

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

Anonymous Referee #2

Received and published: 26 June 2012

This paper is, so far as I know, the first attempt to include a detailed snow surface scheme into a GCM. For that reason, this work is very interesting. However, a significant drawback is the low model resolution. The chosen resolution, 3.75x1.875 degrees, is not enough to get a realistic estimate of the Greenland SMB or any other surface property. This manuscript shows that technically one can include a detailed snow surface scheme in a GCM. Honestly, that is the main conclusion I would like to draw. Even for evaluation of model results, the resolution is at the coarse side. The Greenland ablation margin is narrow and temperature observations can hardly be compared with model values.

The methods are presented well and seem to me to be correct. The only main comments are on the resolution and suggestions to make the paper better accessible.

The largest improvement to the paper would be a rerun of all (principal) simulations with doubled resolution. Then, the results become valuable to be used by others. Now, the paper is won't grab much attention, I'm afraid. The results on a higher resolution would be a significant step forwards and give this paper much more scientific impact.

Furthermore, I would suggest a revision of the results section (section 3). I have tried to read it twice, but I got lost twice too. Basically, section 3 needs more focus; try to make the text better readable. The main scientific results are the impact of the physical snow scheme on the model results, a guess of the effect for different climatologies; and the different behavior of a physical snow melt scheme compared to PDD. For a non-specialist, the changes due to the altered model level are much detail. Also, the effect of changing LBC conditions is rather small (why were climatological LBCs used at all?). Consider to leave the discussion of interannual LBCs out, or move this to a separate subsection, like PDD as suggested below.

I know there is no perfect solution; in the figures, one puts all results for one variable together; in the text, one discusses the impact of each model change sequentially.

My suggestion is the following:

- Focus in section 3.1.1 only on the results from L_cPI and LScPI (or LSiPI) compared to observations, MAR and RACMO2. Add a table with bias and RMSE of the monthly mean temperature values.
- Reduce the number of numbers in the text, especially on page 1541 L8-21.
- Leave subfigures out which have little information (see suggestions below).
- Bring all information on PDD together and write a separate section (3.5) on the comparison with PDD.

One thing worried me:

1532 L5: Why are Greenhouse gasses left unchanged? This could significantly change the results, especially for 115 ky BP.

Specific comments

- 1524 L20-23: Make the conclusions on ocean forcing more specific. (not state that it changes, but what it changes (and why)).
- 1530 L10-L19: This is not clear. Is the snow load only counting snow, how does it work if all the snow is gone? If ice is counted too, rephrase. In case that ice does count for the snow load: Is the minimum snow load 200 kg m⁻², thus 20 cm of ice? Is this a typo (e.g. 2000)? Otherwise, how does this thin ice layer affect melt at locations with strong ablation? Would this not give spurious strong response of the snow scheme? In case ice doesn't count: how does this work, explain more.
- Section 3.1: Evaluation is the core of every model study. However, mention in the evaluation the coarse model resolution and keep that in mind that is also might cause the differences.
- Subfigures in Fig 2, 3, 6, 7 and 8 are small; therefore, labels are hard to read. Combined with not too intuitive simulation names, the figures are difficult to access. Consider adding comments (or header row) like (for figure 2) "baseline", "Adjusted model level", "SISVAT", "Full adjusted". You might also consider removing subplots with little new information, for example, LSiPI in Fig 23 (nearly equal to LScPI); in Fig 4 surface albedo changes between LVcPIr and L_cPIr (zero per definition).

Textual (first pages only)

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- 1524 L6: 'Issues'. Reformulate
- 1524 L16: 'SMB diminishes largely'. The SMB can't diminish, and ice cap can. When the SMB becomes negative, for example, it still exists; it isn't gone. Reformulate.
- 1524 L16: 'melting affects areas with today high surface altitude...' incorrect English.
- 1524 L26: 'top' -> surface
- 1525 L16: reference should be 'Kuipers Munneke et al, 2011'.
- 1526 L10: avoid confusion: latter -> PDD
- 1527 L2-17: are used -> were used. Apply also on following sentences. It is past research.

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

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