

Review of manuscript “Sensitivity, stability and future evolution of the world’s northernmost ice cap, Hans Tausen Iskappe (Greenland)” by Harry Zekollari, Philippe Huybrechts, Brice Noël, Willem Jan van de Berg and Michiel R. van den Broeke [The Cryosphere Discuss. doi:10.5194/tc-2016-271]

General comments

This paper describes a modelling study for an ice cap in northern Greenland, outside the main ice sheet. It applies a coupled ice flow – mass balance model with PDD – runoff/retention model and precipitation downscaled from RACMO. The experiments are well designed and conclusions drawn from this study are interesting, one being that there is no gain in performing time dependent simulations for the ice cap, Holocene or future, as the response of the model is independent of the model initial conditions and there appears to be 4 sets of steady states possible for the ice cap. The model study shows hysteresis response for a narrow band of temperature forcing (around 0.5°C higher temperature than 1961-1990 average). Authors also point out that the SMB-elevation feedback is a crucial mechanism for the ice cap evolution and stability and that infiltrating meltwater in the ablation area is necessary in order to simulate englacial temperatures. The paper is clearly written and the conclusions are clear, some minor comments for improvements are suggested below. To improve the overall clarity of the paper, better description of the model resolution as well as the temperature forcing would be good, see below.

Specific comments:

It is now clear whether the input fields for the PDD scheme, precipitation from RACMO and parameterized temperatures are downscaled to the ice flow model grid resolution or if the SMB field is downscaled. Clarification in the model setup section is needed, see suggestions below. In several places it is stated that RACMO is run at 11 km and then precipitation downscaled to 1 km, but is it then further downscaled to 500 m or 250 m?

Some confusion is in the discussion of the results, the description of the forcing is not clear, are all the forcing scenarios shifted relative to the 1961-1990 condition? And then some of them fall onto 1981-2010 or 2005-2014 mean conditions? Figure 9 has both 1961-1990—0.5°C and different periods, but Figure 10 has all temperature scenarios relative to the reference. Some clarification in the model or experimental description is needed.

Technical corrections:

Page 1, Abstract, Line 24, suggest to replace “grow” with “thicken”

Page 2, line 5, delete “s” on exist

Page 3, line 15-17, sentence is confusing, how do inconsistencies arise with bedrock from Starzer and Reeh (2001) if the direct ice thickness measurements are not included in the Bamber et al (1013) dataset?

Page 6, line 31-32, make sure that the minus sign - sticks with the number

Page 7, line 24, suggest to add “daily” before variability

Page 8, here the resolution of the T parameterization could be mentioned, ice flow model resolution?

Page 9, line 11, is the precipitation then further downscaled to ice flow model resolution?

Page 9, line 20, what is “frontal SMB” - terminus ablation?

Page 9, line 27-32 – here the different forcing scenarios, shifted relative to 1961-1990 or other periods, could be presented and explained

Page 10 line 6, suggest to replace “further” with “below”

Page 10, line 12, what does “imposed” mean here? is the SMB regrided to 250 or 500 m resolution?

Page 10, line 21, edit, something strange in the sentence “but except”

Page 10, line 31, is the grid not at 250m resolution?

Page 11, line 10, suggest to replace “heating” with “heat flux”

Page 11, line 21 and onward, it is not clear what is discussed here, paragraph needs rewriting “With a value of 150 mW m⁻²” - is not clear

Page 12, lines 1-4, strange sentence, suggest editing

Page 12, line 17, suggest to replace “to” with “with”

Page 12, line 17-20, too long sentence, suggest to split into two

Page 13, line 10, here it seems like SMB is calculated at the ice flow model resolution, is then T and P downscaled to this resolution?

Page 13, lines 18-21, long sentence, suggest to split or rewrite

Page 13, line 25, “which results in smoothing...”

Page 14, line 2, something is missing in title, “of”?

Page 14, line 23, text is confusing “(vs. “ do you mean relative? Is it only temperature shift?, what are 1981-2010 conditions, do you mean in the RACMO model?”

Page 14, line 28, “build up faster than under 1961-1990 condition” – does not make sense, what do you mean by faster?

Page 15, line 5, replace “parts” with “part”

Page 15, line 15, what does “largely similar” mean?

Page 16, line 15, needs editing, text is unclear

Page 16, line 19 “slightly different transient geometry” needs editing, not clear

Page 17, line 20-22, text needs editing, two times “potential” in sentence

Page 18, line 4, suggest to replace “was” with “is”

Page 19, line 1 “Both” – and then three things are mentioned, needs editing

Figure 3 Annual and mean July are in different sequence in the figure and in the caption; (a), b) vs c) d)), suggest to move the precipitation figure to the right column so that RACMO fields are all in the same column

Figure 5, suggest coloring dotted line white, it is hardly visible as it is now

Figure 6 b) is not clear, suggest less vertical exaggeration?

Figure 9 C is the period 1961-1990? Or 2010?