

Interactive comment on “A surface energy and mass balance model for simulations over multiple glacial cycles” by Andreas Born et al.

Andreas Born et al.

andreas.born@uib.no

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We are grateful to both referees for their positive and constructive comments. It is our intent to address all of them in the revised manuscript. Here, we will reply to the major points that were raised in the discussion:

We agree that processes on time-scales shorter than one day are potentially important for the mass balance in certain regions and we will revise the manuscript to discuss how their omission may impact our results. Referee Krebs-Kanzow requested that we compare BESSI with spatial patterns from more sophisticated models. We refer to the recently published study by Plach et al. (2018), and Plach et al. (2019, in revision) where we did such a comparison with MAR for four different time slices ranging from

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relatively cool to notably warmer climates. The main difference is that BESSI estimates much less refreezing than MAR, which can at least partially be explained by the lack of a diurnal cycle in our model. We will reference the Plach et al. papers in the revised manuscript. We will also weigh the benefits of a parameterization of diurnal melt-refreeze cycles in a future version of BESSI (Krapp et al. 2017; Krebs-Kanzow et al. 2018), and include these considerations in the discussion.

Regarding the comparison with observations from large glaciers outside Greenland, a suggestion made by both reviewers, we feel that the number of neglected processes becomes too large (slope angle and orientation, snow drift, micrometeorology, etc.) and the lateral resolution too large (40km) for this comparison to provide meaningful insight.

The request to make the model code publicly available is very reasonable and we will follow it. Our preferred solution would be to include the source code as a supplement to the final paper.

In response to comments from both reviewers, we will revise title and abstract, and better motivate the use of a multi-layered model. The advantages include the explicit simulation of meltwater percolation, and that of vertical heat transport.

A. Plach, K.H. Nisancioglu, S. Le clec'h, A. Born, P. Langebroek, Chuncheng Guo, M. Imhof and T.F. Stocker (2018): Eemian Greenland SMB strongly sensitive to model choice, *Climate of the Past* 14, 1463-1485 DOI: 10.5194/cp-14-1463-2018

A. Plach, K.H. Nisancioglu, P.M. Langebroek and A. Born (2018): Eemian Greenland ice sheet simulated with a higher-order model shows strong sensitivity to SMB forcing, *The Cryosphere Discussions* (in revision) DOI: 10.5194/tc-2018-225

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2018-218>, 2018.

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