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Climate of the Past Discussions

Interactive comment on "Effect of vegetation on the Late Miocene ocean circulation" *by* G. Lohmann et al.

Anonymous Referee #3

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Review of "Effect of vegetation on the Late Miocene ocean circulation" by G. Lohmann, M. Butzin, A. Micheels, T. Bickert, and V. Mosbrugger

The authors report on a series of climate modeling experiments that illustrate the potential influence of vegetation on ocean circulation. The conclusions of this paper are very interesting and might eventually be publishable. However, both the presentation and model analyses described in the paper are frustratingly poor. Finally, the conclusions of the paper are not supported by the study results.

1. I found the Introduction to be confusing. The first paragraph is largely unnecessary and could be summarized in one or two sentences. In the second paragraph, it is stated that the Tortian was characterized by glaciation of Antarctica and the Northern

Hemisphere but then continues to discuss the “low gradient paradox”, which to my understanding is a warm climate problem. The authors need to clarify their thesis.

2. There is some key information missing from the Methods section. In the description of the AGCM, the authors indicate that the ocean heat transport has been tuned as in Stepphun et al., 2006. This information is very relevant to this study and should be shown in a figure. Other information that should be included in a table is the orbital parameters, solar luminosity, and any greenhouse gas specifications in addition to CO2. I assume that these were all set at present day? In the LPJ model, how were soil textures specified? What were the initial conditions for the ocean model?

3. Section 3.1., paragraph 3. It is stated that reduced ocean heat transport is responsible for shifting the thermal equator, and presumably the ITCZ, southward. And, yet, the moisture transport from the Atlantic to the Pacific is 3 x larger in the TVEG than TGEO experiment. Please explain this. Why is the moisture transport larger in the TVEG experiment? What is the domain for the moisture transport analysis? In general, the choice of figures and results is curious. If vegetation is the key here, shouldn’t the results be focusing on TVEG, TGEO differences?

“...local precipitation is increased over Northern Greenland (Fig. 2).” This change is very small, and likely not statistically significant.

4. Section 3.1, paragraph 4. This section is not really relevant to the paper. I recommend removing it. If it is kept, biome plots for the CNTRL and TVEG should be shown (rather than differences). Then direct comparisons can be made with Fig. 1, the observations.

5. Section 3.2. It’s not clear from the description why the TVEG and TGEO are giving such different overturning circulations. The authors state “In TGEO, the surface winds and net freshwater flux in the North Atlantic are not able to overcome the freshening...” while implying that this is not the situation in the TVEG experiment. The authors need to show the differences in these quantities (surface-air temperature, wind stress, p-e)

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between TVEG and TGEO. This section seems to raise more questions than it answers.

6. Section 3.2. I have a problem with the methodology used here. The authors force the ocean model with fluxes from an AGCM that includes specified heat transport. In one ocean model experiment (TVEG) the heat transport remains high, in the other (TGEO) it decreases due to a reduction in overturning. One or both of these experiments is now out-of-balance (not in equilibrium) with the atmospheric forcing. If the ocean and atmosphere were coupled, would the solutions be the same? Is the high sensitivity demonstrated in these experiments due to this asynchronous scheme? The authors could test this by iterating between the ocean model and AGCM (as they did between LPJ and the AGCM).

I would also add that these experiments would have been much easier to evaluate if the ocean heat transport in the AGCM had not been altered for the Miocene experiments.

7. Section 4, paragraph 2. The authors discuss the enhanced export of water from the Pacific and suggest that it might be "Ean important external parameter of ocean sensitivity studies..." This may be the case in other studies. But these authors haven't shown that it is particularly important in their study. In fact, they might argue the opposite, that even though vapor transports increase the overturning is similar between TVEG and CNTRL. Moreover, the vapor transport is greatest in the TVEG experiment, and yet the TGEO experiment is the one with the weakest overturning circulation.

8. Section 4, paragraph 4. The authors suggest that ocean heat transport driven by tropical-cyclone mixing might be missing from their GCM. It might be, but by prescribing the ocean heat transport (after Steppuhn et al., 2006) in the AGCM they have already compensated for this shortcoming.

9. Section 5. paragraph 2. The authors conclude that vegetation-ocean interactions might be the missing link for increasing ocean heat transport that could explain the reduced pole-to-equator problem. This is unlikely. The reduced pole-to-equator problem is global (i.e., it occurs in both hemispheres). The solution presented by the authors

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(i.e., enhanced overturning) only increases the heat transport in one hemisphere, and decreases it in the other as prevoiusly shown by Crowley and others. In addition, the magnitude of the warming in the North Atlantic is large (8 C), but the downstream warming over Eurasia is most likely much smaller (in fact, see the Arctic cooling in Fig. 5b).

10. There are minor typographical errors and grammatical errors throughout the text.

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