Answer to the referee comment from Anonymous Referee #1

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

Summary
The paper evaluates the sensitivity of output from a simple glacier surface mass and energy balance model to changes in its parameters. For this study the model has been extended from a previous version to include the description of turbulent latent heat fluxes, deemed important for cold climates. The evaluation is performed over the Greenland ice sheet for two contrasting climate states (present day:PD and last glacial maximum: LGM) and several regions with distinct surface mass balance regimes. The work provides detailed information about the importance of key model parameters for the surface mass and energy balance and confirms the importance of latent heat fluxes for the LGM climate.

General comments
The conclusions of the paper are fairly specific for this particular model. I was wondering if the manuscript wouldn’t find a more appropriate audience if it was instead submitted e.g. as a model evaluation paper in GMD. This is an editorial decision, but I think it is worth considering.

We did consider GMD, but refrain from it for two reasons. Firstly, it is not directly model development, but sensitivity testing. Secondly, we wanted to raise the awareness of sensitivity and uncertainty in glaciological models.

The paper is well organised and the text is largely clear in its presentation in sections 1-2, which requires some improvement to be more precise (see detailed comments below).

My main problem with the results section (Sec. 3) is related to the challenge to present results for 9 different parameters for two different climate states, 6-12 different regions and two different analysis techniques in a concise and interesting way. I believe this section in its present form lacks focus and direction and much improvement can be made in presenting these results. More precision of the descriptions is also needed here.

I suggest the authors should look for possible generalisations across these four axes of analysis and of clear story lines that are followed throughout the discussion of results. To give an example: the manuscript discusses the notion that the Greenland margins at the LGM exhibit similar features to the interior at the PD. Maybe this can be used to generalise the results further and reduce the amount of individual cases that need to be discussed.
Overall, one possible approach could be to define a few main conclusions of the study first and then find evidence for those in the different results. If possible, consider moving less important results to an appendix or supplement.
What struck me as particularly difficult to digest are parts of the text where the description of the results happens without accompanying figures (e.g. p17.l21, p19.l17). I strongly suggest to provide additional figures to make the discussion of results more tangible. In all cases where results are not shown in figures or tables, add ’not shown’ in the text, otherwise, make a reference to the figure.

We try to be more precise in the description and provide a clear distinction between the two climate states, the regions and the parameters throughout the manuscript. In particular, we will follow the referee's suggestion to use LGM and PD headings in the results and discussion section.

We want to avoid using a supplement, but will move content to the appendix. The need for additional figures is a shared concern among the referees. We agree with this and will include them in the manuscript and the appendix. This includes an extra panel for figure 5 with the regions of Greenland. A figure similar to figure 6 for the LGM period and the sensitivity of the turbulent latent heat flux as an additional figure. We will be adding selected additional figures to the appendix. As there are two climate states, nine parameters and 11-13 regions, we will refrain from creating a supplement with all figures. Though, we will make more figures similarly to figure 6 and 7 available via github and/or zenodoo. This will be added to the current line: " 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. Upon acceptance the branch will be archived via zenodo."
To increase the readability we will be including "shown/not shown" statements.

Regions. It is confusing to me that the paper apparently operates with three different sets of regions (those defined in Fig2, Fig 5 and those not shown for the LGM). If at all possible, I'd suggest that one set of regions (or at least one clear definition of regions that may then results in differences between PD and LGM) be used throughout the manuscript? In the current framework, the regions defined for the LGM should be shown (they should be different from the PD if they are based on elevation) as results are given for those. It seems that the PD analysis is limited to region 5 only, so it is a surprising choice to show all PD regions in detail, but none of the LGM regions.

We will provide a clear definition for the 11 respectively 13 regions. They are defined geographically by the present day ice divides and elevation. Though due to the different ice sheet topography during the LGM, they are similar but not identical. The regions in Fig 2 are chosen to be only based on elevation to keep the focus on the GSA method and its uncertainty rather than a regional definition. We want to introduce the concept rather than providing in depth analysis, which is done based on figure 3 and 4 for the GSA. Regions solely based on elevation do not take into account the large climatic differences between parts of Greenland. Therefore the GSA analysis is mainly based on a distributed approach shown in Figure 3 and 4.

As pointed out in the text, the relative importance of different parameters in the global sensitivity analysis are dependent on the sampled parameter ranges. I miss a clear motivation and argument for the plausibility of the assumed ranges beyond reference to Born et al. (2019). This seems like an important aspect of the paper, so it should get some attention in the text. This includes the question if the parameter ranges supposedly derived for PD climate hold for the LGM and what could be done to mitigate this effect, if any.

We will add literature references to Table 1 regarding the parameter range. Additionally, we will extend the discussion of the dependency on the range in the respective session of the manuscript. The only clear change from parameter range used in Born et al. (2019) is in the snow albedo, this is due the implementation of additional albedo schemes where a wider range is plausible than in the two cases one used in that study.

Specific comments
Up front a few points that are repeated throughout the manuscript. Some examples are given below.
- Reconsider the use of 'it' and 'this' in cases where the subject of the sentence is not clear.
- Distinguish between physical quantities and mechanisms on one hand and the parameters that influence those on the other hand.
- Be clear about what is shown in a given figure (PD or LGM) and what results you are discussing in a given paragraph (PD vs LGM). Possibly use section headers to make that distinction.

- Be explicit what you are comparing in a given part of the text: PD vs. LGM, one region against another or one parameter against another.
- In the context of this paper, I would always refer to the contrast between PD and LGM as 'difference' rather than 'change', since there is no time dependence here.
Title: Add 'surface' before 'mass and energy balance'

We will incorporate these comments as much as possible. We agree that the title could be changed.

Abstract: Could add more information about the model and experimental setup.

We will consider this possibility.

p1.l2 remove 'climate' after 'present day'. A climate is not a period.
p1.l16 If this is supposed to be a reference for the ITM method, more appropriate references may be Bintanja et al., 2002 or Van den Berg et al., 2008
p2.l2 Add 'computationally' before 'too expensive'.
p2.l9 Maybe 'can be used', to make clear they are not used in parallel.

We will include all suggested changes.

p3.l9 Not obvious what a 'mass following' grid is. Clarify, add a reference.
p3.l9 Add 'in the snowpack' after '15 layers' if that is the correct description.
p3.l9 Maybe 'The mass of each layer is 100 - 500 kgm-2'. Clarify if the mass is decreasing/increasing with depth or where the range originates from.
p4.l12 We don't know yet how large the boxes are! Also, you use the term 'layers' before. Is large the right term for a layer defined by its mass?

The vertical grid is defined by mass and not height. We will clarify this in the methods section and make a clearer reference to Born et al. (2019). The mass of each layer is 100-500 kg/m2. Each cell is initially filled up to 300 kg/m², but due to melt and refreezing the mass may in- or decrease. Cells above 500 kg/m² or below 100 kg/m² are split or merged respectively. We are referring to a large box, meaning being thick. We will add max and min estimates to the particular statement (0.2-1.4m).

p3.l12 Clarify what happens to the other variables if they are not downscaled to the model topography. Are they just interpolated?
p3.l17 Which two? The last two? Clarify

All variables are interpolated bi-linearly to the horizontal model grid. Only the atmospheric temperature is corrected for the actual model topography that is generally different from that of the input data. Only precipitation and turbulent latent heat flux are associated with a direct mass change on the RHS of the equation.

p3.l24 Insert 'then' after 'The actual melt is'. flux
p4.l1 Consider adding numbers for the 4 different parametrizations below. 1. Constant, 2. Oerlemans and Krapp …
p4.l12 The end of the sentence 'would likely already be wet if the real surface was resolved' needs further explanation to be comprehensible.
p4.l14 Consider using same notation as for the other forms (number) author: ...

p4.equ(4) Add 5d for Ts = 273K?
p4,l21 Clarify what the first 'this' refers to in 'this was adapted for this model'. Clarify what 'fixed and temperature dependent' means. How can it be both at the same time?
p4.l25 Clarify what 'it' refers to in 'Keeping it constant'

We will include the changes and clarify where necessary. The terms 'fixed' and 'temperature dependent' are misleading and will be rephrased.

p5.l7 Could explain physically what this approach is trying to mimic. Supposedly that the first snow that falls on a wet surface will get wet immediately.

This albedo increase always depends on the amount of snowfall, a few cm of snowfall will not lead to full fresh snow albedo as solar radiation penetrates and the darker old snow is still visible at the surface. Therefore we have an incremental increase with the amount of snowfall. Albedo reseeding is present at every snowfall, but if there is still liquid water present in the layer the albedo will be decreased depending on the liquid water content. We are not resolving standing water at the surface, but only have the liquid water content of entire grid cells.

p5.l21 'ice-sheet' –> 'ice sheet'
p6.l16 Typo 'fesetup' –> setup
p6.l24 Insert 'in the temperature snowpack' after 'grid cell'. Consider consistent use of terms 'layer' vs. 'grid cell' vs. 'grid box'.
p7.l12 'The global sensitivity analysis is a variance-based method'
p7.l13 'In contrast to other methods'
p7.l13 'all parameters are varied at the same time'
p7.l15 remove 'using' after 'hypercube'.
p8.l19 'As the ice sheet has different shapes' –> 'As the ice sheet geometry differs between the two climate states' or similar.

All changes accepted.

p6.l23 'heat supplied by precipitation depends on the temperature'. Which temperature?

"atmospheric" was added for clarification.

p7.fig1 Why is the colour over the ocean different in a and c? Why is there a contour line in the ocean? Are elevations at LGM relative to LGM sea level (as they should) or relative to PD sea-level? Suggest to plot all topographies with ocean surface at sea-level = 0.

During the present day we have the sea floor also resolved, we will change this by setting the ocean surface to 0°C everywhere. References are relative to the sea level at that time.

p8.l18 Specify temperatures in degree C instead.

We will change the temperature to °C everywhere during the climate discussion.

p8.l19 Why not use the larger ice sheet area of the LGM for both to avoid biases e.g.

from the large ocean area in the south-east?

Biases arise in either case as the actual ice sheet extent is not similar. The statement is just taken as a rough comparison between the climate states, therefore we do not provide uncertainties and just describe how it was calculated.

p8.l25 How is the model run back and forth? Is it reversible problem? in time?

We will clarify this in the revised manuscript. “BESSI was run for 500 years with the same forcing data looping the forcing data back and forth (1979-2017-1979-2017…).” This effectively avoids unrealistic jumps in the boundary conditions that would otherwise arise from the (temperature) trend in the observational period. The model itself always runs forward in time.

p8.l31 Explain why the ensemble is split in two.

We are going to include the following description in the revised manuscript: For computing both sensitivity indices the estimator from Sobol et al. (2007) was used. It splits the initial sequence into two subsets A and B each consisting of one half of the initial sequence (1000 × 9). Then an additional set of matrices BAi, which are based on the matrix B where the values for parameter.

p9.l1 Suggest to move ’A detailed description of the algorithm can be found in (Sobol et al., 2007) and (Saltelli et al., 2010).’ after ’used to estimate the model sensitivity.’ to where the general description of the method ends. Also, specify k in your example.
p9.l15 Insert ’STi’ after ’total sensitivity index’.
p9.l16 Clarify temporal or spatial average in ’surface mass balance and the average surface temperature’.
p9.l17 Specify which variables are averaged and which are summed.
p9.18 ’reseeding’ –> ’residing’

We will adopt all suggested changes and clarifications.

p10.fig2 Do you explain somewhere how the sensitivity is normalised? The plot of Greenland looks distorted. Can this be plotted in equal aspect ratio. Additional (white) contour lines could make the region separation clearer. Caption: Add panel for ’entire ice sheet’ to the description. Consider adding panel indicators a-f for the boxes and g for the GrIS plot and use them in the text.

Equation 17 and 18 explain this. The plot is slightly distorted as the focus on the aspects was on the content of the graphics, we will try to adjust this. We will not add white contour lines, the focus of this plot is the sensitivity analysis and its uncertainty by elevation, we want to avoid focus on regional differences. We will add the indicators a-f.

P10.l4 Maybe ’low’ –> ’limited’
p10.l4 Remove ’changes’ after ’SMB’
p10.l5 See general comment on relative sensitivity of parameters dependent on choice of parameter range. Should be clarified here.
p10.l6 Check consistency Eatm (here) - Eair (Figure 2)
p10.l7 Check consistency DSH (here) - Dsf (Figure 2)
p10.l9 Add ’albedo’ after ’the fresh snow’

We apply the changes and check for consistency.

p10.l14 is 'above 2000 m' > 2000 or the region 2000-3000? Clarify

This will be changed to "regions above 2000 m".

p11.fig3 Title: 'Sensitivity of the SMB at PD' Are values >1 actually defined for this analysis? If not, why is the yellow arrow on the colour bar? What does a sensitivity index above 1 mean? The colour scale with the darkest colour for the least important results is not convincing me. Contour lines are not visible on most plots. Suggest a different (lighter) colour and omitting the numbers. Caption: Mention figure is for PD. Mention colour choice for ice free land. 'mass balance' –> 'surface mass balance'. Reformulate 'are not to be taken too seriously'. If we don't take the absolute values seriously, what is left in this figure? If relative values are more important, find a way to plot those instead.

Total sensitivity indices, which include interactions could mathematically be greater than 1 due to it being only estimated. The sum of the total indices can be greater than 1, while the main order indices cannot. We will change the contour lines and adjust the figure caption. Though we will keep the color coding. The wording of seriously is unfortunate and will be changed. We wanted to highlight that these numbers similarly to figure 2 come with uncertainties, but we wanted to avoid showing two additional uncertainty figures.

p12.l2 Reformulate 'the structure is much more complex'. What does that mean? There is more information in 2D compared to 0D?

We will change this to "... but there is also a spatial dependency which is not purely elevational".

p12.l3 remove 'glaciers' after 'west coast'.

We are actually referring to small ice caps and glacier cells on the west coast of Greenland south of Disko Bay. We will remove the statement as it does not serve any discussion purpose, though the feature is clearly visible in the GSA map.

p12.l7,8 2x 'becomes' –> 'is'. Otherwise this implies important a process.
p12.l30 Reformulate 'negative ensemble member'.
p12.l33 'interior of Greenland

We will adopt the changes.

p12.l33 Clarify 'the atmosphere is more in balance with the snow surface'. What does that mean?

It refers to "the temperature is much closer to the snow surface temperature".

p12.l34 Consider adding a section header 'LGM analysis' or similar to make a clearer separation between the two climate states in the text.
p14.l8 Would an additional figure similar to Fig2 for the LGM help?

p14.l2 ’The ice sheet integrated SMB’. Do we see this somewhere? Consider adding a figure or table and refer to it here.

See general comments. We will include a similar plot as fig 2. in the Appendix.

p13.fig4 Title: ’Sensitivity of the SMB at LGM’ See comments for fig3 for general layout.
Caption: Start with description what is shown, not with discussion of the figure.

We will use a similar caption description as for Figure 3.

p14.l4 ’do not impact the SMB’. Not at all? Clarify

We changed the wording to “marginally”.

p14.l4 add ’the’ in ’either of the two climate states’. Refer to fig 3 and 4 then.
p14.l4-7 First start discussion of LGM, then continue comparison LGM-PD.
p14.l8 ’increased’. Relative to PD? Clarify.
p14.l9 Add ’surface’ before ’mass balance’.
p14.l11 ’intra-annual variability’ –> ’seasonal variability’
p14.l15 remove ’temperature’ after ’surface and the air’, to avoid duplication.
p14.l16 ’the fewest precipitation amounts’. Is this shown somewhere? If not, add ’not shown’ in the text.
p14.l18 Add ’at LGM’ after ’The reduced model sensitivity’.
p14.l21 ’The sensitivity of ...’ to what? maybe ’model parameters’?

We include the suggested changes and clarify where necessary.

p14.l12-14 ’the ... impact of ... impacts the latent heat flux more than the actual exchange coefficient’?? Not clear. Reformulate. Clarify.

We will change this to “...because the surface temperature via the Clausis-Clapeyron relation has an exponential impact on the latent heat flux resulting in a greater impact than the actual exchange coefficient.“

p14.l22 ’without additional figures’. Not sure this is a good idea, see general point.
Maybe add a table with results instead?

We cannot show 2D data in a table in a reasonable fashion. Therefore, we will include a figure in the appendix showing at least the sensitivity of the turbulent latent heat flux.

p14.l23 What is ’final firn albedo’? Reformulate
p14.l24-25 Not sure I understand this conclusion. Reformulate?
p14.l26 What does ’it’ refer to in ’it is most sensitive’? Clarify
p14.l28 ’as are the snow albedo related ones in the north’ –> ’as are the ones related to snow albedo in the north’
p14.l30 Start sentence with ’Globally’ and then give specific details in the end.
p14.l31 ’the framework’ , maybe ’this framework’, ’our framework’

We include the suggested changes and clarify where necessary.

p15.fig5 Add panel with regions for LGM, which are different and actually used in the analysis (unlike only region 5 for PD). Why invent new regions after what is already introduced in figure 2? Could you not do the analysis for region 1000-2000 instead of region 5? Or find a common subset to use in fig 2? Caption: Start caption with what is displayed in the figure. Results are for the text.

We are including a second panel for the LGM. The regions are defined based on the same present day ice divide and the elevations respectively. Our approach is to start from simple elevation based regions and then go more into detail of more complex patterns. We cannot use 1000-2000 m as one region as the SE is too different from others for example. Region five is 1000 -2000 m at the west side. The regions used here are chosen based on similarity, but we don't want to overcomplicate figure 2 with introducing this already. It makes it easier for the reader to start with known regions. We initially had 28 regions with four elevation bands and 7 geographical areas, we joined them based on similarity in sensitivity of the surface mass balance.

p15.l1 'more' or 'less' than what? Maybe 'closely linked to the SMB'?
p15.l1 'and shows similar sensitivities as have been reported for the SMB'
p15.l4 Add 'surface' before 'mass balance'.
p15.l9 'and 13 for the LGM (2 more around Elsmere Island)'. Need to show these in a figure.

We include the suggested changes and clarify where necessary.

p15.l2 'much lower.' compared to what? Why is that expected? Explain.

Just as expected, the impact of the latent heat flux switch on the snowmelt is much lower than on the SMB.

p15.l6 'Parameters which result in either surface heating or cooling'. More precision needed. It is not the parameters that result in heating or cooling, but the physical process that is parameterised.

We will change this to "physical processes which result... like the turbulent fluxes and the associated parameters".

p15.l7 Add 'Conversely' before 'Albedo', as these are examples where GSA will work.
p15.l8 Add 'so that GSA gives clear results' or similar after 'mass balance'.
p16.l4-6 According to you, parameter Eatm can be well analysed with GSA. Why does it need more detail here?

We want to clarify that GSA always works, but there is additional information extractable with other analysis.

p15.l19 'based on elevation and similarity'. Similarity of what? Explain.

See the comments to figure 5.

p16.fig6 Add yticks in column 2 and 3. Suggest to plot all results as discrete boxes. The mix between continuous quantiles and discrete outliers looks strange to me. Caption: Add that this is for PD.

Discrete boxes do not work for this amount of boxes, we will try to plot the outliers at their actual location rather than the center of the box.

p16.l1 What does 'It' refer to in 'It shows'?

We added Fig 6 (a-i).

p16.l6 'accelerating manner' could suggest that the parameter should be sampled non-linearly.

Yes, for research on a particular region or point in Greenland sampling the parameter space non-linearly makes sense, but in this study we investigate the entire ice sheet. Therefore, it is not feasible.

p16.l8 ' the width of the distribution decreases' Could you explain why this is the case? I would think with more available energy (l7), differences in the other parameters have a larger impact on the SMB. Similar with lower albedo (l8), differences in the other parameters are more effective in making a difference.

This is exactly the case. If there is already high energy input (through low albedo or high atmospheric emissivity), and the surface is close to or at the melting point the SMB is much more sensitive to changes in other components of the SEB.

p17.l4 'has the highest median mass balance'. Explain why.

This is explained in line 15 ff.

p17.l6 'The strong impact' on what?
p17.l7 'the other fluxes'. What kind of fluxes? Energy?
p17.l21 'During the LGM the western region between 1000 - 2000 m'. Should be shown.
p17.23 'three distinct changes' –> 'three distinct differences relative to PD'
p17.l23 'χQL results in a decrease of SMB'. Distinguish physical process and parameters.

We include the suggested changes and clarify where necessary. There will be a Figure similarly to Figure 6 for the LGM.

p17.l26 'slower snow albedo decay'. This is discussed as a general result, but is not available in all albedo models, is it?

Though the meaning of the statement is not wrong, we added "for all albedo subroutines which incorporate decay" at the end of the statement.

p17.l30- Make clear that the discussion is back to LGM results.

See general remarks.

p17.l28 ’sublimation ... results in a mass loss rather than a mass gain as in PD.’ You should probably distinguish the opposite sign using the term ’deposition’ or ’desublimation’.

No, we are not talking about deposition or resublimation. Due to the sublimation the surface cools which results in less melting and a more positive SMB.
We removed the parenthesis for clarification. “During the LGM sublimation prevails over the entire year, but in the absence of melt it results in a mass loss rather than a mass gain as in PD via cooling and associated reduced melt.”

p18.fig7 Panels are difficult to compare due to different vertical scale. Add xticks in row 2 and 3 Caption: Add that this is for LGM. Highest elevation at bottom is counterintuitive, consider changing order. Add figure with regions and link from here.

This is not for the LGM, but we add PD for clarification and adjust the caption accordingly.

p19.l2 ’The smallest spread of the ensemble is found in the high altitude-regions 9, 10, 11’. Difficult to judge with different vertical scales in figure. Also, this is a new point. First finish discussion of DSH?

We will change the statement to “smallest relative spread”

p19.l3 ’a result of higher air-temperatures than snow surface temperatures’. Needs more explanation to be clear.

Added: “the warming effect that D_SH has on the surface due to on average higher air-temp.”

P19.l7 What is ’moisture differences between surface and atmosphere’?

We change this to the water vapor pressure of the surface and the atmosphere.

p19.l8 ’7-11’ was 9-11 in the explanation above at l2. Clarify.

The first refers to narrower, while the other mentions smallest.

p19.l14 ’it acts as a buffer of the SMB’. Not clear.

At strong turbulent sensible heat exchange the surface temperature will be buffered by the air-temperature heat reservoir.

p19.l18 Add ’Ql’ after latent heat flux.
p19.l17- Hard to follow this part without any guidance. Include a figure?
p19.l28 ’the SMB decreases’ with what?

p19.l29 ’behavior to the GSA’ –> ’behavior as shown in the GSA’
p19.l35 ’Similar to the GSA’ –> ’Similar to the results from the GSA’
p20.l1 ’above 2500 instead of above 3000 m’. Is this comparing to PD? If so, mention it.

We will clarify and change the respective statements. A figure will be included for the turbulent latent heat flux.

p20.l6 ’in region 5’. And in in all the other regions? No discussion of those?

We focus on region 5 as it shows interesting features. All other regional data will be made available.

p20.l8 ’the air-temperature buffers the snow temperature’. Not clear. Clarify.

At strong turbulent sensible heat exchange the surface temperature will be buffered by the air-temperature heat reservoir.

p20.l14 ’The model sensitivity in this study is evaluated’ –> ’The model sensitivity is evaluated in this study’
p20.l15 ’big’ –> ’large’

p20.l17-18 I would say it is the other way around: lower atmospheric temperatures ... ’leading to fewer areas where melt and runoff occurs’ and consequently ’reduce the impact of QLWin and εatm

At lower atmospheric temperatures the net SEB gets more negative (i.e less heat input from the atmosphere) due to a reduction of QSH and QLWin. Less energy will result in colder snow temperatures, reduced melt and melt area extent.

p20.l20 ’This is due to the absence of melt’. I read this as complete absence of melt. Is that correct? Otherwise ’negligible amount of melt’?

We add in large parts of the ice sheet, as this seemed ambiguous despite mentioning it in the sentence before.

p20.l26 Is it correct that the long-wave radiation is twice as large as the incoming solar radiation? This is for heavy cloud cover?

These are annual averages for coastal areas. So for areas with higher cloud cover, but not for individual days of heavy cloud cover.

p20.l25 ’bigger’ –> ’larger’
p20.l25 ’for the surface during PD’ –> ’for the surface energy balance at PD’
p21.l1 Add ’surface’ before ’mass balance’.
p21.l12 ’the temporal change of the sensitivities’. What is that? The contrast between LGM and PD?
p21.l15- Try to formulate this positively to make it clearer.

p21.l18 Replace ’increased’ by ’larger’
p21.l19 ’during the LGM’ –> ’at the LGM’. Similar for PD and in other places.
p21.l19 replace ’increase’ by ’influence’.
p22.l4 Move ’climate’ to after ’glacial maximum’ in the next line.
p22.l5 ’study the change of the model response under different boundary conditions’ –> ’study the differences of the model response under LGM and PD boundary conditions’.
p22.l6 add ’for the LGM climate’ after ’is a necessity’
p22.l9 ’creates a SMB model uncertainty’ –> ’govern the SMB model uncertainty’
p22.l9-10 ’With the change in circulation during the last glacial a changing energy input from the atmosphere to the surface will result in a SMB response’ –> ’With the different circulation during the last glacial maximum a changing energy input from the atmosphere to the surface will result in a SMB difference.’

We will consider all suggestions mentioned by the referee.

p22.l11-14 I don’t think this has been shown in the manuscript. This could be a discussion item, but not a conclusion of the manuscript if it is not even mentioned before.
p22.l16-18 This reads like a discussion item, not like a conclusion.

We will move this to the discussion.