

## ***Interactive comment on “Mid-Pliocene global climate simulation with MRI-CGCM2.3: set-up and initial results of PlioMIP Experiments 1 and 2” by Y. Kamae and H. Ueda***

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The authors wish to thank the reviewer 2 for his/her constructive comments which will help us to improve the paper. We would like to respond to the major and minor comments.

»Major point

»The two authors carried out AOGCM simulates with flux adjustment and without flux adjustment. In the paper, they described that the control experiment with flux adjustment produced a better simulation for modern climate. However, they did not explain how they adjusted flux for the Pliocene experiment. They should explain the method

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for flux adjustment, or show figures for the adjusted fluxes, in particular for the Pliocene experiment.

»Did they use the identical flux adjustment to modern climate in the Pliocene experiment? If yes, why did they think that this adjustment was good for the Pliocene experiment?

Yes. The flux adjustments used in the Pliocene run are the same values with the Control run. This experimental methodology was also used in the earlier paleoclimate studies under the PMIP protocols (Kitoh et al. 2001; Kitoh and Murakami 2002; Kitoh et al. 2007). The use of the same flux adjustment values enables us to investigate the difference of the sensitivity of the modelled-climate under the external forcings by comparing the climate simulations with and without flux adjustment.

We agree the comment that the explanations of the method for the flux adjustments applied in this study were deficient in the submitted manuscript. We added the clarifications as follows:

In Chapter 2 (page 388 line 7):

"The geographical patterns of the flux adjustments are similar to those used in previous version of the model (see Fig. 1-3 in Yukimoto et al., 2001)."

In Chapter 2 (page 388 line 5) and Section 3.1.3 (page 392 line 8) :

"In this study, we used the same flux adjustment values for the Control and Pliocene runs."

In Section 3.1.3 (page 392 line 8):

"We simulate the Pliocene climate by the AOGCM with and without flux adjustment and compare their sensitivities to the external forcings."

References

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Kitoh, A., Murakami, S., and H. Koide, H.: 2001: A simulation of the Last Glacial Maximum with a coupled atmosphere-ocean GCM, *Geophys. Res. Lett.*, 28, 2221–2224, 2001.

Kitoh, A. and Murakami, S.: Tropical Pacific climate at the mid-Holocene and the Last Glacial Maximum simulated by a coupled ocean-atmosphere general circulation model, *Paleoceanography*, 17, 1047, doi:10.1029/2001PA000724, 2002.

Kitoh, A., Motoi, T., and Murakami, S.: El Nino-Southern oscillation simulation at 6000 years before present with the MRI-CGCM2.3: effect of flux adjustment, *J. Climate*, 20, 2484–2499, 2007.

»I notice that there are clear differences between AOGCM\_FA Cont and AOGCM\_NFA Cont in the global mean SAT. However, why the differences between AOGCM\_FA Plio and AOGCM\_NFA Plio are so smaller (see figure 3)?

In Figure 3, bold solid lines represent the averaging periods of the simulations. During the integrations, the difference in globally-averaged SAT between AOGCM\_FA Cont and AOGCM\_NFA Cont is meaningful, but the time-averaged values in the last 50 years show little difference (12.6 degree C and 12.7 degree C). The difference between the Pliocene simulations is also very small. These values are summarized in Table 4.

»It is more important that the authors can add some discussions, to show which AOGCM simulations are better for future PlioMIP works, with or without flux adjustment.

We agree the comment. This issue was also pointed out by the reviewer 1 and we have replied as follows:

»» 2/ In the SAT section (4.2) and the discussion section (5), you mention the differences in calculated SSTs between AOGCM\_NFA and AOGCM\_FA simulations. Could you (very briefly) compare the calculated SSTs to the SST data? Is one simulation closer to the data than the other? (especially in the Northern Atlantic)

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»It is difficult to judge which SST (simulated in AOGCM\_FA or AOGCM\_NFA) is closer to the SST data than another because the amplitudes and peak locations of SST increases in both integrations do not match with the data. We added the below sentence at the end of the first paragraph of the discussion section (page 400, line 23).

»Comparing to the data (Fig. 8a), both of the integrations failed to reproduce the pattern and amplitude of the SST increase in the Northern North Atlantic.

In this paper, we focused on the comparison of the simulated surface climate. It is not easy to determine which run (AOGCM\_FA or AOGCM\_NFA) is more suitable for the PlioMIP experiments than the other because both of the runs show much discrepancy with the data. This problem is also common to the other models (Dowsett et al., 2012). It is also worthwhile to point out that the simulated AMOC and spatial distribution of deep-ocean temperature (figures not shown) would be good indicators for evaluating their reproducibility. Such works have progressed in the PlioMIP collaborative researches. We added these points in the manuscript as follows:

page 400 line 23

"Dowsett et al. (2012) also shows the most models systematically underestimate the North Atlantic warming suggested by the proxy data. The discrepancy between the simulated North Atlantic SST and the proxy data indicates remaining issue in simulating the Pliocene warm climate using the modern AOGCMs under the PlioMIP protocol."

page 401 line 9

"It is difficult to determine which run, AOGCM\_FA or AOGCM\_NFA, is more consistent with the proxy data than the other because the general patterns in the simulated surface climate is very similar. However, the simulated AMOC and associated DOT would help to evaluate the model reproducibility."

Newly added reference:

Dowsett, H. J., Robinson, M. M., Haywood, A. M., Hill, D. J., Dolan, A. M., Stoll, D.

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K., Chan, W.-L., Abe-Ouchi, A., Chandler, M. A., Rosenbloom, N. A., Otto-Bliesner, B. L., Bragg, F. J., Lunt, D. J., Foley, K. M., and Riesselman, C.: Assessing confidence in Pliocene sea surface temperatures to evaluate predictive models, *Nature Climate Change*, doi:10.1038/nclimate1455, in press, 2012.

»Minor point

»English should be improved in the paper. I suggest the authors can ask for some helps from editors of GMD/GMDD to improve the English, if it is possible.

»The authors should notice the tense in the paper. When they described their experiments, they often used present tense, but suddenly changed to past tense. Try to make them consistent.

We revised descriptions in the experimental design. We used present tense throughout the description in the revised manuscript.

»There are also some sentences that are too difficult to be understood. Try to improve them.

»Page 389, lines 17. What is the meaning of "Over the off the western coast of the continent"?

Revised as "Off the western coast of the continent". It was also pointed out by the reviewer 1.

»Page 390, lines 24. "As with the present-day condition, any modifications were applied to the land-sea mask in the Pliocene simulations (e.g. Central American seaway, Bering Strait, Hudson Bay, and West Antarctica)." It is difficult to understand this sentence.

Revised as "The land/sea mask being set to modern, no modifications were applied". It was also pointed out by the reviewer 1.

»Page 391, lines 7. "The SiB distribution for the Control run well reproduced that for the

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present-day represented in Sato et al. (1989)." It is difficult to understand this sentence. We deleted the sentence to avoid confusing. This sentence doesn't have much importance.

»Page 392, lines 2. "Any modifications are applied for initial condition of the sea salinity." It is difficult to understand this sentence.

Revised as "No modifications are applied ...". It was also pointed out by the reviewer 1.

» Page 400, lines 14. Change "Above two characteristics are not appeared in AOGCM runs." to "About two characteristics do not appeared in the AOGCM runs."

Revised as "Above two characteristics do not appear in the AOGCM runs".

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