

This paper evaluates quantify the relative importance of individual boundary conditions and forcings, including greenhouse gases, ice sheets, and Earth' s orbital parameters, on determining Last Glacial Maximum (LGM) climate using AWI-ESM. The results reveal that both the greenhouse gases and ice sheets play a major role on defining the anomalous LGM surface temperature compared to today. And the Northern Hemisphere monsoon precipitation is influenced by the opposing effects of LGM greenhouse gases and ice sheets. These large-scale changes are related to the AMOC and sea ice-albedo feedbacks, and hence modulate the atmospheric dynamics. I think that this paper shows an interesting topic, thus, I recommend the publication of this manuscript. Before publication, some minor issues that need to be addressed.

General comments:

1. This paper shows that the the enhanced AMOC exist in Ice sheet simulations, causing temperature anomalies over Northern Hemisphere. So, how about the AMOC changes induced by the CO2 changes?
2. An interesting result is that the weakening of the Southern Hemisphere Hadley cell in Figure 7, but what is the reason of this change? Maybe need further discussion of this. Besides, some studies, such as Han et al. (2022), consider the influence of imbalance of atmospheric energy budget on Hadley cell and ITCZ, and the Hadley cell change is because of the imbalance of atmospheric energy budget?

*Han, Z., Zhang, Q., Li, Q., Feng, R., Haywood, A.M., Tindall, J.C., Hunter, S.J., Otto-Bliesner, B.L., Brady, E.C., Rosenbloom, N. and Zhang, Z., 2021. Evaluating the large-scale hydrological cycle response within the Pliocene Model Intercomparison Project Phase 2 (PlioMIP2) ensemble. *Climate of the Past*, 17(6), pp.2537-2558.*

3. How about the standard deviation of each terms in Figure 6. Suggest to add the error bar in each term in Figure 6.
4. How about the spatial distribution of the moisture budget terms? Suggest to plot this figure in Supplementary Materials.
5. Which season in Figures 3, 8, 9, 10? Need to clarify.
6. The nonuniform warming pattern under global warming can influence the monsoon precipitation as well. Thus, the summer monsoon is not consistently weakened in the future warming scenarios. For example, Li et al. (2022) indicate that the South Asian summer monsoon is weakened but the East Asian summer monsoon is enhanced in the future warming scenarios. Han et al. (2022) show the North African summer monsoon is strengthened under SSP5-8.5 scenarios. Thus, I think the following sentences may need to be organized: "Therefore the increased monsoon precipitation in a warmer climate results from the compensation between the effects from enhanced moisture flux convergence and weakened atmospheric circulation".

*Li, T., Wang, Y., Wang, B., Ting, M., Ding, Y., Sun, Y., He, C. and Yang, G., 2022. Distinctive South and East Asian monsoon circulation responses to global warming. *Science Bulletin*, 67(7), pp.762-770.*

Han, Z., Li, G. and Zhang, Q., 2022. Changes in Sahel summer rainfall in a global warming climate: contrasting the mid-Pliocene and future regional hydrological cycles. Climate Dynamics, pp.1-18.

7. Please test the significance of variable changes in Figure 7 and 8.

Specific comments:

1. The colorbar and labels in Figure 10 need to be larger. And the labels of latitude and longitude is too small as well.
2. “Modeled” suggest to change to “simulated” in line 167.
3. Please check the whole paper, sometimes there is “ice sheet”, but sometimes is “ice sheets”.