

The Cryosphere Discuss., referee comment RC1
<https://doi.org/10.5194/tc-2021-379-RC1>, 2022
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Review of Zolles and Born

Anonymous Referee #1

Referee comment on "How does a change in climate variability impact the Greenland ice-sheet surface mass balance?" by Tobias Zolles and Andreas Born, The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-379-RC1>, 2022

This study investigates the impact of temporal variability in climatic forcing to drive a snowpack model over Greenland. The idea is that for many time periods of interest, climatic datasets of daily or higher resolution are not available, but are needed to drive snowpack models. Therefore different strategies may be needed to obtain consistent results using this sparse forcing with a model that is tuned based on high-resolution climatic data. It is a valuable study that should be published with only minor revisions.

The experimental setup is interesting, and serves to demonstrate the importance of accounting for variability in the climatic forcing. However, I get the impression that a lot of details are provided for the different ordering of years (Figs. 1 & 2, 28 panels each), when in fact, it is determined that the shuffling of the years does very little to change the estimated SMB in the end. I would recommend relegating all of these panels to an Appendix, and rather show two representative cases of the forcing and resulting SMB in one figure. This allows you to make the point, and if the reader is interested they can check the other cases in the Appendix. But importantly, then it brings the focus more to your main point, which is the intra-annual variability.

With regards to the intra-annual forcing, the findings here are quite valuable. It is clear that if a model is tuned with historical daily input fields, forcing it by climatological averages of daily input fields can result in strong biases in the simulated SMB. The study nicely diagnoses that precip is the key factor here, while climatological averages of other variables do not increase the bias much. The proposed method to reduce this bias is also valuable and nicely tested.

However, I am less convinced by the idea that imposing a little bit of precipitation each day is problematic. By using daily forcing, the model is already being driven by forcing that is "not realistic", since it does not capture some of the strongest variability in the

fields - namely the diurnal cycle. And yet, it can be tuned to do a good job against an RCM.

My suspicion is that if BESSI were tuned against the climatological SMB of RACMO while driven by climatological-average variables, it would still be able to produce a reasonable estimate of climatological SMB. Based on the analysis given here, one could guess that the optimal albedo parameters would change to reduce the sensitivity of the model to precip. And then, in principle, it would be ok to use climatological variables from other time periods. Would it be possible for the authors to test this easily? I would not say it is a requirement for publication, but at a minimum, it would be good to include some discussion of this possibility and its implications.

Minor comments:

L7: "However, using daily averages as forcing ..." <= This could use some clarification. What kind of data were you using before, that were not daily averages? I.e., what are you contrasting to here?

L43: weather => whether

L45: Global Circulation => General Circulation

L48: prior => previously

L70: We use => As forcing, we use

L83: (rows) => (rows in Fig. 1)

L134: where found => were found

L156: I note here that the SMB changes drastically when a frequency of 30 days is imposed - SMB goes down to 87 kg/m²/yr from 255 kg/m²/yr, so it seems you can get any SMB you want bracketing the 'right' value using historical forcing. So, it is not clear why the bias remains at "10-25%" (L165) using this approach.

L166: decreases with precipitation frequency => decreases with decreasing precipitation frequency [right?]

L195: physical more => physically

Fig. 8: The meaning of this figure is not really clear to me. As I'm not really sure what is being shown, I cannot offer suggestions for improvement.

L212: physical not reasonable => not physically reasonable