

Interactive comment on “Dependence of Eemian Greenland temperature reconstructions on the ice sheet topography” by N. Merz et al.

Anonymous Referee #1

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In the present study the authors investigate the influence of the Greenland ice sheet on Greenlands surface climate during the Eemian interglacial. A comprehensive climate model is forced by different realizations of the Greenland ice sheet. The results show a significant impact of the topography on the surface air temperature despite a correction for the different elevations. Local changes of the energy budget appear to be the dominant mechanism while anomalous advection due to changes of the large scale dynamics is less important. For winter, the sensible heat flux is most affected due to surface wind anomalies controlled by the slope of the ice sheet. For summer, temperature anomalies are related to changes in surface albedo. The results suggest that a substantial part of the Eemian warming signal in Greenland proxy data may be attributed to local forcing due to changes in topography.

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Paleoclimate reconstructions from proxy data are an important source of information in climate science. In particular the Greenland ice sheet provides an extensive archive of valuable data. However, to interpret these data correctly and to draw significant conclusions uncertainties need to be assessed and the data need to be linked to the underlying processes. Here, sensitivity studies based on model simulations can be of substantial help. For Greenland, the relatively pure knowledge of its paleo-topography introduces a high degree of uncertainty. In addition, the role of Greenlands topography for the local climate and the large scale atmospheric dynamics is still not completely understood.

The present study is a valuable and substantial contribution. It is clearly written and well structured. Overall, it provides sufficient new information to warrant publication in *Climate of the Past*. I only have three points the authors may consider to further improve the paper:

- 1) Most changes found in this study are related to changes in the planetary boundary layer. However, it is well known that there are large uncertainties in representing boundary layer physics in GCMs, in particular for stable stratification which is the case here (e.g. Holtslag et al. 2013). The authors may discuss/note this issue.
- 2) Figure 8 may be completed by the flux for snow melt.
- 3) In section 2.4 (page 6693) the authors state that in the present day simulation the implemented Greenland ice sheet is 'rather too flat' compared to the real world. In the sensitivity studies, however, it appears that the prescribed perturbations are directly taken from the ice sheet model output without any scaling. Questions: How large is the difference to the real world in the present day setup? Does this means, that the effect of the reduced ice sheet is somewhat overestimated in the simulations? And, wouldn't it be more appropriate to use scaled ice sheet anomalies?

References: Holtslag, A. A. M., and Coauthors, 2013: Stable Atmospheric Boundary Layers and Diurnal Cycles: Challenges for Weather and Climate Models. *Bull. Amer.*

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