**Climate
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Discussions

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Interactive comment on "The importance of snow albedo for ice sheet evolution over the last glacial cycle" *by* Matteo Willeit and Andrey Ganopolski

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Willeit and Ganopolski show the importance of considering the effects of snow aging and dust on the snow albedo and consequently on satisfactorily simulating glacial cycles. The article is well written and its relevance is properly justified. In my opininon, the novely of the paper does not lie directly on the results but on the presentation of the parameterizations for accounting on the mentioned effects on snow albedo. Accordingly, the main weakness of the study is reproducibility. The authors should expand on the snow albedo parameterization in order to other groups being able to reproduce (and benefit from) the current study.

General comments

About reproducibility:

Ice sheet – climate coupling represents a considerable ongoing effort for modeling groups. The authors of this article have already convincingly shown in previous studies the necessity of accounting for the snow albedo reduction from ice aging and dust in order to succesfully simulate a deglaciation. This article furtherly contributes to this idea and presents the needed albedo parameterizations to do so. This later aspect can be of great importance to groups currently starting to couple GCMs to thermodynamical ice sheet models. Thus, these parameterizations need to be accordingly described.

1. In page 3, line 14, the snow age factor parameterization is described:

1.1 It might be obvious, but the reader could wonder whether the aging of the snow can simply be computed as a function of temperature and snowfall. Please, ellaborate on this and add references.

1.2 The definition of T_0 is missing.

1.3 The age factor is used to represent the grain size. And Fig.1 shows grain radius. How is CLIMBER-2 translating each other? It is linear? Please provide the related expression.

1.4 Fig.1: Besides the pure snow case, CLIMBER-2 seems to be underestimating the albedo compared to the two other parameterizations. Why? A potential explanation is given by the sentence: "... explained by the choice of the imaginary refractive index of dust". Please, be more specific. On the other hand, the effect of the alternative parameterizations on simulating the glacial cycle is described in the Results section, but it s not explained. I imagine this can simply be a matter of "tunning". Re-calibrating the age factor (or other components of the model) for the two alternative approaches will produce a succesfull ice-volume evolution. If this is the case, please aknowledge in the paper. Otherwise, the reader remains wondering about the realism of the different approaches.

2. In page 10, the effects of considering aeolian and glaciogenic dust individually are discussed. The interactive aeolian dust representation is conveniently described in previous studies. I could not, however, find the equivalent for glaciogenic dust. How is glaciogenic dust generated in CLIMBER-2? Please provide the necessary information. Furthermore, when Fig.7 shows glaciogenic dust as a necessary condition for a full deglaciation.

About discussing the necessity of including a dust cycle:

In the Conclusions section it can be read: "In this study we used an Earth system model of intermediate complexity to show that a proper parameterisation of snow albedo over ice sheets is a crucial ingredient for a successful simulation of the last glacial cycle." This and previous studies from these authors support this conclusion. Nevertheless, other models/groups have shown succesfull glacial cycle simulations without the necessity to invoke "a proper parameterisation of snow albedo". For example, in Abe-Ouchi et al 2007 CP and 2013 Nature, the ablation-isostatic adjustment feedback together with elevation and other feedbacks appear to represent enough processes to simulate the deglaciation.

The current main conclusion (see above) of this paper give rise to interesting related questions: Could CLIMBER-2 simulate a deglaciation without considering the effects of dust on snow albedo? If affirmative, which are then the key processes? Are those other processes equally realistic? Is all the relevant physichs necessary for understanding deglaciations already contained in EMICs? . . . I understand that the authors could see these questions as out of the scope for the current article, but I also believe the readers will appreciate further the current paper if a discussion on this aspect is included.

Specif comments:

Page 1, line 10 and 14: Please use "light-absorbing ..." as later in the paper.

Page 3, line 8: add "in" afer "snow albedo used..."

Caption figure 9: erratum: glaciogenic

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Interactive
comment

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Discussion paper