

# ***Interactive comment on “Sensitivity of the Greenland mass and energy balance to uncertainties in key model parameters” by Tobias Zolles and Andreas Born***

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We would first like to thank the Referee for his constructive criticism of our manuscript “Sensitivity of the Greenland mass and energy balance to uncertainties in key model parameters”.

Characterizing model sensitivities is an important step towards reducing uncertainties in model projections, making the manuscript both timely and useful. The model setup based on Sobol Sequences is carefully done and the use of global sensitivity analysis appropriate, GSA should become a mainstay in a modeler’s toolbox. My main criticism relates to the structure and language of the paper, not the science. The manuscript

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lacks clarity and precision. To improve readability and to make the manuscript more engaging and flow better, I suggest some reorganization and rephrasing:

- When possible, switch from passive to active language (e.g. “Here we set  $x = 20$ ” instead of “ $x=20$  is being used in this setup”). “Figure Z shows what X depends on Y” could be rephrased to “We find that X strongly depends on Y (Fig Z)”. - When presenting and discussing results, make sure that figures and tables are referenced whenever applicable. This makes it easier for the reader to follow. - Try to reduce the frequent use of “this” and “these” to improve clarity and readability.

[We will follow these suggestions where possible.](#)

- I think the equations underlying the different parameterizations that are part of your uncertainty quantification are not crucial for the message of the paper. Consider moving the details to an appendix.

[Due to the inherent importance of the parameters in the aim of our study, we want to keep the equations within the main manuscript text.](#)

- Since you only analyze and discuss main effect Sobol indices, you could simplify the paper by removing mentions of total effect indices, unless you have a good reason to keep them. (A single sentence what total effects are and why you exclude them may be sufficient).

[We are only using the total effect in our discussion and paper. Considering the discussion in our paper, we will add one clear sentence why the main effect is not used.](#)

- Before submitting I recommend having the manuscript proof read by a native speaker to iron out remaining minor issues.

OK

- I agree with the other reviewer that more focus and precision is needed in the results

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section.

A more clear structuring of the results and discussion will be applied. In particular we want to follow the suggestions of reviewer 1 in regard to LGM and PD subheadings.

To the best of my knowledge, a novelty of this manuscript is to present spatial patterns of the Sobol indices. Aschwanden et al (2019) and Bulthuis et While al (2019) only showed Sobol indices of scalar quantities. It may be worth pointing this out.

Thank you for pointing this out to us. This will be emphasized throughout the manuscript.

Fig. 6 vs 7: In Fig 6, the mean is always lower than the median, which is not the case in Fig 7. What does this say about the underlying PDFs?

Fig 6 shows a particular region (region 5), where melt occurs and therefore the PDF has a longer tail towards negative values resulting in a lower mean than median. In contrast, figure 7 shows the sensitivity of SMB to a single model parameter for different regions. Here, the PDFs do not all have negative tails.

In equations I recommend using roman font for sub- and super-scripts if they do not describe variables, e.g.  $Q_{in}$ . Use of *SMB* and variables like *SW* are always tricky. Writing  $(1 - \alpha)SW_{in}$  could be interpreted as  $(1-\alpha) * S * W_{in}$ .

We will look into this in all equations and try to optimize it following the journal's guidelines.

Rewrite paragraph about the global sensitivity analysis (p 7, l 12-20). I wonder if it would be better to first outline how you designed the ensemble and what method was used to draw from the parameter space, and then introduce the global sensitivity analysis that you use to analyze your ensemble.

We will rewrite the paragraph but would prefer to keep the order as it is now.

Please find technical comments attached. I've tried to make suggestion how to

rephrase sentences here and there, but these comments are not exhaustive.

We thank the referee for the detailed technical comments and will address a few specific ones here. We will submit a complete list of replies to all comments along with our revisions.

How do you downscale temperature, and how do you treat other variables:

All variables are interpolated bi-linearly to the horizontal model grid. Only the atmospheric temperature is corrected for the actual model topography using a temperature lapse rate of 0.65 for PD and 0.85 for the LGM.

Why 273K, not 273.15K for the melting point?

We are using 273.15 K in our model, we will change the manuscript and use the actual value or a corresponding symbol throughout the revised text.

Add a column with references to justify the range. Also consider listing the distributions used.

We will be adding references to Table 1. All parameters are distributed following a pseudo random sobol sequence.

Conclusion section: Here you introduce a new idea/model that has not yet been discussed.

The new idea introduced in the conclusion will be moved to the discussion.

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-251>, 2019.

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