

Review of the manuscript entitled “PlioMIP2 simulations with NorESM-L and NorESM1-F” by Xiangyu Li, Chuncheng Guo, Zhongshi Zhang, Odd Helge Otterå and Ran Zhang.

This paper is a contribution to the special issue dedicated to PLIOMIP2. The authors describe the core simulations performed by 2 different versions of NORESM model.

The paper is well written and illustrated.

It fits the goal of the PLIOMIP2 special issue which is to describe the different model simulations. This manuscript is devoted to the comparison of two different versions of NorESM GCM in the common framework of PLIOMIP2 boundary conditions. In addition, for one of the model versions only, the authors provide the comparison between PLIOMIP1&2 configurations.

My general conclusion is that the study is appropriate for publication in Climate of the Past special issue after the authors answer some comments I raised below. More importantly, the authors have to clarify the inconsistency between numbers in the text and Table 3 and Fig. 1 of the paper concerning SAT. The latter mainly concern the description of what they expect from the comparison of both versions within the PLIOMIP2 framework and a more detailed discussion over northern hemisphere responses of both model versions.

- Abstract

1 The results concerning SAT and SST anomalies between mid-Pliocene and preindustrial depict a very large warming of more than 3° on the continents at global scale. Here the terrestrial warming is nearly twice as large as the ocean one. The authors should maybe emphasize on this large contrast between continent and ocean. Is this sensitivity of the warming between oceans and continents consistent with IPCCRCPP simulations using NorESM versions results for ocean and land contrast?

2 The authors should if possible give the major differences between both versions to better understand the large sensitivity to the AMOC.

3 The intensification of the water cycle in a warmer climate (Clausius-Clapeyron relationship for global scale) is expected but more importantly, we would like to know whether regional patterns of precipitations are similar or not.

The abstract should briefly clarify these points..

- Section 1: Introduction

The introduction is excellent for me, summarizing the evolution of the PLIOMIP project and the contribution of the NORESM group.

- Section 2 : Model description

This section needs some improvements so that the reader may understand better the results section.

1. We need to know a bit deeper in the main text which modifications have been done in version 1-F and if they provided improvements for the preindustrial control run. Are they related with a better spatial resolution or related to the hydrologic cycle simulations?

2. What do the authors expect using the version 1-F for PLIOMIP2 with respect to what they already obtained in the previous standard (L) version? I agree that the authors referred to the paper by Guo et al (2019) for a detailed description, but we need a minimum of details for better understanding of the results described in the next section.

- Section 3: Experimental design

Why the spin up procedure is different for version 1-F?

- Section 4: Results
  - Section 4.1 Temperature

Superimposed to a zonal description, it would be interesting to discuss the result in terms of land/ocean.

The authors write: “The simulated Pliocene annual mean SAT increases by 3.2°C (NorESM1-F) and 7.6°C (NorESM-L) at the northern high latitudes and by 5.2°C (NorESM1-F) and 4.9°C (NorESM-L) at the Southern high latitudes.”

This is totally inconsistent with fig. 1 and Table 3. It may be possible that the authors confused Northern and Southern hemisphere in the text. Anyway, it is crucial to clarify this point. If you believe the text, there is a large warming over the NH for both versions, but the enhancement is much larger especially for NorESM L. It should be discussed as well as the enhanced seasonal cycle which is certainly largely responsible for the seasonal sea ice behavior in the warmer L version.

- Section 4.3 :SST

The version 1-F depicts a smaller global warming, but a larger one at high latitude of northern hemisphere compared to the L version. It would be interesting superimposed to the analysis which is already provided for the southern Hemisphere to add as a new section in part 5 a similar discussion concerning northern hemisphere to investigate why 1-F version is depicting a weaker response most over the globe except over mid to high latitudes of northern hemisphere. The different behavior of the two versions in north and south hemispheres should be emphasized.

- Section 4.4 Salinity

Large differences on salinity are depicted between both versions. This result needs to be analyzed and understood at global scale and not only for the southern hemisphere. This also points towards a new subsection in the discussion focused on Northern hemisphere.

- Section 4.5: Sea ice

An important result concerns the summer arctic sea ice especially with regard to future climate. It could be interesting, in the discussion, to add more details on the causes of these differences.

- Section 5: Discussion

This part includes 2 sections. The first one could be improved and enlarged because it deals mainly with the Southern Hemisphere.

In the discussion section, the part concerning south hemisphere salinity difference and its relation with ocean dynamics and sea ice is appropriate but we expect a bit more discussion on topics I raised above, especially on differences between both versions on NH high latitudes for land and sea thermal contrast and arctic sea ice and AMOC/PMOC responses.

The second part of the discussion raises an important point on sensitivity of different models to the closure of seaways and the authors should point out also in their conclusions that these new results, because they are different from the previous synthesis provided by Shang for PLIOMIP1, could certainly be an important focus of the future intercomparison within PLIOMIP2 project.

Figures and Tables: The numbers in Table 3 are compatible with Fig. 1, but the text is not constituent with them. Concerning Table 3 and section 4.3 (SST), it is difficult to know from the table if the numbers in the text are correct.