

Interactive comment on “Soil frost-induced soil moisture precipitation feedback over high northern latitudes” by Stefan Hagemann et al.

Anonymous Referee #1

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This study evaluates the implementation of a permafrost and updated snow scheme into the land surface component of the ECHAM climate model, focusing on an analysis of the hydrological impacts. The implementation leads to a strong decrease in liquid and transportable soil water, changing the seasonal amplitude of all other hydrological balance components: discharge, evaporation (and consequently temperature), precipitation and shortwave radiation. The strong impact on the precipitation makes the authors conclude that a positive soil moisture-precipitation feedback is also present in these high latitude areas, a feature that has been overlooked in previous studies exploring these feedbacks.

Although the set-up of the experiment and the discussion of the results are well done and straightforward, I find some of the conclusions somewhat speculative. First, the existence of this positive feedback cannot be diagnosed very well from comparing two

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(ensemble) simulations of different model configuration. An experimental design is required in which this feedback loop is explicitly affected, which is not the case here. It is surprising that earlier feedback studies as the ones by Koster et al and a few successors did not pick up this positive feedback in this area, in spite of targeting the same summer season as discussed extensively by the authors. Also, such a positive feedback, when present, does require a sufficient amount of energy to generate a reasonable hydrological cycle. It should be shown that a significant fraction of available energy is not used for precipitation, by computing a kind of Budyko index. Second, it is somewhat unclear why the large effects of the new scheme also tend to extend to areas where snow and permafrost occurrence is much less pronounced. Apparently strong alterations of the scheme to the entire soil hydrological balance are imposed.

For both notions a different presentation of results would be favorable. Particularly figs 2-4 should be presented as a difference between the 2 model versions rather than (or in addition to) the difference to observations. This provides a better connection to fig 12, and allows a discussion on the spatial structure of the supposed feedback.

Specific comments

L57: “becomes CO₂” sounds a bit odd

L76: whereat -> whereas

L108: excluded from

Fig 1: the difference in permafrost area is not very clear nor impressive

L362: Koster et al 2004 did not present annual means but JJA means

L406: the advection of warm air is also of influence on the recycling ratio that is computed. You should address this aspect

Fig 6: the dark blue and black colors are too similar to be distinguishable

Fig 8: which model is shown here? Why only one model?

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Fig 12: what is the role of temperature in this diagram? It seems an important variable

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