Interactive comment on "Climate and African precipitation changes in the mid-Holocene simulated using an Earth System Model MIROC-ESM" by R. Ohgaito et al.

Reply to Anonymous Referee #2

The authors thank the reviewer to review the manuscript and recommendations to publish the study. We sincerely consider the reviewer's suggestions and reply all of them below. Our answers are written in blue and boldface.

In this study, Ohgaito et al. performed simulations of time-slice experiments at 0k and 6k with two models, and in some case, even a third model was employed to conduct sensitivity experiments. The climate changes at 6ka in atmosphere, ocean and lan surface were well addressed both at global and regional scales. They found that dynamics vegetation and improvements in atmospheric processes do not have significant impacts on representing the 6ka monsoon change suggsted by reconstruction data; changes in African monsoon precipitation may be attributed to SST rather than vegetation coupling.Â˜aOverall, it is a very coprehensice study. Although this paper in some sense bears a style of "techinique report", it is still a much-needed work given the fact that many earth system models are involved in CMIP5/PMIP3 for the first time, the performance of ESM compared to its OAGCM version to reproduce the climate changes at 6ka must be of interest to broader climate modelling community. I recommand this paper to be pulished in the journal Climate of the Past. The paper is well-written, only minor modifications are needed.

Our study is the first analyses and report on the mid-Holocene experiments using the newly developed ESM, MIROC-ESM. Hence, we are not only going into detail of a specific aspect of the climate change but also covering the global and various aspects of the climate change simulated by the model in comparison with the previous version of MIROC, AOGCM, MIROC3. That is why the article includes simulated general changes, i.e., "technical report" like parts, but also focuses on inevitable aspect of the mid-Holocene simulations, i.e., the African monsoon changes.

CommentsÂ˜ a: P3287, Fig3. The SST biases in the northern Pacific and Atlantic are much more significant for MIROC-ESM than for MIROC. What is the possible reason?
Do these biases have any impact on the climate over the mid-high latitudes?

Watanabe et al. 2011 reported that the SST bias is attributed to be the albedo of the low level cloud. They said that there is no significant impact on the simulated present day climate was admitted. However, we are not able to say it doesn't affect the results of the climate change simulations. The

explanation is also added in the text.

P3290: Fig10: SST changes for MIROC-ESM is negative over northern high latitudes, which are quite different from the changes for MIROC. The authors claimed that they are unable to state which model is better by the proxy records, but it would be helpful to put these SST changes in the context of PMIP2 simulations, so the readers could get an idea about the likely sign and amplitude of SST changes at 6ka simulated by other OAGCMs. It isn't clear if the large difference in SST between ECM and OAGCM impede the air-sea-land interaction in ESM for Asian monsoon. Please comment on this issue.

As the reviewer has pointed out, the PMIP2 models simulate generally warmer change over the Northern Atlantic SSTs during the boreal summer in 6 ka. And it is the expected change following the change of the solar radiation in 6 ka. This is added in the text. What causes this cooling in MIROC-ESM is examined at Sect. 4.2.

We have explored the influence of the difference of the SST change in 6 ka for the two models using the sensitivity experiments discussed in Sect. 5.3.2. The sensitivity experiments suggested that the difference of the SST can influence the precipitation change over the Sahara and the overall cooling in 6 ka simulated by MIROC-ESM may also have influence the precipitation change. On the other hand, the influence of the land status (LAI in MIROC-ESM) was not significant (Sect. 5.3.4).

The sensitivity experiments are the tests for each component (sea, land). We should admit that there is a limitation for what we can learn from the sensitivity experiments because they are the tests using the experimental setting with less complexity. As the reviewer has pointed out, there is a possibility of the air-sea-land interaction causing further change of the precipitation enhancement. If we study further, we need to perform sensitivity experiments using MIROC-ESM with inactivated vegetation feedback for example which were not possible this time from the limitation of the computational resource. We'll add this point in the article.

Sec. 3.3 and 4.4 describe the distribution of carbon in MIROC-ESM and its change in 6ka. But these aspects have loose connection with the aims of this papers, I don't see them necessary to be included in this study.

The study is not only discussing the monsoon changes but also present what has simulated in MIROC-ESM in comparison with MIROC3 and discuss which newly developed component is affective for the climate change simulation for 6 ka. However, the carbon change cannot be compared to MIROC3 results and less connection with the rest of the study as the reviewer pointed out. We eliminated the carbon cycle descriptions from the text.

P3292 L22-24, Fig14, it’s a novel way to interprete the proxy record.

It is an idea coming up during looking at the model results. What would happen if 60 % of the time was desert and 40 % was grass land for example? We are interested in what the people working on the proxy would comment on it.

Figures 26&27 look very "noisy". It would be better to suppress the black contour lines.

We omitted zero line of the contours and zoom to the area of the interest, i.e., monsoon related area. Fig. 27 is deleted because we are mainly discussing the boreal summer monsoon.