Answer to the Referee:

This manuscript investigates the parameter sensitivity for a glacier surface mass and energy balance model. I'm less familiar with this model, which calculates energy balance using just temperature, precipitation, and incoming shortwave radiation as inputs, and parameterized other components, but the model is well-described. Authors perform experiments for parameter sensitivity over Greenland for two time periods: the present day and Last Glacial Maximum (LGM).
The introduction sets up the paper well. I think that the experiments in this paper, showing which parameters mass balance is most sensitive to, are important and will be useful for others simulating mass balance for glaciers and ice sheets. The presentation of results isn't always intuitive, and at times the manuscript does not clearly and accurately communicate the key messages.

We thank the referee for the thoughtful comments.

Specific comments
p1 L4: Is 'invariant' the correct word? You show that the sensitivity varies by region (Fig 3).

We fully agree that it is the magnitude of sensitivity change that are similar in space and time. We changed it to: "The sensitivity towards individual model parameters and parameterization are as variable in space as in time". Which also includes the case of the 3 "non-sensitive" paramters which are just not variable at all.

P1 L4: Should you clarify that emissivity has, by far, the highest sensitivity (at least in present day)?
Changed to include the emissivity and the long-wave radiation in this sentence.

P1 abstract: Is it useful to note differences between present and LGM? The comparisons seem like a big part of the paper.
We changed the sentence about the turbulent latent heat flux, so it puts higher emphasis on the difference between the LGM and PD.

P1 L22: The use of the word 'unfortunate' here feels like an opinion. This occurs throughout the text, with words like 'rather' and 'clearly'. I think these words should be removed.
We changed the wording of unfortunate and removed multiple usages of the other words.

P9 Table 1: Does parameter #5 have a citation?
No it does not have one directly. As it was not used in these relative terms, though Rolstad et al. and citations within discuss the differences of the exchange coefficient for sensible and latent heat flux.

P9 Table 1: Parameter #8, I think a different abbreviation is used later in Fig 2 (am). Keep these consistent.
We added the full names to the table.

P10 L16: Lots of acronyms here. Better to say 'Present' instead of PD?
We keep the acronyms through out the text, but repeat "present day (PD)" at the beginning of every section now.

P10 L21: remove 'a slight influence of'
We followed the referee's suggestion.

Fig 2: Great, this seems like a key figure. It's not clear what the difference between main and total effect are. Did I miss this in the methods? Also, as a key figure, why is the equivalent for LGM not in the main text? It seems like it would be more useful to have that figure in the text, and current Figures 1 and 5 either smaller or in the supplement.
Figure 3 and 4 do show the sensitivity indices on a distributed scale, therefore we show those two for both climate states (PD, LGM) and consider it as the key figures. The additional gain of figure 2 are the uncertainties of the GSA method, but we consider it not necessary to show these for both states at the main part of the manuscript.
The sensitivity indices are described in the methods, we added a reference and a brief description to the figure caption to make it easier to understand.

P15 L6-7: Delete 'Due to their large size,' and 'but we include the main findings here'.
We followed the referee's suggestion.

P15 L30: I'm confused here. Maybe just 'Conversely' needs to be removed?
We want to show the contrast between parameters that are directly correlated with increase and decrease, and those that may give either depending on the environmental conditions. We changed the wording to "on the other hand".

P 16 L 5: Why pick region 5? Later you mention the ELA is within the region, maybe include that here.
We added a statement about our decision concerning the region and the ELA.

Figure 6: Text says that a) and b) show sensitivity, but not c) (P16 L 10-14). But they all look pretty similar to me. Maybe labeling SMB on all axes would help.
There is a trend in a and b and not in c. The plot without shared y-axes is too crowded and complicates the readability.

Figure 6: Why are the lightest color vertical bars, while the 3 darker colors are continuous?
These are the outliers of the 90% range and are plotted at the center of each bin.

P18 L 22-25: Really hard to follow the list, adding numbers in front of each point could help (e.g. 1) The impact of …)
We followed the referee's suggestion.

Figure 7: I'm a bit confused here, you're looking at the sensitivity of parameters on surface mass balance only with QL on, still for region 5 at the LGM? I would expect it to be the equivalent to Fig 6 but for LGM, but what is going on with QL?
If we only consider the sub-ensemble where QL_on is present than there are no members which have QL_off, therefore the plot for X_QL has no "left" box.

Figure 8: This is figure 8, typo in caption?
Thanks for noting the referencing error figure 7 was meant.

Figure 8: Why did you choose to show parameter sensitivity by region only for Dsh?
Discussion: I found this section a bit hard to read. Some sentences might need commas to make the point clear.
We focus the discussion on this parameter as it may lead to a higher or a lower SMB depending on the atmospheric conditions. We added an additional line, referencing the supplement for further figures for the other parameters.
The whole section was reworked to make it easier to follow.

P23 L12: delete ‘while’ and rewrite? There is still sensitivity to emissivity during the LGM.
We changed this to “During the LGM the SMB shows additional increased sensitivity to the fresh snow albedo, the choice of albedo parameterization, and the turbulent latent heat flux.”

P23 L15: what does ‘though desirable’ mean?
Uncertainties in SMB related to this parameter are small, so we conclude that it is not necessary to include it, but better to do so.

P24 L8: Change ‘neither’ to ‘None’, as you have multiple variables?
We followed the referee’s suggestion.

P24 L16: Do you show you improve the model with these new additions?
No, we do not show it in this manuscript, but there was a previous bias in dry regions due to a lack of sublimation (Born2019, Imhof 2016) which is removed now.

P24 L 23-25: Is there a previous description of the different circulation during the LGM? Having it just brought up here is missing an explanation if one doesn’t know about it.
We added a connection to the results and discussion section about the circulation changes due to the Laurentide ice sheet.

Appendix: Some plots mentioned in the text are missing, or is there also a supplement? If so, why are some in Appendix and some in supplement?
There is supplement which is referenced together with the model code. “The BESSI model code is available on git-hub (https://github.com/TobiasZo/BESSI/tree/TobiasZo---GSA-model-version). Additionally, the github branch also contains the analysis and plotting scripts. It is also available together with the supplement at 10.5281/zen-odo.4310369.”
There are a total of 176 figures in the supplement, we systematically named them so searching for particular figures is easier than having on supplement document. Only figures that are discussed in more detail are in the main manuscript or the appendix.

Born, Andreas, Michael A. Imhof, and Thomas F. Stocker. "An efficient surface energy–mass balance model for snow and ice." *The Cryosphere* 13.5 (2019): 1529-1546.

Imhof, Michael. *An Energy and Mass Balance Firn Model coupled to the Ice Sheets of the Northern Hemisphere*. Diss. Universität Bern, 2016.

Rolstad, C. and Oerlemans, J.: The residual method for determination of the turbulent exchange coefficient applied to automatic weather station data from Iceland, Switzerland and West Greenland, Annals of Glaciology, 42, 367–372, 2005