

Interactive comment on “Setup of the PMIP3 paleoclimate experiments conducted using an Earth System Model, MIROC-ESM” by T. Sueyoshi et al.

Anonymous Referee #1

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General comments

The paper by Sueyoshi et al. provides an overview of the methodologies applied in order to perform paleoclimate simulations (for the Last Millennium, the Mid-Holocene, and the Last Glacial Maximum) in the framework of CMIP5/PMIP3. As such simulations need to take into account a number of paleoclimatic boundary conditions, the preparation and setup of these simulations requires several steps and spin-up procedures which are described in the paper. The study also contains a few simulation results, which are presented in a rather short manner as the authors intend to present in-depth scientific results from the simulations in other publications. This is acceptable

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given the fact that the focus of this paper is on rather technical issues of paleoclimate modelling. However, if the authors decide to show figures on the scientific results from the simulations, these should also be discussed in the paper. Sueyoshi et al.'s study warrants publication as a documentation of the details of setup and initialization procedures which often are beyond the scope of paleoclimate modelling papers.

In general, the overall structure and the content of the paper are clear. However, for final publication, there are many details which need to be corrected, e.g. with respect to language, or clarified with respect to technical aspects of the methodology. Suggestions on this are listed below in the "Specific comments" and the "Technical corrections" parts. I suggest to have the paper read by a native English speaker who is familiar with the modelling language.

Specific comments

In the paper, the expressions "initial data", "initialization" and "spin-up" should be defined and used in a consistent way. It is not completely clear whether you refer to the whole initialization or spin-up procedure or whether it is the set of data from which the experiment (highlighted in blue in Fig. 3) starts.

I suggest to mention why for 6 ka, seasonal changes are discussed, whereas for 21 ka, annual means are presented.

ch. 1 p. 2529 l. 9: References to the CMIP table (exp. 3.4,..., Tier 1,...) can be omitted here. It is sufficient to have them in Table 1.

ch. 1 p. 2529/2530: "contrasted with attenuation" - I guess what you mean is that at 6 ka, the Asian monsoon is still stronger than today, but due to the ocean feedback, the signal is weaker.

ch. 1 p. 2530 ll. 18-23: This sentence is rather long and would be clearer if split into parts.

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ch. 1 p. 2531 I. 2/3: "has relatively rich proxy data" => This expression could be improved and combined with lines 13-15 and the References given there (Trouet et al., Mann et al.,...).

ch. 1 p. 2531 II. 3-8: This is of rather general nature and could be moved to the beginning of the chapter as a motivation for the whole work.

ch. 2: I would suggest to change the title of this section into "General characteristics of the model".

ch. 2 p. 2533 II. 26-28: "not referring the PFT..." => This needs some clarification. At the end of line 28, you could add "...and neglects..."

ch. 2 p. 2534 II. 9-13: I think this paragraph (slightly modified) would better fit to the beginning of ch. 3. You could close ch. 2 with "These model components are all activated in our paleoclimate experiments which will be described in the next section."

ch. 3.1.1 p. 2534 I. 20-22: => "...land index for MATSIRO (Fig. 2a) is based oncrop-lands than at present to account for a plausible..." I would also add half a sentence on what the land index actually is. Looking at Fig. 2 and section 2 where 13 PFTs are mentioned could cause some confusion. Can the individual grid cells have fractional contributions from, for instance, sea ice, land,... Are 0-category grid cells set to "undefined" in MATSIRO? 0 (white) should be included into the colorbar. Where does the "plausible 1850 distribution" with "less croplands" come from?

ch. 3.1.2: I would suggest to change the title of this section into "Spin-up for the PI simulation"

ch. 3.1.2 I. 3: Does it mean that the first 380 years were calculated as an AOGCM, with all the other components specified in Fig. 1 switched off?

ch. 3.1.2 I. 10: This contradicts the discussion of trends in later sections where you state that there is still a trend in PI. So the last paragraph from section 3.1.3. should be moved to 3.1.2. How large is the trend in the last 100 years of PI which are used for

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the analysis?

ch. 3.1.3: This section should be carefully reformulated. To clearly demonstrate the model performance, a comparison of a present-day simulation with modern observations would be required. One cannot expect a one-to-one correspondence of a PI simulation with modern-day observations.

ch. 3.2.1: Regarding the presentation of Fig. 6, a discussion of the main features would be helpful for the reader.

ch. 3.2.2 p. 2536: Do you mean that the spin-ups for PI and 6ka were the same but that the 6ka experiment was branched off from one of the 530 PI years from the "PI Experiment phase" given in Fig. 3a?

ch.3.2.2 p. 2536 II. 22-24: What does "physical quantities from the last 25 years...recursively adapted for 2000 years" mean? This is not clear to me.

ch. 3.2.2 p. 2537 I. 2: "200 simulation years" - This confuses me when looking at Fig. 3b. Text and Figure are not consistent here.

ch. 3.2.3 p. 2537 II. 5-7: This would become more clear with a slight modification of Fig. 3.

ch. 3.2.3 p. 2537 last paragraph: If you show Figures, you also need to discuss a few aspects. Therefore I would suggest to briefly say something about the land-sea contrast in the temperature response or about the increase in precipitation over the Indian Ocean and the tropical Atlantic.

ch. 3.2.3 p. 2537 I. 11: From Fig. 6a, wouldn't one expect a warming of the tropical oceans for JJAS? Is it a delayed response, as raised in earlier papers (I think Amy Clement has worked on this, but also others)?

ch. 3.3.1 p. 2538 I. 4: You should mention a little bit more about the salinity setting / initialization according to PMIP and why you did not change it.

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ch. 3.3.1. p. 2538 l. 16: Do the different reconstructions mainly vary in elevation or extent?

ch. 3.3.1 p. 2538 l. 20: "as other boundary data" - Please be more specific.

ch. 3.3.1 p. 2538 l. 21: Is there a justification/reference for the 90 m in contrast to the "classical" 120 m?

ch. 3.3.1 p. 2538 l. 28: "as the surrounding grids". I guess you mean "grid cells" here. How did you do this? Did you chose the vegetation from neighbours in the zonal or meridional direction? Was some weighting applied in the selection process?

ch. 3.3.2 p. 2539 l. 3: "of LGM experiments" - Is it actually from several LGM experiments or a set of restart files for the different model components from ONE previous LGM simulation using MIROC?

ch. 3.3.2 p. 2539 l. 26: It is not completely clear what you mean by "both options were applied".

ch. 3.3.2 p. 2540 l. 13: What do you mean by "was given recursively to the off-line model"?

ch. 3.3.2 p. 2540 l. 21: For the sake of completeness, I'd mention the final 100 model years used for analysis.

ch. 3.3.3: It would be nice to discuss briefly the land-sea contrast. Units (°C) are missing in this section.

ch. 3.3.3: The large-scale precip. changes in the South Pacific Convergence Zone (Fig. 11) could be discussed.

ch. 3.3.3: How has the MOC been defined? "various forcing conditions" (l. 10) is very vague. How does the AMOC temporal evolution look like throughout the experiment?

ch. 3.4.1 p. 2541 l. 24: It would be good to provide a bit more details here (temporal

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resolution, implementation in the model).

ch. 3.4.1 p. 2542 l. 5: "scaled linearly" - Is this part of the authors' work?

ch. 3.4.1 p. 2542 l. 11/12: Is there a specific reason for this?

ch. 3.4.1 Regarding the volcanic forcing, please be more specific on which variable is provided in the datasets by Crowley and Gao (AOD?). The description of how the data are used in the model is not fully clear to me.

ch. 3.4.1 p. 2542 l. 25: The authors decided to perform the experiment as a "prognostic CO₂ experiment". You could put this into perspective by briefly mentioning why you decided this and whether this is an exceptional approach compared to other CMIP5 groups.

ch. 3.4.2 p. 2543 l. 16: Is this resetting procedure a common approach in the "millennium community"?

ch. 3.4.3 p. 2544 l. 3-4: How do you separate anthropogenic and natural parts? What would be the amplitude of the trend?

ch. 4 final sentence: remove "we hope" and find a better link to the previous sentence solar forcing for LM (Fig. 12b): Why are there two parts where high frequency components seem to be missing (around 1400-1500 and around 1620-1650)?

Technical corrections and language suggestions

Abstract l. 5: "climate feedback" => "climate feedbacks"

Abstract l. 10: "an Earth System Model, MIROC-ESM" => "an Earth System Model (MIROC-ESM)"

Abstract l. 11: "experimental settings and procedures" => "experimental settings and spin-up procedures"

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- p. 2528 l. 17: "the value of evaluating of climate models" => "evaluating climate models"
- p. 2528 l. 23: "an Earth System Model (ESM)" => "the Earth System Model (ESM)"
- p. 2528 l. 24: "conducted as a series..." => "conducted in the CMIP5/PMIP3 framework and for the Intergovernmental..."
- p. 2529 l. 1: "Model simulations using ESMs, which..." => "ESMs consisting of atmosphere-ocean general ..."
- p. 2529 l. 4: "or model inter-comparison using AOGCMs" => "or AOGCM inter-comparison"
- p. 2529 l. 14: "the type of scientific" => "the scientific"
- p. 2529 l. 15: "climate reconstruction during 6ka" => "climate reconstructed for 6ka"
- p. 2529 l. 17: "enhanced vegetation activity" => "pronounced vegetation changes"
- p. 2530 l. 6: "precipitation. Experiments with ESM..." => "precipitation. This demonstrates that experiments with ESMs..."
- p. 2530 l. 15: "migrated southward, replaced" => "migrated southward and were replaced"
- p. 2531 l. 19: "and this study follows...." => "Our study uses a similar approach in evaluating the strength...."
- p. 2531 l. 21: => "This paper presents the technical aspects of CMIP5..."
- p. 2531 l. 24: "and these" => "as these"
- p. 2531 l. 26: "Model and common settings" => "The model and its general characteristics"
- p. 2532 l. 3: "based on a global climate model" => "based on the MIROC AOGCM"

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(introduce the MIROC acronym earlier in the paper)

- p. 2532 l. 16: "against 20th century" => "against observed 20th century"
- p. 2532 l. 20: => "between the surface and the stratosphere up to about 0.003 hPa"
- p. 2532 l. 23/24: => "were performed without the coupled..."
- p. 2532 l. 25: acronym CCSR not explained
- p. 2532 l. 26: => "has a resolution of 1.4° in longitude and 0.56-1.4° in latitude"
- p. 2532 l. 28: delete "flux"
- p. 2533 l. 1: => "sea ice model", "and has zero-layer thermodynamics"
- p. 2533 l. 15: What is meant by "individual-based"?
- p. 2533 ll. 20-21: => "is predicted at daily time steps....and mortality based on the climatic conditions simulated by MIROC-ESM"
- p. 2534 l. 1: => "simplified version of..."
- p. 2534 l. 5: you could add a list of the four components of alkalinity in brackets
- p. 2534 l. 19/20: => "285 ppm for CO₂, 0.3 ppm for N₂O,...CH₄ (Table 1)"
- p. 2535 l. 1/2: Start a new sentence after "Fig. 3a".
- p. 2536 ll. 10-12: => "Since 6 ka GHG levels are not drastically different from PI (except for methane), this experiment essentially tests the climate response to a change in seasonal incoming shortwave radiation due to different orbit parameters."
- p. 2536 ll. 14/15: "prepare the initial data for the 6 ka" => "set up the 6 ka experiment. It has been branched off year 250 of the PI run.... orbital parameters with 6 ka values."
- p. 2537 l. 21: "though they" => "though non-desert PFTs"
- p. 2538 l. 18: => "The data provided by PMIP3 was regridded..."

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- p. 2539 l. 5: => "This experiment has been integrated for 1900 years under PMIP2 LGM conditions"
- p. 2539 l. 7: => "Since the PMIP3 LGM ice sheet topography slightly differs from the PMIP2 version, a spin-up time..."
- p. 2539 l. 28: delete "in the initial data"
- p. 2541 l. 17/18: => "in preparing the data for atmospheric CO2 concentration"
- p. 2542 l. 9: "integrated TSI over the spectra" => please rephrase
- p. 2543 l. 21: This Figure reference should be given in Section 3.4.1 already.
- p. 2544 l. 12: include reference to Fig. 12e
- p. 2544 l. 22: typo => Fig. 12
- p. 2544 l. 28: I would write "about 400 ppm"
- p. 2545 l. 17: specify some other studies
- p. 2542 l. 27: "many" => "some"
- p. 2546 l. 12: Do you mean "typical timescales" instead of "time constants"?

References:

- ch. 1: Hoeltzmann => Hoelzmann
- ch. 1: Petit et al. (1981) missing in Reference list
- ch. 1: Rojas et al. (2009) in text vs. Rojas et al. (2008) in References
- ch. 2: l. 6: MIROC-AGCM, 2010 missing in Reference list

Table and Figures:

Table 1: "given, time variable" => "prescribed, variable in time". If you get space prob-
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lems, one could combine the five entries into one table cell.

Fig. 1: This figure is as in Watanabe et al. (GMD 2011). But here it contains typos. Please correct.

Fig. 3: You already made big efforts to make this figure as consistent as possible. Is there another meaning of the vertical dashed line than separating the spin-up from the experiment? As these are specified by the thick blue arrows below, this would be sufficient. Would it be possible to align as much as possible so that corresponding parts in PI and the paleo experiments (the red arrow parts) become immediately evident?

Fig. 6: What exactly is shown here? Net SW, incoming SW.... Try to use the same contour intervals for the colouring and the contour lines. The caption is missing a) and b).

Fig. 7 and 8: For the Figure titles, specifying the seasons would be sufficient. The titles have a mixture of fonts.

Fig. 9: Are the values over the oceans negative as well, as a result of spectral transformation? Maybe one can mask that out.

Fig. 10: Is it 2m air temperature over the oceans or SST (Fig. 7 has "surface temperature" as well, but the Figure title says "2m air temperature")? I also would suggest a finer resolution for values between -2 and 0°C. This would help for the reference to MARGO on p. 2540, l. 26, as well.

Fig. 12: Figure and caption are contradictory in a and b.

In some Figures, you could add "Note the irregular contour intervals" to the caption text where appropriate.

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