Review of the article "Deciphering the spatio-temporal complexity of climate change of the last deglaciation: a model analysis"
by D. M. Roche, H. Renssen, D. Paillard
Clim. Past Discuss. 6, 2593-2623, 2010

This manuscript is interesting and valuable addition to debate of climatic trend detection, leads and lags, and on inference of simulation results. It is strongly focused on simulation results, and call for validation by proxy records. As the study was already expansive, it is reasonable to do this in another study. However, referring to this validation should be more clear.

Scientific significance: good

Scientific quality: good

Presentation quality: good

Does the paper address relevant scientific questions within the scope of CP?
yes

Does the paper present novel concepts, ideas, tools, or data?
Yes (with minor improvements and clarifications)

Are substantial conclusions reached?
Yes, with clarifications

Are the scientific methods and assumptions valid and clearly outlined?
yes (with some minor improvements suggested)

Are the results sufficient to support the interpretations and conclusions?
The model results and statistical tests are sufficient, extended discussion might be needed regarding the interpretation (see below).

Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?
yes

Do the authors give proper credit to related work and clearly indicate their own new/original contribution?
yes (few citations suggested below)

Does the title clearly reflect the contents of the paper?
yes

Does the abstract provide a concise and complete summary?
yes

Is the overall presentation well structured and clear?
yes

Is the language fluent and precise?
yes

Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?
yes

Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?
Yes, clarified, see below.

Are the number and quality of references appropriate?
yes

Is the amount and quality of supplementary material appropriate? NA

Individual comments:

Abstract:

1 Introduction:

The introduction explains the sequence and factors of deglaciation. However, some studies suggest that a glacial termination materializes because Earth's climate system passes a critical threshold (S. Barker et al., Nature 457, 1097 (2009); F. Lamy et al., Earth Planet. Sci. Lett. 259, 400 (2007); E. W. Wolff, H. Fischer, R. Rothlisberger, Nat. Geosci. 2,206 (2009)). Also consider that it is theoretically possible that a particular set of boundary conditions may not give rise to a unique climate state (Lorentz, 1968, 1970, 1976). Please include this in the introduction.

Lines 41-46 should be rephrased, to introduce the concept that this is study of simulation model results, not a modeling study. A modeling study would involve implementing either new mathematical descriptions or new numerical models for the physical processes they describe.

2.1 Model description

Please expand on the differences compared to other intermediate complexity ES models. Stress what are the strong points and the weak points in comparison to these other models.

2.2 Deglaciation forcing

Lines 86-99: As the authors are using ice5gv1.2 ice sheet evaluation, the exact method how this is incorporated, how is the interpolation done etc. should be mentioned. How is the difference between ice thicknesses given at two consecutive heights assumed to melt? As the authors state, it is not obvious how the changes should be taken into account to conserve mass, momentum and salinity.

Lines 117-118: Please rephrase "theoretical framework ". This study does not bring forth new propositions nor new hypothesis, but to test the reliability and validity of the warming signal in simulation model results.

Lines 119-120: Even if the aim of the study is not in a detailed data-model comparison, it should be considered as the simulation models challenge the question of reliability. We need to know why it is possible to relay on the results derived from the simulations. So at least mention at what data sets one should look at for a comparisons.

3 Analysis Method

Lines 125-126: Please define what the authors mean by first significant warming in reality? Is it a synchronous or asynchronous event? How should this be incorporated in the modeling results testing context?

In lines 126-129: Mention that the control run (constant conditions) is the null hypothesis compared to transient run.

Lines 140-142: As the analysis method is about looking at local starts, how to conceptually get from local starts to global start? Can the study bring more that global average?

How about also including/introducing uncertainty analysis, inference about the simulation model output given uncertainty in simulation model input? Quantitative knowledge of these limits is an important prerequisite for designing the diagnostic procedures and for interpreting results

adequately.

The probability of detection could be defined as the chance for identifying, from one pair of model simulations, a prescribed change. This quantity is equivalent to the power of the statistical test and it depends on the magnitude of the change, the length of the model integrations and the rarity of events under consideration. See for example Frei, C., 2003: Statistical limitations for diagnosing changes in extremes from climate model simulations.

4.1 Results Annual mean

The results analysis pinpoints several interesting responses.

Why not underline the time periods when slow forcing was the main driving force? What can be deduced from those time periods? It would be really interesting to do the simulation results – proxy records comparison for these time periods.

4.2 Seasonal means

Lines 198- 199: the authors state that they are doing the confirmation of previous results. The proponents of simulations as theory-based inferential processes ignore, to some extent the iterative process of reliability. This has been suggested by Boumans (2004) (Boumans, M.: The reliability of an Instrument. Social Epistemology 18(2-3):215-246. The value of model predictions is undermined by their uncertainty, which arises primarily from the fact that our models of complex natural systems are always open (see Oreskes, 2000). Models can never fully specify the systems that they describe, and therefore their predictions are always subject to uncertainties that we cannot fully specify. Moreover, the attempt to make models capture the complexities of natural systems leads to a paradox: the more we strive for realism by incorporating as many as possible of the different processes and parameters that we believe to be operating in the system, the more difficult it is for us to know if our tests of the model are meaningful. Here, one cannot confirm simulation model results inherently: both are products of the same simulation run.

4.3 Precipitation evolution

Lines 216-217: explain why the change in precipitation is the most likely?

Line 225: Define ITCZ.

4.4 Impact of interannual variability

How about looking autocorrelations?

5. Discussion

Lines 310-313: Natural climate is of course one trajectory of many possible solutions, but our reconstruction of the trajectory is uncertain. Simulation model is a heuristic tools to facilitate the study complex phenomena. Even the best models of natural phenomena do not depict it completely. The more complex the model gets, the more difficult it is to test the model. I would drop this analogy statement.

Lines 304-309: Ensemble runs could really open new study possibilities. Even if they would have needed unattainable computer power, what could they reveal? How about replacing temporal samples with ensemble samples? What size?

Discuss computational constraints => what was the constraint? How to get past it?

Lines 328-332: "the readers should not forget" – please do not underestimate the readers, better to either a) compare to other model results or b) state what is plausible/not plausible in the model context.

Do we see seasonal trends?

Discuss the importance of slow forcing factors, are they visible or are abrupt events needed to induce noticeable changes? Discuss how the missing ice sheet component affects comparisons with results and records?

6 CONCLUSIONS

Please clarify based on comment above, what can really be concluded from the simulation results and what cannot? Be specific on uncertainties.

The main conclusions could be substantiated with:

a) First, looking at the areas to react: point out proxies where to look. This could really be an interesting next study!
b) Secondly, consider the passive areas: is there reasonable possibility to deduct lag?

c) Questioning the climate change is here is irrelevant – it should be done in introduction and in analysis methods. There the authors discuss first significant warming, without definition. Define it there, and here state if the definition was good/restrictive/…
d) The valuable and strong point of this work is defining the sample size. In conclusions, do not give self-evident truths (”has to be long enough to be detected against background noise”). State your results, and against what proxies these could be validated.