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Climate of the Past Discussions

Interactive comment on “Numerical reconstructions of the Northern Hemisphere ice sheets through the last glacial-interglacial cycle” *by* S. Charbit et al.

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The PMIP and PMIP II exercises offer a valuable assessment of GCM modelling against observations. This paper fills a gap in this assessment. The authors present a useful and detailed examination of the strong ice-sheet model sensitivities to the intermodel variance of PMIP AGCM results for last glacial maximum. I therefore recommend acceptance of this paper after the minor points are addressed below. I also look forward to the repeat of this study with updated PMIP2/ICE-5G fields.

general comments

The results offer a further indictment of the simplistic del 18O weighting climate index forcing between LGM and present-day climate fields that us glacial modellers have had to rely on for want of something better within available computation resources. This work also identifies the importance of having an accurate ice sheet boundary condition for paleo intercomparions of GCMs. These points could be more clearly spelled out in the introduction and conclusions.

One question that I would like to see addressed is to what extent the LGM ice volume discrepancies are due to the lack of adequate fast flow representation in the ice-sheet model. My own large ensemble modelling (Tarasov and Peltier, 2004) required strong (ie up to 20 km/yr ice velocities) geographically constrained fast flow (due to basal till deformation) to obtain reasonable fits to relative sea level data. Whether this can be addressed in this paper or in future work I would leave to the authors' discretion.

specific/technical comments

abstract: l 13-15: Given the limitations of the climate forcing, and missing processes in the ice-sheet model, this work can only offer a partial "evaluation of the ability of GCMs to simulate climates.."

Introduction:

pg 881, l24-26: One point that the glacio-hydro-isostasy modellers have defacto hidden, is that their models are hand-tuned with no meaningful error bars extractable and therefore no clear concept of the extent to which these models are constrained.

A good example of the impact of under constraint is the difference between the ICE-4G and ICE-5G deglacial chronologies for Greenland. The ICE-5G Greenland chronology was derived on the basis of thermo-mechanical modelling (hand) tuned to fit RSL data (and some other constraints, Tarasov and Peltier, 2002). The Greenland contribution to LGM eustatic sealevel change was reduced by half. It should also be noted, that even if there were adequate RSL data coverage, the trade-off between ice-thickness and timing, still leaves much underconstraint in these types of models that do lack

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ice-sheet physics. These models have no intrinsic glaciological self-consistency nor climatic self-consistency.

In addition to the two stated alternative modelling approaches for reconstructing glacial and deglacial chronologies, the third alternative is a synthesis of the methodologies as started in Tarasov and Peltier, 2004.

pg 882 25-30: Good point! Past modelling exercises have been hardly constrained.

pg 883 23-28: The second stated aim can not be fully addressed, as it remains unclear to what extent many of the result shortcomings are due to limitations in the ice-sheet model.

Change "observed sea-level" to "inferred eustatic sea-level" line 26-27 as the modelling does not address relative sealevel variations.

2 Description of the approach

Need to insert a brief description of how ice-calving is treated.

2.2 forcing method

pg 885, l20-22, it would be worthwhile citing Marshall et all (2006) who report evidence for much lower surface elevation lapse rates in the Canadian high Arctic, to emphasize the uncertainties associated with these commonly used values.

pg 886, notation: it would make things a bit clearer if GCM fields were subscripted with "GCM" following the treatment of ISM fields

section 3.1

pg 890: l 15-17, It should be stated that none of the models produces a well-defined Quebec dome at LGM. It would be worth mentioning that past studies have found strong geographically constrained fast flow (due to till-deformation) was required to obtain a reasonable multi-domed ice surface topography that fit relative sea-level con-

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straints (Tarasov and Peltier, 2004).

pg 891 l 10-17, A thick Keewatin ice dome (and therefore attendant coalescence of at least the Northern half the of the Cordilleran ice sheet with the Laurentide) has been shown on the basis of large ensemble glaciological modelling (Tarasov and Peltier, 2004) to be required in order to fit observations for present day rates of uplift at Yellowknife.

In refering to ICE-4G LGM for the Cordilleran/Laurentide interface sector, it should be noted that this part of the reconstruction has no constraints (RSL needs past marine innundation).

section 3.2: I find this section offers the meatiest results. However, I have trouble coming up with a clear picture. I think the paper would be much more valuable if a detailed table were included to summarize the comparison between model runs and key characteristics of the GCM results. Eg, columns could include mean northern hemispheric summer temperature anomaly at LGM (relative to present), relative mass-balance deficit for each GCM run in Pollard et al (2000), key present biases of each GCM, LGM ice volume for the two major northern ice complexes,... This difficulty in clearly comparing the PMIP GCM results has in my opinion permeated PMIP (heck this is difficult to fully address), and I think a useful contribution could be made here in this regard.

pg 896 l 7-10. The simulated completion of deglaciation is well-delayed compared to that inferred. This should be made clear here.

figure 1-a caption: correct " atmosphereic general circulation model" to "atmospheric general circulation models". Also, I'm not sure whether this figure is required, since summer-time temperature (1-b) is the critical field wrt ablation.

Interactive comment on Clim. Past Discuss., 2, 879, 2006.