction Ǻ". This is certainly correct for the best-fit pseudo-simulation. The ensemble mean, however, does not pick up the higher frequency variations.

Climate of the past millennium Ǻ (p 10, second paragraph): When referring to the good agreement between best-fit pseudo simulations and Luterbacher et al., perhaps say that this is an expected result, given the way the pseudo simulations are calculated.

Climate of the past millennium Ǻ (p 11, second paragraph): Re-word and make this more suggestive. Refer to the uncertainty in this forcing (land use changes) and the rather rough estimation over the past millennium.

Climate of the past millennium Ǻ (p 11, third paragraph, lines 6-10): This doesn't sound very logical. It is first stated that solar and volcanic forcings are important in explaining 19th to 20th century differences. It is then stated that this observation supports that GHG are important during the same period. The early period chosen for comparison (1801-1825) includes the Dalton minimum and a series of cold years related to volcanic activity. This should be mentioned.

Climate of the past millennium Ę (p 12, first paragraph, lines 2-3): Here and elsewhere in the ms, I wouldn't necessarily derive such a conclusion from the model simulations, but rather directly from the proxy based reconstructions.

Climate of the past millennium Ę (p 14, first paragraph, lines 3-4): Delete after "and with ourĘ".

Conclusions (p 14-15): In the conclusions, make sure that statements on the long-term course of temperatures are supported by the proxy-based reconstructions. The model applications as detailed in this study are relevant to estimate the forcings of these long-term changes. I also expected some critical evaluation of potential weaknesses and uncertainty in the model approach and forcing timeseries, with particular focus on the simplicity of the land use forcing. Increasing knowledge on past land use changes and derived climatic forcing could potentially alter the conclusions derived here considerably.

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Interactive comment on Clim. Past Discuss., 2, 285, 2006.

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