

## ***Interactive comment on “How might the North American ice sheet influence the Northwestern Eurasian climate?” by P. Beghin et al.***

### **Anonymous Referee #2**

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General comments: Based on an atmosphere GCM, this manuscript by Beghin and colleagues investigates the role played by the atmospheric changes associated with different Laurentide ice sheet (LIS) configurations on Eurasian climate, especially on Northwestern Europe. Via gradually increasing the LIS heights (similar approach as Zhang et al. 2014 Nature), authors propose that the atmospheric responses over Europe are characterized by seasonal and spatial heterogeneity. The results are interesting but might not be robust enough. In addition, the experimental design possesses weak relationship with real climate. Thus, I would rather recommend a major revision on this stage.

Major comments: 1. Lack of results/comprehensive discussion about potential effects of ocean circulation response on their conclusions. The core results of this study are

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based on AGCM simulations, in which the sea surface properties (e.g. SST) are fixed to the LGM outputs. This approach is able to well evaluate the initial responses of atmosphere circulation to the changed boundary conditions (here is LIS), but cannot provide in-depth information on the real climate (incl. atmosphere-ocean interaction). In the model setup of this study, prescribed LIS changes encompass two extreme cases (e.g. the white and flat LIS and the LGM LIS) and the cases in between. This large spread of LIS heights will significantly affect ocean circulation, for instance, the Atlantic Meridional Overturning Circulation (AMOC) (e.g. Ullman et al 2013 CP, Zhang et al 2014 Nature), potentially leading to different patterns of the temperature and precipitation over Europe in comparison to the fixed ocean boundary. I would recommend to additionally performing another suit of sensitivity experiment in which a different ocean boundary is used to force the atmosphere. For instance, the ocean boundaries from the fully coupled 00dhL and noIS simulations. If performing additional simulations were not possible, however, the authors would have to carefully discuss this issue in the revised version (which is not at all considered in this version).

2. The authors show plenty of anomaly fields from different LIS simulations to support their arguments. But without any significance test, it is hard to evaluate whether the contrasts associated with different LIS configurations are robust as well as the proposed mechanisms. Thus I would suggest here to include the corresponding t-test at least amongst simulations of noIS, 00dhL, 50dhL and 100dhL. In addition, it would be better to provide the ice sheet mask in all corresponding figures.

3. In the part associated with AGCM outputs, the authors carefully demonstrate the mechanisms accounting for different temperature and precipitation responses over different regions of Europe. From my point of view, there is no flaw on the logic but on the way to clearly present the results. As two main factors accounting for the ice sheet mass balance, I would recommend two sections associated with temperature and precipitation in this part, and putting the corresponding mechanisms as the subsections.

4. The ice sheet modeling part is the most novel part in the whole manuscript. In

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the present version, the authors only discussed the responses of Fennoscandian ice sheet to the atmosphere circulation changes associated with different LIS configurations. How are the responses of LIS per se? For instance, how would the LIS respond to the corresponding atmosphere forcing? Given the co-evolution of both LIS and FIS during glacials, it would also be interesting to evaluate the feedbacks of FIS on LIS mass balance via the atmosphere circulation.

Minor comments: P29 Line 19-22: In Ullman et al 2013, it is shown that the tsurf and p-e do not change significantly over Fennoscandian ice sheets under two extreme 21ka ice sheet configurations. Can you give a potential interpretation on this point, possibly based on your results?

P33 Line 21-22: Please show the 2-d absolute fields of the LGM forcing, as well as 2-d variance fields of the interannual variability.

P36 Line 11 Does the precipitation in the maintext always refer to the total precipitation (incl solid and liquid)?

P38 Line 28-P39 Line It would be more instructive to show the similar figure as your Figure 10 w.r.t. the southward expansion of the Labrador trough and westerlies positions.

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Interactive comment on Clim. Past Discuss., 11, 27, 2015.

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