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Climate of the Past Discussions

Interactive comment on "Climate of the last glacial maximum: sensitivity studies and model-data comparison with the LOVECLIM coupled model" *by* D. M. Roche et al.

Anonymous Referee #3

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– "general comments" –

* The manuscript consists of two parts: comparison between LGM simulation by Earth System model and paleo data, and sensitivity study on THC. Although broad range of comparison between model and data is impressive and investigation of THC sensitivity is also an interesting topic, I feel that paper should be organized so that these two parts are more tightly linked each other. To do this, for example, my suggestion is that the authors additionally compare the sensitivity experiments with paleo data, and discuss difference from the case of standard experiment. The authors state that the climate obtained using standard parameter values is in good agreement with available paleo

data. How about the climate obtained from sensitivity studies? Especially, it seems interesting to investigate whether the climate under the decreased THC (results from LGM freshwater sensitivity experiment, shown in Fig.9) is still in agreement with data or not.

* In the former part of the manuscript, LGM climate simulation by the Earth System model is compared with various available proxy data. The model results are in good agreement with the data such as vegetation, sea-ice cover, and SST. However, the simulated deep ocean circulation is different from the classical view of LGM circulation where the glacial delta 13C distribution suggests that the overturning cell associated with NADW formation becomes shallower than the present. The authors interpret recent Pa/Th data (e.g., McManus et al., 2004; Gherardi et al., 2005) as consistent with the simulated circulation, and conclude that the simulated circulation pattern is not inconsistent with evidence. Because the simulated circulation is completely against the classical view of LGM ocean circulation, I think that the manuscript should provide more careful discussion and more convincing explanation for rebutting the previous classical view before this conclusion can be accepted. The ocean circulation shown in Fig.3 indicates that overturning cell associated with NADW formation is stronger and deeper than the present. On the other hand, in my understanding, delta 13C data and Pa/Th data (e.g., Gherardi et al., 2005) agree to suggest that the overturning cell associated with NADW formation becomes shallower at LGM than the present (although some studies suggest its strength is almost same). Then, although the authors claim that the model is consistent with the data in that deep circulation between 3 and 4.5 km was sluggish between 30 and 40N, this claim seems invalid because the north Atlantic deep ocean is apparently well ventilated by northern overturning cell shown in Fig.3. In addition, although the authors avoid discussing comparison with delta 13C, it is required for the authors to make some discussion or comment. (I think discussion can be made even if explicit simulation of carbon isotope is not possible.)

* In sensitivity experiments on THC, the obtained results indicate that none of simu-

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lations could enable a drastic change in circulation. Does this reinforce the authors' claim that the circulation with standard parameters is consistent with paleo data? Or, is this an intrinsic feature of your model? I think the results of sensitivity simulations on THC is given descriptively and scientific interpretation and discussion are not made enough. In addition, as I already mentioned, these simulations seem independent from the previous part (comparison with paleo data) of the manuscript, which should be improved for clarifying the objective of the sensitivity simulations. Then, (as I also already suggested), my opinion is that results of sensitivity simulations should be compared with paleo data. Especially, I suggest the authors pick up the state with decreased THC from freshwater experiment (Fig.9) and compare this with paleo data. There, the authors could investigate how ocean deep circulation affects climate at LGM, and also discuss which pattern of ocean circulation, classical view or that obtained from standard experiment, is more appropriate for explaining LGM climate.

– "specific comments" –

p1107: line 9-10 This should be replaced by more specific statement of each reference. Which reference shows that inclusion of more components in the model enables better agreement with the data?

p1113: 3.3 Changes in simulated vegetation Because no figure of vegetation is cited in this paragraph, citation of Fig.4 is helpful.

p1114: 3.3 Overview of the simulated deep ocean circulation Figures for present ocean (corresponding to Fig.3) are very helpful because difference between present and LGM is important for discussion in the text.

p1115: line 25 The statement "most models produce an increase in overturning rate" seems overstatement. Table 2 of Weber et al.(2006) indicates that half of participating models simulate a decrease in overturning rate.

p1131: line 8-10 The reference for this statement is helpful. (I don't understand very

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well what you want to check by EXP9.)

p1144: Table 3 To indicate quantitative amplitude of "w.e.", it is helpful to add the value of natural variability in the table.

– "technical comments" –

p1106: line 2 'different from that ot' –> different from that to

p1116: line 13 Some words are missing before head of line.

Interactive comment on Clim. Past Discuss., 2, 1105, 2006.