Review of "Modelling med-Pliocene climate with COSMOS"

The manuscript of C. Stepanek and G. Lohmann describes the experimental setup and the essential results of model simulations in the framework of the PlioMIP project. The utilized model system COSMOS comprises the atmospheric model ECHAM5, the land surface and vegetation model JSBACH, and the ocean and sea ice model MPIOM. In total four different runs are presented. In the simpler setup, labeled <u>experiment 1</u>, is the atmosphere-land surface/vegetation exposed to a prescribed SST distribution following the PlioMIP experimental guidelines. In contrast the <u>experiment 2</u> uses a fully coupled atmosphere-ocean model system. For each setup two model simulations are presented for two different time slices that represent either the preindustrial or the mid-Pliocene state.

The manuscript informs after the introduction about the characteristics of the three model components ECHAM5, JSBACH, and MPIOM. The experimental setup of each component describes the applied simplifications and their justifications. It also highlights principal differences between the experimental guidelines and the actual implementations in the model components and how they have been solved. The description of common central climatologically features of the modeled climate states and their distinct differences between the eras and setups are the core of the paper. The focus is here on global averaged integrated energy flux in and out of the system, the atmospheric distributions of the surface air temperature and precipitation. In the ocean the focus is directed onto the surface properties sea surface temperature (SST), sea surface salinity (SSS), and sea ice as well as the meridional overturning. The discussion and conclusions close the manuscript.

The manuscript is overall well structured and is well written. Since the selected journal Geoscientific Model Development (GMD) is "dedicated to the publication and public discussion of the description, development and evaluation of numerical models of the Earth System and its components," the presented simulations in framework of the PlioMIP project are placed in the right journal. *I recommend the publications of the manuscript after minor revisions*.

Minor comments about the text

In section 3.2 (Mid-Pliocene simulations), you describe how your have adjusted the land ocean distribution in the atmosphere and ocean components in respect to the contemporary setup. Here in particular you explain the changes around the Antarctic continent. Do you flatten the land surface to zero and digging out the ocean to 500 m depth? How is the exchange of momentum, heat, and flux water at these points implemented? Please clarify it.

The mid-Pliocene 3dim ocean temperature distribution has been obtained by utilizing two interpolations; firs onto a coarser grid and second back to the finer target grid. Does this kind of smoothing introduce large errors? How large are the differences in the worst case?

Specific comments

In the following text, the given page and line numbers refer to the printer-friendly version of the manuscript.

Page 927, Line 25-27: You talk about the distribution of glaciers, but I doubt that the model resolution is high enough to resolve any glacier. Should you name this distribution ice cape distribution or, in particular, ice sheet distribution?

Page 933, Line 1-3: I am with you that the prescribed SST might cause the size of the imbalance. Immediately it came to my mind, how does the latitudinal difference in the SST look like? Since

you present this quantity later (Fig. 6), you might add here a comment about the coming analyzes.

Page 934, Line 24-25: The warming is partly driven by changes in the topography. How large are the height difference in Greenland for example and to what an extent is the detected warming driven by the height effect alone considering a lapse rate of -6.5 K/km?

Page 935, Line 1-4: What might cause the exceptional strong warming in the Weddell Sea? Do the convection sites change their location in the Southern Ocean?

Tables

Tab. 1: Since in the text on page 930, lines 19-21, you lump together the plant functional types (PFTS) 1-4 to a generalized forest type, and 5-8 to a generalized grass type, you might highlight these clustering by either add an additional horizontal line, extra space between these groups, or an additional column highlighting these groups.

Tab 2: The main difference between experiment 1 and 2 is the coupling to an active ocean model. Since this table might be consulted frequently to quickly resolve this main difference, you might add a corresponding additional column or comment in the table caption.

Figures

Fig. 1: In the Hudson Bay the difference between the setups is clearly identifiable, but in the southern Pacific offshore of Antarctica, the changes are a little bit hidden. Have you tried another projection to resolve this issue?

Fig. 2: I personally find it hard to identify the grey contour lines that represent the 90% sea ice concentration contour line.

Fig. 6: Have your tried to use an additional higher resolved axis for the anomalies, on the right panel side for example? However I understand that using a common zero line is of great benefit and helps to read the figures.

Fig. 6d: Do you might consider adding an additional anomaly ratio axis for the precipitation?

Fig. 11: The gray isoclines are hard to identify. In addition, what is the contour line interval? You might consider adding this information to the figure caption.

Fig. 13-15: Please name the contour line intervals in the figure captions. It seems to be common to add in MOC plots the bottom topography. Do you consider adding the bottom topography as well?

Fig. 13: Is the contour interval is 1.5 Sv?

Fig. 14: Are the contour line intervals irregular?