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Climate of the Past Discussions

Interactive comment on "Glacial marine carbon cycle sensitivities to Atlantic ocean circulation reorganization by coupled climate model simulations" *by* M. O. Chikamoto et al.

Anonymous Referee #1

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General comments

In this paper, the authors discuss the complex problem of how the low glacial atmospheric CO2 level (around 190 ppm compared to 280 ppm during the preindustrial) could be explained. Contrary to most studies, which use box models or intermediate complexity models, they use a global climate model (GCM). They study the role of three processes: the sea ice coverage in the Northern and Southern ocean, and the ocean circulation. In that view they use the sea ice coverage and ocean circulation of two different realizations of simulations for both the preindustrial and LGM, and analyze their effect on atmospheric CO2 with a biogeochemical model.

Specific comments

This study shows new results on the effect of physical changes on the glacial atmospheric CO2 with a GCM model, which should be published. In particular, the effect of different sea ice coverage in the North and South is relatively new and of interest. A few points should be developed.

1. The impact of different ocean circulations has already been studied in details with another GCM (Tagliabue et al., 2009) and the new results presented here have to be discussed more in the light of the previous study.

2. Moreover, although the glacial ocean circulation cannot be directly constrained, the use of proxy data such as d13C and D14C is very useful. As the model simulates both (as presented for the preindustrial simulations) the glacial distribution of d13C and D14C obtained in the different model configurations should be compared to the data (and presented on figures). Oxygen is also an important constraint (whether the deep ocean becomes anoxic or not) which can be looked at.

3. Only two different circulations are presented: LGa which has a stronger NADW and lower AABW and LGb which has a lower NADW and stronger AABW. In the conclusion, the potential effect of other possible circulations should be discussed, for example a case with stronger NADW and stronger AABW or one with lower NADW and lower AABW.

1.Does the paper address relevant scientific questions within the scope of CP? yes

2.Does the paper present novel concepts, ideas, tools, or data? Yes

3.Are substantial conclusions reached? yes

4.Are the scientific methods and assumptions valid and clearly outlined? yes

5.Are the results sufficient to support the interpretations and conclusions? yes

6.Is the description of experiments and calculations sufficiently complete and precise

to allow their reproduction by fellow scientists (traceability of results)? yes

7.Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Yes, more discussion of Tagliabue et al., 2009

8.Does the title clearly reflect the contents of the paper? yes

9.Does the abstract provide a concise and complete summary? yes

10.Is the overall presentation well structured and clear? yes

11.Is the language fluent and precise? yes

12.Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? yes

13.Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? no

14.Are the number and quality of references appropriate? Yes, a few additional references are suggested

15.Is the amount and quality of supplementary material appropriate? -

Technical corrections

1. Introduction

p. 1262

l. 20 Two references should be added: Sigma et al., 2010 and Fischer et al., 2010

l. 23 One additional reference should be added as different methods have been used to infer the change of vegetation: Bird et al, 1994

p.1263

l.7 Because of the reduced vegetation, the remaining glacial-interglacial CO2 difference

is more than 75 ppm, it is important to remind it.

Paragraph on the reorganization of ocean circulation: Other studies have also discussed changes of circulation and mixing, for example Toggweiler, 1999; Paillard and Parrenin, 2004; Koher et al., 2005.

p. 1264

l. 3 The effect of sea ice on atmospheric CO2 has also been studied by Archer et al., 2003.

l.14 “outin” should be replaced by: “out in”

l.16 Another GCM has also been used to evaluate the impact of different oceanic circulations on the glacial atmospheric CO2 which can be introduced here: Tagliabue et al., 2009.

l. 21 “past, present, and future”: the future is not discussed in this study, so “future” should either be suppressed, or it should be explained.

2. Method

2.2. p. 1266

l.9-11 Why is there a warming bias?

l.13-16 Is there any physical reason to change the GM parameterization?

3. Preindustrial and glacial marine carbon cycle simulations

3.2. p1271

l.1271 How is the ACC? Does it change significantly?

4.1. p1275

l.3 Is the temperature lower in experiments b compared to a? Could it play a role in the solubility pump?

4.3. p.1276

l. 3 The effect of sea ice coverage should also be discussed in the light of Menviel et al., 2008.

4.4. p.1276

l. 16 Please specify by how much CO2 is changed.

5. Discussion

5.2. What about iron fertilization?

5.3. p. 1280

l.6 The possible role of winds has been discussed in Toggweiler et al., 2006, which could be included here.

6.Conclusions

p.1280

l.26 Studies have also been carried on with GCM simulations (Tagliabue et al., 2009).

p.1281

l. 4 “Enhanced of” should probably be replaced by either “enhancement of AABW” or “enhanced AABW”.

Figure 7. The atmospheric pCO2 response is for both PIa and Lga on the left panel and PIb ans Lgb and the right panel, it should be explained more carefully in the caption and Lga and Lgb on the figure should be changed, for exemple to a and b.

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