Clim. Past Discuss., 11, C195–C197, 2015
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Climate of the Past Discussions

Interactive comment on "Coupled Northern Hemisphere permafrost-ice sheet evolution over the last glacial cycle" *by* M. Willeit and A. Ganopolski

L. Tarasov (Referee)

lev@mun.ca

Received and published: 31 March 2015

This is a nice model-based examination of glacial cycle permafrost evolution, extending and improving on various aspects of previous studies. The bedthermal permafrost model has appropriate detail and it's great to see a full surface energy balance coupling. The importance of appropriate bedthermal initialization is clearly shown. There is also some thoughtful physical analysis of some of the parametric sensitivities and time evolution. I have only a few comments below that can be easily addressed:

The included sensitivity studies address some of the bedthermal parametric uncertainties. However, the interpretable value of the results would increase if there was

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more discussion on the temperature uncertainty/bias of the CLIMBER 2 climate+ice sheet model. There are significant uncertainties in the climate forcing which in good part controls the ice sheet extent and thickness evolution. Both of these will affect bedthermal energy balance and permafrost extent.

Even better would be some ensemble results to partly quantify the uncertainties due to climate model parametric uncertainties (only bedthermal parametric uncertainties are considered) and climate model initialization. However, I suspect the computational time for such an endeavor would excessively delay revision.

"Laurentide ice sheet (LIS) during the last glacial cycle. Marshall and Clark (2002) suggested that at the last glacial maximum (LGM) 20–40% of the LIS was warm-based but the value increased to 50–80% during glacial termination. Ganopolski et al. (2010) found a temperate base fraction of around 20% throughout most of glacial periods with only a minor increase during deglaciation. Studies including the effect of"

I'm curious why the much higher LGM warm-based fraction of Tarasov and Peltier (2007) isn't discussed nor mentioned. From my perhaps ice sheet centric orientation, that's an important statistic with respect to ice sheet evolution. Part of this difference can be attributed to the better initialization in the current study (going by the larger permafrost volumes with earlier initialization shown in figure 16). Is the rest due to a more advanced treatment of thermal conductivity and the full surface energy balance calculation? But as a counterpoint, the 2007 study had better constraint of LGM and deglacial ice extent/thickness through initial large ensemble calibration against a large set of paleo data. Quantification of the role of earlier initialization in explaining the difference could be made much clearer by a warm based fraction comparison of 120ka versus 780 ka initialization.

"simulations indicate that deep permafrost has a memory of surface temperature variations going back to at least 800 kya."

An alternative to such a long run for bedthermal initialization would be an more ap-

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propriate choice of equilibrium temperature forcing for initialization, eg as described in Briggs et al, 2013 (TC).

"The thermal offset is not accounted for in our model as it would require a detailed representation of the seasonally varying active layer, which is beyond the scope of this study focusing on permafrost evolution over much longer timescales."

Or one can regress the impact of the thermal offset as done in Tarasov and Peltier, 2007.

"As already shown in Ganopolski et al. (2010); Ganopolski and Calov (2011) CLIMBER- 2 realistically simulates the Northern Hemisphere ice sheets variations over the last glacial cycles."

what does realistically mean? That word gets way over used by modellers. Please be more precise.

** # minor grammar/wording **********

pg 558 It also allows to address the -> It enables the assessment of the

pg 560 does generally not freeze -> generally does not freeze

table 1, kw has wrong units, should be W/m/K

Interactive comment on Clim. Past Discuss., 11, 555, 2015.