Clim. Past Discuss., 5, C851–C854, 2009
www.clim-past-discuss.net/5/C851/2009/

Climate of the Past Discussions

Interactive comment on "Northern high-latitude climate change between the mid and late Holocene – Part 2: Model-data comparisons" *by* Q. Zhang et al.

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Received and published: 23 October 2009

We would like to thank very much the first reviewer for his/her suggestions on inputting additional discussions and comparisons with the previous model-data comparison over Europe and high latitudes. We have mentioned and cited those works in our manuscript but have not given a sufficient comparison and discussion. We accepted these suggestions and will improve our manuscript following the major and minor comments.

Major comments

1.Our motivation on this model-data comparison is to use as much data as possible from the published proxy archives and available model data. This will help to establish a spatial pattern that can be directly compared with the model patterns of climate response to forcing. The advantage of this comparison offers an opportunity to evaluate the physical reliability of the reconstructions from different proxy on one hand. The application of the multi-proxy data provide more rigorous estimate than a single proxy approach, and the multi-proxy approach may help to identify possible seasonal biases in the estimates. As shown in Part I, the temperature reconstructions in the presented work are mainly from pollen data, as this is the most abundant proxy type for the time period studied here. The reconstructions from the other proxies will provide complementary information to that from pollen data, and hence serve as complementary validation data.

2.Most of the temperature reconstructions we used in this paper are from bioclimatic proxies such as pollen, and this type of proxy main provides information of climate in summer. Even if an individual proxy type may theoretically perhaps be more affected by indices such as growing degree days, it is a fact that the target for calibration chosen by the original proxy data investigators has often been seasonal mean temperatures. We have chosen to study seasonal mean temperatures to make it possible to obtain and compare a large number of proxy series. If we had chosen to study different target climate indices for different proxies, then it would have not been possible include as many proxy series in the analysis and this would have made the model-data comparison being based on much fewer data. It may be that studies of more 'optimal' calibration targets for different proxies could increase signal-to-noise ratios, but such a study has been beyond our scope. Our choice instead has the advantage of doing model-data comparisons of temperatures in both summer and winter. However, since few data are available outside the summer season, especially in winter, it is hard to get a whole picture of climate response. For example, the change in annual mean temperature in proxy reconstructions is not equivalent to the average for summer and winter temperature, even higher than the summer temperature in our case. While the monthly mean results from climate model can explain why this happens, because of the feedback in the climate system, the dramatic response in autumn could show a larger response in annual mean temperature. Therefore, model variables can help us to clarify the nature of the climate signals seen in proxy data.

3.Please refer to reply to first comment by Eduardo Zorita.

4.Thanks for pointing out that the model uncertainties should be included in weight factor of the cost function. Here it should be noted that our topic is on 100-year mean comparison which representing the centennial time scale. The model uncertainties at centennial time scale could be obtained by several 100-year ensemble simulations under the same boundary conditions, however, this is not available in PMIP2 database. We notice that in the PMIP2 database there are 50-years simulations and 100-year simulations have been done by MRI. The comparisons between this two "ensemble" show that the variance for annual mean temperature between 100-year simulation and 50-year simulation is 0.0036K. Comparing to the uncertainties in reconstructions, the uncertainties in the model could be neglected. This simple test results are included in the revised version of the manuscript to clarify why the model uncertainties are not considered in the cost function.

5.Thanks for this suggestion. The comparison with the other similar model-data comparison work, as well as the possible mechanism as replied to second comment by Eduardo Zorita, will be included in the revised version of the manuscript.

6.Our original intention with combining the cost functions for summer, winter and annual mean into one number was in attempt to find the best model(s) showing good match with reconstructions in all parts of the year. We agree with the reviewer that this method is not appropriate here since the annual mean temperature is not independent of summer and winter, particularly in reconstructions. As this combination is somewhat confusing, in the revised manuscript we have removed the black curve in Fig.5. Here we thank the reviewer's suggestion on the test of cost function for the zero change in

model. It means that model has no sensitivity to orbital forcing at all. One can speculate that the cost function would be very high since the model has no response. The results are not out of our expectation. In the case of Tmod=0, the cost functions are high both in summer, winter and annual. However, there are a few models show a bit higher CF than this zero change CF, two models are not good in summer, three models are not good in winter and one model is not good in annual. This test has been included in the revised manuscript.

7.The reviewer is right on this point. The cost function for the OA ensemble and OAV ensemble shows that the OAV is better than OA simulations, this may partly due to that more OA simulations than OAV simulations (13 vs. 5). If we only compare cost functions for the five OAV simulations with their OA versions, there is no significant difference. Take into account summer, winter and annual together, three OAV simulations are better than their OAV versions, two OAV simulations are worse than their OAV versions. Therefore, in the current comparison, it is hard to conclude that OAV models are overall better than OA models. In the revised manuscript we have selected the OA models to discuss the mechanism of the climate response, in order to focus on the response of atmosphere and ocean, but not mix with the response of the vegetation which is uncertain in current comparison.

Minor revision

We have followed the three minor revision suggestions and modified the text in the manuscript. We have used the latest PMIP2 database in version of 09-30-2008.

Interactive comment on Clim. Past Discuss., 5, 1659, 2009.