**Climate
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Discussions

Interactive comment on "Investigating the consistency between proxies and between proxies and models using data assimilation: a mid-Holocene case study" *by* A. Mairesse et al.

Anonymous Referee #1

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This is a useful data-model study about the temperature patterns and their drivers in the northern hemisphere at 6 ka. Although number of data-model papers with focus on 6 ka or the Holocene thermal maximum have been published in the recent past, many of them as part of the PMIP project, the current study is interesting, mostly because it contains a methodological innovation related to the data assimilation and because of the palaeoclimatological insights associated with atmospheric and oceanic circulation at 6 ka. There are, however, many aspects of the paper which require improvements and clarifications.

The modelling part is based on the use of LOVECLIM earth system model of interme-diate complexity, which is run without data assimilation and with data assimilation, the

latter run constrained to follow the results of 50 continental and oceanic temperature reconstructions. In addition, three model runs for 6 ka with different general circulation models are included for comparison. The data is based in total on 50 records, which is of course a very low number given the hemispheric scope of the study.

My main comments:

1 LOVECLIM model with data assimilation is one of the more novel aspects of the paper. The authors write on page 3965 that although some improvement is obtained in proxy-model comparison due to data assimilation, it is not expected to have a model state which displays values fully consistent with proxy records. I am not a specialist in data assimilation issues, but is it not natural that the data-model consistency increases if you force the model with the data and why is it not possible to force the model to be fully consistent with the data? There probably is an explanation for this, but I failed to fully comprehend it with the way it is described in the paper.

2 The second major issue is the proxy dataset. The authors write that "the proxy dataset used in the simulations with data assimilation results from a selection among more than 300 Holocene records..." and later on, that "on the basis of these criteria, we have selected 50 records". A critical question is how did the authors end up with only 50 records for the whole northern hemisphere and why where these records selected and so many excluded, including many which would fulfill the criteria given in the text? Why are so few continental records used from North America and northern Europe compared to, for example, the 6 ka dataset used in Bartlein et al. 2011 paper? Why so few marine records from the Atlantic and the Pacific? Why only Agassiz and Renland ice core 18O records, but not the 18O records of the other Greenland ice cores and why not the direct temperature records from the GRIP ice core based on 18O data and borehole temperature measurements? Why is only one speleothem 18O record used from Europe, where the real number of Holocene time-series speleothem records is probably over 10 these days?

3 Another proxy-related issue is the nature of the records. First, the way to authors use the term "proxy" is wrong. The term "proxy" refers to any biological, physical or chemical type evidence that provide indirect palaeoclimate data. "Proxy" does not mean an individual palaeoclimatic record. It is therefore misleading to write in the abstract that "...the comparison of the LOVECLIM simulations with and without data assimilation has also objectively identified 16 proxies whose reconstructed signal is either incompatible..." A correct way would be to write that "...has also objectively identified 16 proxy-based palaeoclimate records whose reconstructed signal is either incompatible..." There is a fundamental difference of meaning.

4 In many reconstructions the climate parameter is annual temperature. But the models simulate winter and summer temperatures. How were the annual mean temperature records handled in the data-model comparisons?

5 It is understandable that the quantitative temperature data from biological proxies are suitable for this type of data-model comparison, but what needs to be explained is how the non-quantitative climate records, such as the Greenland ice core 18O data or the speleothem 18O data were used for this comparison?

6 The title of the paper is misleading because in reality there is no investigation of consistency between proxies in the paper. And it is good that it does not exist, because it would require a more complete and extensive proxy dataset.

Minor specific comments and technical corrections:

Page 3954 line 9: "...pattern but the models underestimate..." Page 3954 line 14 "all the 50 proxy records..." Page 3958 line 6: why is the mid-Holocene period 5500-5000 y BP here, but 6000±500 y BP elsewhere in the study? Page 3956 lines 20-24: this paragraph is unnecessary Page 3964 lines 1-5: this should be in the methods Page 3969 line 26: Gulf Stream

Figures are in principle good and informative, but too small.

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