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Interactive comment on “Impact of model developments on present and future simulations of permafrost in a global land-surface model” by S. E. Chadburn et al.

Anonymous Referee #1

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Impact of model developments on present and future simulations of permafrost in a global land-surface model

General Comments

This paper investigates the impact of new developments, i.e. organic soil, moss, bedrock and a modification of the snow scheme, in JULES, on simulated permafrost. The new developments are shown to improve significantly the soil temperature, active layer thickness etc. The article further explores projected changes to near surface permafrost area, and reports a 50% decrease by the end of the 21st century for RCP8.5 scenario. Very few studies are available so far on this topic and therefore this is an

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important contribution to understanding representation of permafrost in land surface schemes and permafrost evolution in a future warmer climate. The paper is very well written and is easy to follow and I only have some minor suggestions.

First of all, the use of 'permafrost' and 'near-surface permafrost' is a bit unclear in the text. The authors can state upfront the definition for near-surface permafrost and use it where appropriate.

The experiments orgmossD and orgmossDS differ in SWE. The authors indicate that in the old zero-layer snow scheme, the insulation from snow was incorporated in the top layer of the soil. How exactly is this done? What about the hydrology part? This is not clear from reading the text. I would suggest that the authors add few more lines to clarify this in this text.

The authors show and discuss figures that demonstrate the impact of the new developments on the soil thermal regime, but I did not find any discussion on the soil hydrologic regime. Some discussion in this regard should be there in the article as the soil thermal and hydrologic regimes are tightly linked.

The simulations for current climate is driven by WATCH forcing dataset and those for future simulations, starting in 2006, are driven by adding future climate anomalies from CCSM4 to the meteorological forcing, for two scenarios. It would be useful to show these anomalies, particularly for summer temperature and SWE, for the two scenarios, since these are the most important factors controlling near-surface permafrost evolution.

Other specific remarks follow.

Specific comments

Page 1967, Lines 7 to 9: 'Additional new processes....modification to the snow scheme' can be modified to make clear that the sensitivity of permafrost to these new developments are investigated in this study.

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Page 1970, Lines 12 to 18: How are snow thermal conductivity and albedo modelled? Please provide related information.

Page 1971, Lines 18 to 20: The authors mention that the soil column is 10 m deep in all experiments except min4I and min14I. What is the reason behind choosing 10 m? For most of the pan-arctic region, it is going to be smaller than that, at the resolution used in this study. Previous studies have either used constant depths in the range of 3 to 4 m or they vary in space according to available datasets. If these experiments were to be repeated with soil column in the 3 to 4 m range, there could be important changes, isn't it? The experiments with deeper configuration include bedrock. The depth of this layer and thickness of layers should be indicated here in the text, though the information can be found in Table 2.

Page 1976, Line15: As indicated under general remarks, provide plots for the projected changes to SWE and summer temperature.

Page 1980, Line3: '...is less than 3m for the preceding two years is assumed to have permafrost'. Definition of permafrost and near-surface permafrost to be provided in the text upfront.

Page 1984, Line18: 'all permafrost points (a) and all points (b)'. I think this should be near-surface permafrost points and all permafrost points.

Figures:

Figure 2: Difficult to distinguish between shrub tundra and boreal forest in the top panel. Maybe this occurred during the creation of the pdf file.

Figure 8: '...permafrost points only: this includes only those points with ALT less than 3m. 70% thaw to 3m or deeper.' What is the range of ALTs that you got for this 70% points?

Interactive comment on The Cryosphere Discuss., 9, 1965, 2015.

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