

Interactive comment on “Warm Greenland during the last interglacial: the role of regional changes in sea ice cover” by Niklaus Merz et al.

Anonymous Referee #2

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The authors analyze the role of sea ice and SST anomalies in the Labrador and Nordic seas in controlling surface air temperature anomalies over the North Atlantic region (with a special focus on Greenland) during the Last Interglacial (LIG). Using the atmosphere component of CCSM4, a state-of-the-art climate model, a set of sensitivity experiments was performed to disentangle the influence of the Labrador Sea versus the Nordic Seas. The results were analyzed very carefully and in much detail considering heat and moisture budgets. It is found that sea ice retreat and warming in the Nordic Seas is crucial for the simulation of high Greenland temperatures during the LIG, which are evidenced by proxy records, whereas the role of the Labrador Sea is minor. The paper is well written and clearly structured. Although similar experiments and ideas have been published before by Li et al. (2010) with a focus on the last glacial, the results by Merz et al. are novel and show the importance of Nordic Seas ice cover

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for the LIG. As such, the study by Merz et al. is certainly of interest for the paleomodelling community and suitable for Climate of the Past. However, the following points have to be taken into account before publication of the study.

1) p. 1, line 11: "Diabatic processes play a secondary role". This statement is confusing. The simulated SAT anomalies are ultimately caused by anomalous surface energy fluxes, e.g. sensible heating, which is a diabatic process. I think the authors refer to latent heating and radiative processes. Please be more precise.

2) p. 1, line 23: In both models and data the LIG warming is mostly restricted to the extratropics, whereas the tropics show cooling in many regions. Again, please be more precise.

3) p. 2, line 13: The transient CCSM3 simulation used in this study was not part of the paper by Lunt et al. (2013). The CCSM3_Bremen simulation in Lunt et al. (2013) is a time slice (125 kyr BP) run using the T31-version of CCSM3. It is different to the transient simulation by Varma et al. (2015). Please clarify.

4) p. 3, line 5: In addition to the papers by Li et al. (2005, 2010), cite the study by Zhang et al. (2014), which strongly supports the findings by Li et al., but in a fully-coupled setup.

5) p. 4, line 1: In addition to Varma et al. (2015), cite the studies by Bakker et al. (2013) and Govin et al. (2014), where the transient CCSM3 LIG simulation has been published first.

6) p. 4, line 5: The two realizations do not only differ in horizontal resolution. Note that different greenhouse gas concentrations have been used as well as a different solar constant. Moreover, the transient character of the low-resolution run as well as the short integration time of the high-resolution time slice simulation should be taken into account. Please rephrase.

7) p. 5, line 26: How was the decision made on how far the sea ice margin is shifted

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to the north? Is it based on the high-resolution LIG simulation or is it arbitrary? Please explain.

8) p. 6, line 31: The authors have not used the CCSM3_Bremen simulation from Lunt et al. (see above).

9) p. 7, line 1: As mentioned above, the difference is not only due to horizontal resolution. Different GHG concentrations have been used. In particular, N₂O concentration is much higher in the high-resolution CCSM3 experiment than in the low-resolution run. Moreover, a higher solar constant (1367 W/m²) has been used in the high-resolution experiment.

10) p. 7, line 2: Vegetation is fixed (modern) in the transient CCSM3 low-resolution run.

11) p. 7, line 11: As mentioned above, higher N₂O and solar constant contribute to the warming in the high-resolution CCSM3. I agree that the ocean is also a likely candidate. In fact, as shown in Bakker et al. (2013) the AMOC in the transient low-resolution CCSM3 simulation is relatively weak. Reduced oceanic heat transport would contribute to the relatively cool conditions in the North Atlantic. In addition, it should be noted that the pre-industrial reference run by Merkel et al. (2010) has much higher GHG concentrations than the transient LIG simulation (in particular CH₄).

12) p. 19, line 30: The study by Zhang et al. (2014) may be cited here, showing that processes are similar in coupled and uncoupled (Li et al., 2010) experiments.

13) p.36, Table 1: A reference is missing for the chosen GHG values.

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