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Climate of the Past Discussions

Interactive comment on "Simulation of the last glacial cycle with a coupled climate ice-sheet model of intermediate complexity" *by* A. Ganopolski et al.

Anonymous Referee #2

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The CLIMBER-2 climate model coupled to SICOPOLIS ice sheet model is amongst the few models able to simulation the climate changes over a full glacial-interglacial cycle and to provide a detailed study of the processes at work over that time interval. Indeed this EMIC is much faster than GCMs, allowing longer and more numerous simulations. Still it remains enough detailed and it includes enough physics to simulate climate and its processes realistically.

This paper presents a study of the simulated last glacial-interglacial cycle. It is mostly focusing on the features of the ice-sheet module. On that point of view the title is very clear, indeed. The methodology of the paper is clear and straightforward. After a de-

scription of the model the authors present their 'best' simulation and then analyse in detail how their simulation would be affected by changes in less well-known parameters of the model (either SICOPOLIS or SEMI). Several parameters are taken into account. They are related to, for example, the enhancement factor, the bottom sliding, the re-freezing factor, and the slope effect. Other factors that could possibly also have impact on the simulation of the climate of the last glacial-interglacial cycle are not analysed. They are, for example, the isostatic rebound, the desert effect for the computation of snowfall, the snow ageing, the geothermal flux, the sea level change.

Detailed comments

Some parameterisations, although explained elsewhere, could be summarised here for easiness.

1. How is sea level taken into account in the model? I understand that changes in ice sheets affect the climate module via changes in the fraction of land covered by ice sheets, surface elevation and land area. However, the ice sheet module covers only the Northern Hemisphere. But the authors underline that Southern Hemisphere also contribute to continental ice volume and sea level change. This contribution is added to the simulated NH values. Is it done during the simulation (with impact on elevation for example) or is it done only for plotting purpose? Could the authors clarify this point?

2. The authors underline and describe the importance of the temperature correction for North America (American temperature dipole). As far as I understand this correction is based on present-day observation. Moreover, it proves efficient for the simulation of the full glacial-interglacial. However, I wonder whether there is evidence that this dipole correction is valid for the whole cycle with the same amplitude. In other words, I wonder whether we don't have a 'good response for a wrong reason'. In any case I acknowledge that the Baseline Experiment is one simulation with one set of parameters providing a 'good' simulation of the last glacial-interglacial cycle and that other sets of parameters might exist. Actually, do the authors use the estimate sea level rise

contribution of Antarctica for LGM only? Do they interpolate for the rest of the interval? Do they use an estimate every (say) one thousand years?

3. Additional greenhouse gases are taken into account in this work compared to previous works. The concept of equivalent CO2 concentration is used. Moreover, the values are scaled in order that the pre-industrial value remains at 280ppmv. How do the authors perform the scaling? Is it a linear translation of value on the concentration-axis or is it a geometric translation (multiplying factor)? Why did the author chose one or another option? Does it make a large difference?

4. Related with the sliding processes, what is the 'standard sediment mask' ? How is it build? Is it stable over a full cycle or might it change?

P 2282 – line 19. I urge the authors to be very cautious when writing sentences like 'ablation leads Milankovitch forcing'. Milankovitch forcing can be considered as the distribution in time and in latitude of the insolation. Therefore, there are so many 'insolation curves' that they will probably be able to find one that leads ablation.

The acceleration method should be very briefly described, at least its principle.

P 2284 – the authors write: 'During termination, the European ice sheets start to contract first in the response to rising summer insolation and GHGs concentration and practically disappeared already at 10 kyr BP.' According to the figure of ice volume evolution, it seems that the North American ice sheet starts first to melt and then only the European ice sheet. The North American ice sheet do indeed disappear after the European ice sheet. If this is correct, does it mean that the Laurentide part of the North American has a very rapid response, counterbalanced by the Cordilleran ice sheet?

P2290 – line 8: 'ice-volume variability is dominated by obliquity'. I totally disagree with the authors. If they simply put a curve of the obliquity along the ice volume they will see that the phase is changing through time. Moreover, the 'large' peaks (maxima of ice volume) coincide very precisely with those in the BE. In the BE, the authors related

those maxima with large variations in precession. Therefore I support the idea that only every second maxima in ice volume is significant (the other is disappearing for a reason to be determined).

Minor comments

P 2271 – line 10-11: the proper reference should be Loutre and Berger, 2000. No glacial-interglacial cycle in the ice volume simulated under a constant astronomical forcing and a variable CO2. Geophys. Res. Lett. 27(6), 783-786.

P2273 – line15: a reference to the Appendix is maybe missing here.

P2279 – line 22: this sentence (although meaningful) is not relevant here. Indeed it refers to the transient simulation (from 126 kyr BP to present) that is only mentioned and described in the following section.

P2280 – line 9: the authors write that the selection of the best fit is based on three criteria related with the ice volume/ ice sheet. I am not sure that I understand them properly. (1) the amplitude of the signal (though time) is correct. (2) the partition is correct. Does the authors mean partition over the whole time interval? (3) Ice sheets are properly simulated at the LGM. Does it mean volume, extent, thickness, elevation, anything else (temperature?)? Could the authors give clarification?

P2288 – line 15 'the range of a refreezing parameter from 0 to 0.4 are shown in Fig. 9c'. This is not coherent with the figure, which contains only one sensitivity curve for the refreezing factor. Or do the authors mean that one value is for BE and the other for the sensitivity? Then, which one?

P2306 – figure 7. I am not supposed to be colour blind. However, I do not see blue in the top panel but rather violet.

General remarks. There are some typos in the ms. I did not underline them all. For example, P 2276 – line 6, p2289 – line 19, p2293 – line 16, the word qubic in figure 10.

Interactive comment on Clim. Past Discuss., 5, 2269, 2009.