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Climate of the Past Discussions

CPD

Interactive comment

Interactive comment on "Arctic warming induced by the Laurentide ice sheet topography" *by* Johan Liakka and Marcus Lofverstrom

Anonymous Referee #2

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The authors present a study of the impact on the Arctic temperature by varying heights of the Laurentide ice sheets in a AGCM-slab ocean setup under otherwise constant LGM boundary conditions. The experimental setup is clean and allows for direct attribution of effects and very clearly illustrates the role played by the ice sheet height in modifying contributions from standing verses transient eddies to the Arctic energy budget. The study shows that as ice sheet topography increases, the meridional heat (dry static) transport by standing eddies increases enough to overcome the concurrent decrease in transient eddy transport, providing a net increase in meridional heat transport giving rise to a mean Arctic warming. This effect reaches 6.5 degC for an LIS of 125% of the reconstructed LIS, compared to one of 0%.

The paper is well written, organized, referenced and argued. The conclusions are clear

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Discussion paper

and important and they follow logically from the results presented. I support publication of the manuscript with only a few minor issues to consider in the below.

P3L29: Is the q-flux taken from Liu et al. (2009) also the one used in the PI-experiment? If not, please say so and discuss the impact of this. It shouldn't be important for your conclusions as they follow from comparisons of the various LIStopo experiments. But the PI experiment does enter into Figs 1 and 2 and Table 1, and the interpretation thereof could be influenced by the q-flux used.

P4L4: A little more detail on the construction of the LIStopos is warranted given that they are the centerpiece of the study. In the text it sounds as if you simply multiply the actual elevation by a number, N. But is it rather the anomaly of the LGM topo wrt to PI topo that you scale with N? The fact that the N=0 case corresponds to PI topo tells me that this is rather the case. Otherwise, N=0 would mean completely flat topography.

P4L13-14: Does the qflux change also contribute to the change?

Fig 1: - Consider showing this as in a polar stereographic projection instead. Given that "Arctic" enters into the title of the paper, a highlight of Arctic changes could be in place. - Also, consider showing some standard pressure level height (say Z500) as contours on these plots, to illustrate the stationary eddy changes (if they are visible). The paper talks a lot about the changes in circulation, but nowhere are these changes visualized.

P7L24: Given the importance of this analysis, spend a few sentences outlining the principle in the APRP method.

P8L2: Perhaps add "(not shown)" after the discussion of changes in precipitable water.

P10L16-16: Do you perform the vertical integrals on the time-mean output from the model? This often leads to problems if the output is on (hybrid) sigma levels. Usually this has to be taken care of by performing the vertical integrals on-line on the time-step model state and then outputting time means over the vertically integrated quantities.

How did you do it?

P11L2-4: Could you write a little more on how you arrive at these expressions for the split-up in contributions?

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