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Climate of the Past Discussions

Interactive comment on "Modelling snow accumulation on Greenland in Eemian, glacial inception and modern climates in a GCM" *by* H. J. Punge et al.

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We thank the reviewer for his comments on the article. We will address these points and will try to improve the article accordingly.

In detail, we have the following remarks on the review:

C663, L2-10 (resolution):

We agree that resolution is the major limiting factor in the evaluation of our results. We were aware at the conception of the study that, at a GCM resolution, we would not be able to resolve any structure in the boundary layer. This is not feasible with GCMs

at present. Other scientists may be tempted to take the same approach as ours of using a limited resolution GCM and proceed to downscale resulting SMBs for ice sheet modelling. In this sense we see our paper as an orientation for them but also a warning sign on the results to expect. During the study, we considered using the zoomed model approach existing in LMDZ and used for prior studies [Krinner and Genthon, 1997] but found that this would change significantly the modelled surface climate and SMB in the present version of the model. Also, computational cost would have augmented, and still resolution would have been insufficient to resolve the ablation zone. We hence decided to stick with the original resolution and study in more detail the results obtained at GCM type resolution.

C663, L7-9 (station comparison):

We agree that model – station data comparison has to be done with great care when using GCMs. Nonetheless, where station and grid point location and altitude match well, the deviations of the models from observed data can give a good idea at least on the magnitude of model deficiencies, and to document improvement.

C664, L3-6 (resolution):

As stated above, the authors doubt that re-running the simulations at double resolution would be worth the effort. The principal problems remain, and will only be resolved at resolutions on the order of a few km. As long as this is not possible, a scientific impact may still be achieved by improving physics.

C664, L7-16 (structure section 3, variable LBC):

We will try to improve the structure and language of section 3 in the revised manuscript, focussing more on the improvements obtained with the new snow scheme compared to the PPD approach and the gain from using variable vs climatological LBCs. We felt the effect of changes to model levels had to be included for completeness, and may be of some general interest, but will try to reduce its part in this section. As for the

effect of using variable vs. climatological LBCs, it is true that the effect is barely visible in some of the figures. However, we find several non-negligible effects, e.g. for the Eemian in Fig. 8, and their existence is an important motivation to use GCMs instead of simpler energy-balance models. We will try to make this motivation clearer as well in the revised manuscript.

C664, L19-26:

We will try to take your suggestions into account when editing the new version of the manuscript.

C665, L1-3:

Greenhouse gases are still at or close to interglacial levels at 115ky BP (Petit et al, 1999). Here we have considered an experimental design fully consistent with that of the coupled model of which we use the SSTs and sea-ice cover to force our atmospheric model. The strongest forcings for both the 126ky BP and 115ky BP simulations is the orbital forcing, changing the characteristics of the insolation seasonal cycle. This was the aspect which was most interesting to us. Our choice for this simple experimental design is also motivated by its simplicity, although we made the effort to account for changes in SSTs and sea-ice cover. This puts these experiments in the long series of sensitivity experiments to insolation for these periods.

C665, L5-6:

We will try to be more specific.

C665, L7-13:

We will be more precise in the text. The 'snow model' is treating both snow and ice. The criterion is checked at every model time step, so 20cm of ice are always present. This ice can exchange heat with the fixed 'soil' layers of the standard LMDZ below, which have properties of ice on all land ice points. It may be worthwhile to request a minimum number of layers as well in the next model version, to be on the safe side.

C665, L14-16:

We will stress the resolution constraints more clearly.

C665, L17-23:

We will add comments of the type you mention in the article. We will also try to remove sub-figures where they contain little extra information, in particular in the context of the impact of variable vs. Climatological LBCs.

C666:

Thank you for the corrections.

Reference

Krinner, G. and Genthon, C., The Antarctic surface mass balance in a stretched grid general circulation model, Annals of Glaciology, 25, p73-78, 1997

Interactive comment on Clim. Past Discuss., 8, 1523, 2012.