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Discussions

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Interactive comment on "Comparison of surface mass balance of ice sheets simulated by positive-degree-day method and energy balance approach" *by* Eva Bauer and Andrey Ganopolski

Anonymous Referee #2

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The study aims at comparing the northern hemispheric surface mass balance throughout the last glacial cycle on basis of a positive-degree-day (PDD) and a surface-energy-balance (SEB) approach. While the SEB approach allows for a realistic representation of the last glacial cycle, as compared to reconstructions (e.g. sea level), the PDD approach shows significant shortcomings if constant values for melt factors and short-term temperature variability are used. The authors discuss a very relevant and timely research topic, which is important for the understanding of the role of ice sheets within the climate system. While the paper is well structured and the simulations are interesting and insightful, revisions are required to improve the comprehensibility.

Page 1, Line 10 to 18: This paragraph of the abstract is somewhat confusing. It would be good if the authors could revise this section; I would suggest either by explaining the simulation setups in more detail or by putting more emphasize on the results and less on the simulations setup, given that they will introduce the setups in detail later.

Page 3, Line 17 to 20: Please introduce here the "offline" and "online" PDD approaches. This will help to understand what is meant by those two approaches (as they are not explicitly mentioned in the Section "Model description"). To understand the difference is crucial for interpreting the results.

Page 4, Section 2.2: The PDD approach is described in detail but the SEB approach is only briefly mentioned. Although the reference Calov et al. (2005) is given additional information regarding the setup would be useful. How is the downscaling from the 7x18 atmospheric grid to the higher resolution SICOPOLIS grid done? How are certain processes regarded when downscaling (e.g. height desertification effect)? Further, it would be good to mention that a one-layer snow model is used. Please also introduce the parameterization of the albedo, given that changes in the albedo of the ice sheet seem to be crucial for the simulation of the last glacial cycle.

Page 6, Line 29-31: While discussing the differences between the American and European ice sheet I am wondering how well CLIMBER represents the interactions between the two ice sheets. Previous studies (e.g. Liakka et al., 2016) have shown that the European ice sheet is significantly influenced by the American Ice Sheet. While discussing reasons for the different responses of the European and American ice sheets these processes should be shortly discussed in regards to the presented results.

Page 12, Discussion: While the results clearly indicate that the SEB approach is superior to the PDD approach for simulating the last glacial cycle it would be good to point towards the weaknesses of both approaches. This might be covered by a more detailed description of the SEB in the method section (see above) or one or two sentences in the discussion section. Further, how realistic are the SEB results?

Most of the results are integrated over the Northern Hemisphere but how is the spatial distribution? It could be good to see e.g. a comparison between the ice sheets derived with the SEB approach during LGM in comparison to LGM reconstructions on a spatial map.

Page 11, Line 14-16 and Conclusions: The authors state that the American melt depends largely on the snow melt factor, which can be attributed to the effect of dust deposition. I think the authors need to clarify how dust deposition and snow age interplay in the model. Is the albedo change a linear function of the snow age/dust or do other factors play in? What is the relationship between snow age (simply changes of snow properties) and dust deposition? Could it be other factors that cause these differences?

Page 11, Line 25 to 31: Fig. 12 needs to be explained better. Please clarify this paragraph. Currently it is hard to follow the reasoning.

Minor issues:

Page 1, Line 2: precessional

Page 2, Line 20: ... meteorological conditions on high frequency time scales – the difference of the input data between SEB and PDD is not clear.

Page 7 and 8: There is a mismatch between the figure order as mentioned in the text and the actual figure order. Fig. 6 before Fig 4 and 5.

Page 7, Line 18 to 19: Remove second 'lie in the range'. Repetition.

Page 7, Line 23: Remove "range". Repetition.

Page 7, Line 30: "." Before "Thereby".

Page 9, Line 25: "we use the latter alphaI value and vary alphaS"

C3

Several times throughout the text: "vice versa" and not "vice verse"

Fig. 9 and 11: The authors could consider a more realistic map projection.

Throughout the text: Please revise for language mistakes.

C4