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The Cryosphere Discussions

Interactive comment on "Melting of Northern Greenland during the last interglacial" *by* A. Born and K. H. Nisancioglu

Anonymous Referee #1

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Born review Cryosphere

This paper presents Greenland Ice Sheet (GIS) model simulations of the last interglaciation forced by two GCM simulations of 126 and 115 ka with climate interpolated between these time slices based on boreal summer insolation. In contrast to previous GIS model simulations, the authors simulate the greatest GIS retreat in Northeast Greenland. Other simulations have suggested the greatest retreat in the south. The NE retreat is due to its dry climate that does not compensate for greater ablation like at other margins, resulting in positive feedbacks making the region less stable. The authors suggest this could mean that the NE GIS could be more vulnerable to global warming than other margins.

I think this is an interesting paper that should be published, but needs some work,

revision of arguments, and inclusion of more descriptions and figures. I highlight these specifically below.

3518 line 21 - The temps should be 0-5 C with the new Axford temp record from Baffin Island (GSA Bulletin, 2011).

3519 line 21 - What about the other studies of Lhomme et al. (2005, QSR), Tarasov & Peltier (2003, JGR), Huybrechts (2002, QSR), Robinson et al. (2011, Climate of the Past), I would include these references and their GIS sea level contribution ranges.

line 8 - what about shortwave radiation changing the temp-melt relationship (van de Berg et al., 2011, Nature Geoscience)? Why not develop a higher order PDD model that accounts for the change in shortwave for the last interglaciation? The GCM provides the climate forcing for a full energy balance assessment rather than using this crude PDD temp-melt parameterization developed for the latest Holocene.

line 9 - so the study is started with present day ice, which would have present day ice temps. This is incorrect for the last interglaciation, which would have a GIS that was filled with cold glacial ice at the start of the interglaciation $\sim$130 ka, whereas the present GIS has had 10 kyrs of warm ice accumulation. Short of redoing the study, the authors should acknowledge this shortcoming and predict its impact on their conclusions, and soften their conclusions accordingly.

3521 line 20 - I'm not sure what "duration of Eemian melting" means. Melting of what? Sea level is the only precisely dated record that integrates melt of all ice beyond todays extent and thermal expansion. Shackleton et al. (2003, Global & Planet. Change) placed the last interglaciation between 128 and 116 ka, so that's the global "melting" period. I would revise this statement to clarify what the authors mean.

3522 line 7 - note the shortcoming of this approach (see above)

line 13 - why is this "most likely"? Either remove or justify this statement.

3524 line 22 - how much of this rapid thinning in the NE is due to it having warm ice in

the model from a present-day starting point? How would this differ if the ice was cold from the preceding MIS 6 glaciation? I think the authors may overestimate this thinning because of the warm ice. Other studies have utilized long simulations to make a GIS that has the "right" ice temp before assessing last interglaciation ice retreat (Cuffey and Marshall, 2000; Huybrechts, 2002; Tarasov and Peltier, 2003; Robinson et al., 2011).

line 23 - show the CCSM3-forced ice-sheet model results, with the model having this large retreat in the NE. The Otto-Bliesner et al. study did not find this large retreat in the NE, rather in the south. Why do they claim different here? A figure with a map(s) comparing the two GIS results is needed. Also provide a climate forcing map for the simulations used here and compared with the CCSM3 simulations.

3525 line 12 - I don't think a 2003 publication is "recent"

line 18 - Actually, I don't know if this climate simulation is "proofed" because they don't show the climate forcing map. And the CCSM3 simulation has some glaring inconsistencies with data, most notably the work of Henning et al. in the Norwegian Sea that shows a cooler than Holocene last interglaciation and that of Yarrow et al. on Baffin that has climate no warmer and maybe cooler than the Holocene. I would acknowledge these inconsistencies and also show the actual climate forcing.

line 16 - These deposits are not well to not dated in NE Greenland. Its usually an undatable deposit with warm mollusks present and the authors assumed it was of last interglaciation age. I would acknowledge this poor age control.

line 20 - how was this dated to late in the last glacial cycle? And if I read this right, just because NE ice advanced "late in the last glacial cycle", presumably like 20 ka? or something like that?, this doesn't really pertain to what ice did in the last interglaciation.

Discussion to add - So, why does this simulation find greater NE Greenland retreat and other model GIS studies found the N to be relatively stable with the south having the greatest retreat? Even Otto-Bliesner et al. found the latter using the same type

of climate model forcing on Marshall's ice sheet model. I think a paragraph or two is needed to explain why these results are different from others.

Fig. 3 - Add a change in elevation map between present and 126 ka. And show the change in elevation predicted by ice core d18O gradients from NGRIP (2004, Nature). I think the figure on the right may have too much thinning in central Greenland. Also add to this figure the CCSM3 results that the authors claim to match their simulations but in Otto-Bliesner et al. have minimal NE Greenland retreat.

Figures add - climate fields for 115 and 126 ka for the new simulations used here and compare with the CCSM3 fields.

Minor note -interglacial is an adjective, not a noun, yet the authors use it as a noun. Change to interglaciation or interglacial period. I know this is a common mistake, I've made it myself, but we should try to stop this grammatically incorrect phrase.

Interactive comment on The Cryosphere Discuss., 5, 3517, 2011.