

## ***Interactive comment on “PMIP4 experiments using MIROC-ES2L Earth System Model” by Rumi Ohgaito et al.***

**Anonymous Referee #1**

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The paper summarizes PMIP4 experiments using the Model for Interdisciplinary Research on Climate Earth System Model (MIROC-ES2L). Experiments for PI, LGM, interglacials (6k, 127k), LM and historical are presented. The MIROC-ES2L is an ESM developed for CMIP6 (Tatebe et al. 2018, Scientific Reports; Hajima et al. 2020, GMD), but the version has more ESM components like the ecosystem, aerosol and vegetation modules. Most analyses are however related to the more standard physical quantities like SAT, precipitation, and ocean circulation (AMOC).

The paper needs some revisions before publication, somehow in between minor and major revisions. Part of the analysis is not very deep and a little speculative, some innovative aspects of the new model as the ocean biogeochemical model OECO2 are not considered in detail. A positive aspect of the paper is the compilation of different PMIP

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experiments in one paper. The evaluation of the climate sensitivity is not mentioned.

Here are specific critics, some of them are only minor:

1) page 2, line 46, Because cooling at LGM relative to PI is at a comparable level to present-day global warming,

-this statement is not valid. The present day warming with respect to PI is in the order of 0.5-1 K, the cooling LGM-PI is in the order of 3 K, regionally much larger (e.g. 10 K or more)

2) page 3, line 68, However, models have been unable to reproduce the quantitative changes recorded in proxy data.

-Please provide a reference. This statement is not very specific. Please modify and be explicit saying which type of paleoclimate data you are referring to.

3) page 4, SECTIONS 3.2 and 3.3 setup and spin-up:

-Specify how you treat the PFTS. It is not mentioned in the text, but shown in Fig. 4

4) page 8, line 252 We prescribed conventional land PFTs in the LGM experiment.

-This is not clear. The reader thinks that all experiments work with prescribed PFTs.

5) The language needs some improvements.

6) page 7, line 199: calculated for June to August (JJA) and December to 200 February (DJF).

-Please discuss the seasonality issue for past climates. Similar issue in Fig. 12: Please correct for the paleo-calendar (e.g. following Braconnot)

7) page 8, line 223: There is also good agreement between HadCRUT4 data and output from all of the historical experiments at the multi-decadal time scale.

-Be more specific, "good agreement" can be substantiated

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8) page 8, line 237 This could be attributed to a strong AMOC in the models, which leads to an estimate of sea ice expansion over the northern Atlantic Ocean that is lower than that suggested by proxy data.

-a strong AMOC would reduce the sea ice? please comment

9) page 8, line 240 Positive SST bias over the Southern Ocean in the model at PI may also contribute towards the underestimation of abyssal flow and could result in a persistently strong AMOC at LGM.

-too speculative, please substantiate your statement

10) page 8, line 245 Cooling of Eastern Antarctica at LGM relative to PI that is suggested by ice core data is underestimated by the model.

-please provide references and numbers.

11) page 9, line 263 This is consistent with the direction of change suggested by proxy archives (Bartlein et al., 2011; Turney and Jones, 2010)

-Be aware of the proxy for temperature during LIG, it is related to peak interglacial conditions. See e.g. Pfeiffer and Lohmann (2016, CP) for a discussion on that.

12) page 9, line 269 the degree of improvement would be area dependent.

-please be more specific, too vague

13) page 9, line 269 Compared with PI, temperature over the tropics is lower in the 6ka experiment, which contradicts with proxy data.

-This is not correct, see, e.g. Lohmann et al. (2013, CP) for the SST data and model-data comparisons

14) page 24, line 674, peak values of annual mean AMOC.

-please exclude the surface layers since they reflect the wind-driven part. In several papers, the upper 300 m (or similar) are excluded.

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15) page 25, caption of Fig 5:

-the colors are partly difficult to identify, e.g. light blue.

16) LGM: in the paper, please mention the potential bias due to the choice of initial condition. E.g. the deep ocean salinity structure is quite different from the modern one. It shall be mentioned that the spin up procedure, the initial condition, and the limited spin up time of less than 2000 years might be related to this mismatch.

17) page 25, AMOC plots: the figures shall be improved by inserting the minimum ocean depth (e.g. in grey)

18) Figure 10: Indeed a weak precipitation response in the tropics and subtropics. Is the zonal water vapor transport too small ?

19) Please mention the model's climate (or ES) sensitivity in the paper.

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