

Dear Harry,

Thanks a lot for your suggestions. Thanks a lot for all the suggestions. We are glad, that the manuscript has improved and are very glad for all the input! Please find a point-to-point reply to your suggestions below.

l. 9-11: "...The increase in insolation and associated warming early in the deglaciation result in an ELA and SMB increase. The SMB increase is caused by compensating effects of melt and accumulation, as a warmer atmosphere precipitates more?": this is an intriguing finding, which makes it quite difficult to understand for the reader (especially at this stage in the abstract). When you speak about 'compensating' effect, I would expect both processes kind out keeping each other in balance. But my understanding here is that the increase in precipitation outweighs the increase in melt overall (due to which the SMB increases)? And given that the ELA moves to higher elevation, do I understand it correctly that the increase in SMB mainly occurs at high elevation, while at lower elevation the SMB decreased (to a lesser extent)? As you explain elaborately in lines 396-392, this whole process is rather "counter-intuitive". It is therefore important to be really clear in the introduction, to not immediately raise questions related to this finding. May be worth to rephrase to something like: the SMB increase occurs at high elevation (due to increased precipitation) and this effect outweighs the decrease in SMB that occurs at low elevation and causes the ELA to rise.

Thanks for pointing this out. We have rephrased the sentence to "The SMB increase is caused by compensating effects of melt and accumulation: the warming of the atmosphere leads to an increase in melt at low elevations while it results in an increase in accumulation at higher levels, as a warmer atmosphere precipitates more." to make the effect more clear.

Several occurrences where I had to read the sentence several times before understanding it. Here could likely be solved by adding a "," at the correct location, e.g.:

- l.30-31: had to read the sentence several times before I understood it: suggest adding a ',': "...and climate change, output from..."
- l.69: "... long-term climate simulations the coupled..." → "long-term climate simulations, the coupled..."
- l.220: "For grid cells over land melt water..." → "For grid cells over land, melt water..."

Thank you for the careful reading. We added the commas in the proposed locations.

l.64-65: "A thorough evaluation of the long-term model simulations and their forcing data sets used here is subject to a future study (Kapsch et al., in preparation)": here, at the end of the introduction you start referring to future work, which you did not perform here yet. Would recommend leaving this out of introduction. A related question: in the last sentence you refer to a dataset that will be made available to the community: does this refer to the work you present here (if so, refer to 'this dataset is made available'), or also to future work you plan to perform (if so, also best to remove this from the introduction).

We added these references in the introduction in response to previous reviewer comments. We do not have a strong opinion on that, so we removed the reference here in the introduction. Regarding the data set. We changed 'will be made available' to 'is available to the ice-sheet community', as the data set is publicly available and referred to in 'Code and availability'.

In section 2.1, the subdivision of the subsections is not entirely clear: some subsections are not numbered but presented in bold ('height correction' and 'surface mass and energy

balance calculation'), or given in italic bold ('Albedo' and 'Vertical advection and density evolution'). Would recommend numbering all the subsections (potentially introducing new subsections also), otherwise difficult to follow what belongs to what. Another option could consist of removing the all subheading without numbering. Same goes for the non-numbered sections in 2.3 and in section 3.

We changed the headings for better consistency. Specifically, we renamed some sections and chose to number only second order labels.

I.234-235: "we branched off a last millennium simulation at 950 a BP (years before present)": without any explanation, the choice for branching off 1000 years before 1950 seems arbitrary. Why is the branching off for instance not happening 2 or 0.5 ka before 1950? Could you provide a short explanation (one or two sentences should do) why the branching off occurs over last millennium? (maybe a common approach in your field? If so, would then be good to specify this for a non-expert)

We added one general sentence and a reference to last millennium simulations: 'Within PMIP, last millennium simulations are used to provide a seamless transition between the last deglaciation and the historical period (Junglaus et al., 2017). For the simulation, topography, land-sea and glacier masks, [...]'. We reasoned further down in the paragraph also why we have chosen the millennial forcing 'Overall, the applied forcing allows for a more realistic treatment of atmospheric processes associated with changes in e.g., ozone, aerosols, CO₂ concentrations, and land use, and it accounts for their climatic impacts for present day climate conditions.' The millennium simulations allow the model to adjust to the changes in the forcing, which we mention also in the paragraph 'For the evaluation only the years 1980-2010 are used, which allows for a sufficient adjustment of the model to changes in the forcing.'

I.260: "(see Section 2.3 Nowicki et al., 2016; Fettweis et al., 2020)" → "(see Section 2.3; Nowicki et al., 2016; Fettweis et al., 2020)"

Thanks. We changed this.

I.261: in this section, you explain that for the evaluation you rely on ERA-Interim. However, since some time now, ERA5 is out, which is from many perspective a better product than ERA-Interim, which you describe as: "one of the best reanalysis products available" (I. 266-267). Any reason for using ERA-Interim (4th generation product) and not the newer ERA5 (5th generation product)? Especially because you use the new CMIP6 data, I was also expecting to have ERA5 for the past. But maybe this is because the time period available for ERA5 was problematic? Or because ERA5 was not available at the time of analysis (like you mention for instance in earlier section at one point in I.239: "For the years beyond 2010, the forcing fields in the desired resolution were not available at the time of the analysis"). Or because MAR was also forced with ERA-Interim? I am just guessing here, so would be good to shortly mention this in text / provide a brief explanation.

We chose ERA-Interim, as the regional models are using ERA-Interim as boundary forcing. We added a sentence to the section: 'ERA-Interim was chosen, as it is used as boundary forcing in the RCM simulations introduced in the end of this section, which are used for a more thorough evaluation.'

I.331: 'melt' section: for consistency reasons, would it be possible to make a short / qualitative comparison with RACMO here in the text, as you did for the precipitation by

referring to Noël et al. (2019): i.e. just include a sentence on the RACMO value that you give in Table 3, and how this compares to your model simulations.

We added a sentence at the beginning of the paragraph: 'Integrated over the ice sheet, EBM_ERAI, EBM_MPI-ESM-CR, and EBM_MPI-ESM-LR simulate less melt than MAR and RACMO (Table 3) but the sign of the differences varies significantly depending on the region (Fig. 1).'

I. 345-350: you explain some problems occurring with ERA-Interim related to e.g. an "unrealistic representation of cloud optical properties" and "low surface albedos". Out of curiosity: do you think this is better represented with ERA-5, and would this change the outcome of your comparison? If so, potentially worth adding a comment on this.

We have not looked into the ERA-5 reanalysis but the evaluation of reanalysis data is challenging, especially for these kind of parameters (measurements are sparse, specifically in the regions that we are most interested). As we have not mentioned the ERA-5 reanalysis we do not believe that this would add significantly. Also, our main focus is not the ERA-Interim reanalysis but the MPI-ESM-CR simulations. Hence, we did not add any sentence here.

I.353-355: long and difficult sentence to understand. Consider splitting the sentence in two to increase its readability.

Thanks for pointing this out. We have split the sentence to 'The evaluation shows that major differences between MAR and EBM_MPI-ESM-CR are the increased melt on the western flank of Greenland and along the coastal areas as well as the overestimation in accumulation in the southern part of Greenland. The latter can partly be reduced by increasing the model resolution, as shown by comparisons with EBM_MPI-ESM-LR.'

I. 403: "Although melt and accumulation again partly compensate, ...", do you mean that these two compensate one another? Maybe specify to be even clearer: "Although melt and accumulation again partly compensate one another,..."

Thanks for the suggestion. We changed this to 'compensate each other'.

I.414-422: here you describe the state of the ice sheet around the Holocene Thermal Maximum, but you do not explicitly refer to this period / this terminology. Any reason for this? If you think this is adequate, would support a short reference to this period, potentially including references to some studies/observations that have quantified the extent of the ice sheet during this period.

There is no reason that we did not include a reference to this period. We have included a sentence and referred to a recent review paper of this period. 'The minimum SMB (216 Gt a^{-1}) is reached at 8.7 ka, and the maximum ELA (1556m) occurs at 9.3 ka (Fig. 3 and 4), corresponding to the Holocene Thermal Maximum (for a recent review see Axford et al, 2021).'

I.528: "In the future, we will utilize the EBM in...": well, one never knows 100% how things turn out in science and what will happen. Seems really interesting, and hope you can do this, but would suggest having a slightly more conservative/tentative wording: "In the future, we plan to utilize the EBM in..."

In fact, we already completed our first transient fully coupled climate-ice-sheet simulations for the last deglaciation. However, tuning of the model components is still ongoing and the work has not been published yet. ☺ So we take the suggestion despite our first success.

Thank you once again for submitting your work to TC and for fruitfully interacting with the two anonymous reviewers (please acknowledge their help in 'acknowledgments' section also).

Thanks a lot for reminding us! We are very grateful for the discussions with the reviewers and your final suggestions! We added 'Additionally, we are grateful to Thomas Kleinen and two anonymous reviewers for their helpful comments and discussions, which helped to significantly improve this manuscript.'

With best regards,
Marie