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Climate of the Past Discussions

Interactive comment on "Climatic conditions for modelling the Northern Hemisphere ice sheets throughout the ice age cycle" *by* A. Abe-Ouchi et al.

Anonymous Referee #1

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The paper analyses the parameters and the feedback processes that control the temperature over Northern hemisphere ice sheets; the evolution of the ice sheets throughout the last glacial cycle is also simulated in a quite satisfactory manner, although some deviations with known reconstructions. The main originality of the paper relies in the investigation of the relative influence of each feedback process between ice sheets and atmosphere (i.e. ice albedo and topography and desertification effect) compare to external forcings (insolation and CO2). The study relies on numerous numerical experiments. The introduction presents a non-exhaustive list of previous studies that address the question of climate-ice sheet interactions. The method is clearly exposed and the structure of the overall paper is properly organized. However, the analysis of

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the results suffers from a lack of sufficient investigation. I also found some confusion in the interpretation of some results. Providing that these major points combined with other minor remarks (addressed in detail hereafter) are accounted for, I recommend acceptance of the paper.

Major comments :

1)- p. 310 and Fig.1a. : The difference LGMfull - CTLH gives the total cooling between LGM and present, (i.e. the total cooling due to both ice-sheet itself and CO2, insolation and SST variations between LGM and present). The difference of temperature includes all the effects acting on the cooling on the Northern hemisphere; thus the larger cooling shown by this difference was expected. As a consequence, this comparison is not sufficient to justify that the effect of ice sheet is the primary factor that controls temperature over ice sheets. The difference of temperature between LGM and present due to ice-sheet alone can be found with the comparison between LGMfull - LGNnice which includes both albedo and topography effects that can be de-correlated from each other by the comparison between LGMflat-LGMnice and LGMfull-LGMflat. These results should be added in this section.

Also the authors should give some numerical values to quantify more precisely the different cooling effects. They should also explain the warming observed in Fig.1e in Central Europe. The caption of Figure1b should be replaced by “insolation, CO2, and SST effect” Could you explain why the patterns displayed in Fig. 1e are similar to the temperature changes displayed in Fig. 1d ?

2) The first sentence at the top of p. 312 is misleading. According to Fig. 2, the temperature change over Greenland is between -5°C and -12°C, whereas temperature change over Fennoscandia is between 0 and -8°C, smaller than for Greenland (or some parts of the Laurentide ice sheet). Moreover, the interpretation of results shown in Fig.2 should be deeper investigated, as well as the comparison with Fig.1e. Otherwise, Fig. 2 does not have a real interest.

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3) Comment about Figure 3: The difference between M12flat and M21nice does not reflect the albedo effect at 12 ka BP (see Fig.3 caption). By analogy with Fig.1c and the first group of experiments, I guess that the albedo effect is given by M12flat - M12 nice. Also I noticed errors in Table 2 for the description of M12 flat and M12 nice experiments: In M12 flat experiment, the topography should be that of 0 ka, and the ice-sheet extent in M12 nice should be that of 0 ka. Moreover, the results should also be discussed in a quantitative way. A larger albedo effect for LGM is obviously expected because of the larger extent of the surface covered by ice. The only interest of this result relies in the quantification of the difference between LGM and 12 ka BP. I recommend the authors to compare the non local topography effect between both periods, which is more interesting.

4) p. 313 : The authors often refer to the paper YASSN05 dealing with the relation between precipitation and temperature over ice sheets. I suggest that the authors remind the main results of this paper (maybe in the introduction) before the description of the results displayed in Fig. 5, and avoid expressions such as “can be compared to the results of FIG.1 of YASSN05”.

5) The authors should mention that PMIP2 models were run with the ICE-5G reconstruction (Peltier, 2004), whereas the experiments based on the the PMIP1 protocole were run with the older version, ICE-4G (Peltier, 1994). Significant differences between both LGM ice sheet topographies exist, particularly over the Keewatin sector and the eastern part of the Fennoscandia regions. These changes may have a strong impact on the results of the simulations, and this should be discussed.

6) In Figs 6b and 6d, the effect of CO2 is displayed for a difference of CO2 equivalent to the difference between LGM and present. In order that the effects of both prescession and CO2 can be compared, the difference parameters should also be equivalent to the difference between LGM and present.

7) Section 4 : The deviations of simulated Northern hemisphere ice sheets from known

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reconstructions should be analyzed and compared to the results of previous modeling studies. Moreover, it would be useful to superimpose in Fig 8 a reconstruction of the sea-level throughout the last 120 ka BP, and discuss also the results by comparion with sea-level.

Minor remarks :

1) p. 306 : the assumption that the present condition is an equilibrium is not true for at least the Fennoscandian region. This should be mentioned and the impact of such an assumption should be briefly discussed.

2) p. 306 : Values from experimental data of the geothermal heat flux vary can reach values between 50 and 150mWm-2 in the Western part of Canada, while 42mWm-2 is probably valid for the Eastern and central parts and for the major part of Fennoscandia. This could be mentioned

3) The variables in the equations are not always explained (e.g., Eqs. (1), (2), (3), (5), (9), (10)). - How your reference state is chosen (see Eqs(4), (5), (9)) ? - How the numerical values in Eqs.(6) and (7) are chosen ?

4) p. 308 : What are your “periodical boundary conditions” ?

5) p. 311, line 11 : you could also refer to (Kageyama and Valdes, 2000) and (Roe and Lindzen, 2001).

6) The caption of Fig. 4 is not clear. I suppose that “same as Fig.1” means “same as Fig. 1a”?

7) Section 4 : - What is the difference between gamma_area and Area ?

- The authors should explain what they mean by “minimum albedo effect” and “offset albedo effect”. Idem for the temperature aridity.

- The authors should explain how href is chosen

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8) p. 317, line 6 : replace “used Eqs (10) and (11”) by “used in Eqs (10) and (11)”

9) Table 2: change the unit of the lapse rate (K m-1 instead of K m-2).

10) The labels in Fig.7 are not visible.

11) What are the thin black lines in the upper plots of Figs.8 a and 8b? Moreover, numerical values of the varying parameters should be used instead of “lapse rate C, albedo C” which makes difficult the reading of the figure.

Interactive comment on Clim. Past Discuss., 3, 301, 2007.