**Climate
of the Past
Discussions**

Interactive
Comment

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

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First of all thank you very much for the valuable comments. In the following I would like to answer to the Referee comments referring the first referee (Lev Tarasov) as LT and the Annonymous Reviewer= AR.

(1) Reply to the major comments. (1-1) LT points out the lack of explanation of for the choice of a constant surface temperature lapse rate of 5K/km. I agree to LT that it is important to discuss the seasonal and spacial distribution of lapse rate. We are adding a discussion on it in the revised paper. The reason that we did not go into detail of lapse rate is that the focus in this paper is to evaluate the relative role of

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competing processes which is important for ice sheet mass balance as a first step. We additionally tried to demonstrate that the selected processes we chose were good enough to capture many aspects of Norther Hemisphere ice sheet change during the ice age. We noticed, however, the way of presentation is not good in the submitted manuscript and agree that it needs to be revised. It gave misunderstanding that the evaluation of lapse rate was a priority. Therefore we will omit the sentence in the abstract and in the conclusion about the "constant lapse rate" and rather treat the constant lapse rate as an "assumption" or a working hypothesis for simplicity and a first order representation of lapse rate effect which is comparable to other works. By the way, indeed we have analyzed the seasonal lapse rate but we felt it should be discussed in another paper.

(1-2) LT suggests the unfortunate use of ICE4G and suggest to use ICE5G. I agree that ICE5G is the state of the art and indeed we show in Fig. 4c our new model result using ICE5G and compared to other PMIP2 results. Although ICE5G is desirable, when we started the series of high resolution GCM runs (T106) described in 3.1 and 3.2, only ICE4G was available and we have already used quite a lot of time for the high resolution runs which can not be all replaced by ICE5G because of the expensive computer time (one run of T106 10 years takes more than a month CPU, waiting time is more). We would like to mention the importance of using ICE5G in future in the revised text. Although it is desirable, as shown in Fig. 4c using our PMIP2 result, we think the point would not be changed but should be proved in future in another work, which is discussed in the revised paper.

(1-3) LT requests the numerical values quantifying the relative effects of CO2, albedo, elevation Ě. We include a table to show the numerical values as requested in the revised paper. We agree that it is useful.

(2) Specific/technical comments (listed in the order the referee LT lists up)

#Equation variables will be defined in the revised paper as both rereferees suggested.

References on the past GCM analyses of the influence of ice sheets on climate will be added in the Introduction as LT suggests.

#p302, l26: the order of the citations are revised as suggested (LT).

#p305, l25: corrected as suggested (LT).

#p306, l9: LT requires us to provide a better description of the sliding parameter. The sentence was confusing. We rewrite the sentence to mention clearer what we mean or say.

#p306 eq2: LT asks the choice of the numerical grid for the ground temperature field. We believe equation 2 is correct (following Greve, 1997), but it is not directly used for the formulation in the numerical model. As LT told, we use the relative depth from the ice-bedrock boundary. We add short explanation after this part.

#p307 ln2, since the ice sheet model does not include a ice shelf part, the interaction between ice sheet and water in Hudson Bay cannot be treated and we had to define a land for this place. We will explain it in the revised text.

#Mothods section: LT asks how we handle the ice calving. We will add the description in the method section.

#p308 resolution of 0.5deg: I agree to your suggestion and add it as a future work.

#313 par.1 Yes we agree to LT and will add the explanation in the text.

#316 eq10 yes the number comes from GCM results using different ice sheet size. We will clarify it in the revised text.

#318 line8. We agree to LT and we will write it and also move the first sentence of the discussion chapter and insert here that mentions the shortcoming in the result.

#General figs: Short subtitles are added as suggested. #Fig.2 we will give the linear regression values in the caption as suggested. #Fig3 we will add the kind of subtitle

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as suggested. #Fig7 We redraw the figure by colors as suggested by LT. Labels are removed but the color bar is added to satisfy the request by AR (minor 10). #Fig.8 We will follow all the suggestiongs: We will change the order of the legend. We will add the explanation of orbital forcing in the caption. We will add the proxy data information of sea level curve to the figure as suggested.

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