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Interactive comment on "Simulating the thermal regime and thaw processes of ice-rich permafrost ground with the land-surface model CryoGrid 3" *by* S. Westermann et al.

Anonymous Referee #3

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DESCRIPTION

This paper introduces a new land surface scheme, CRYOGRID3 which is a flexible platform for exploring new parameterizations of permafrost processes. In particular, novel parameterizations of thaw processes that account for important lateral and vertical movement of water are developed. The scheme is described in detail and then evaluated against in-situ measurements in NE Siberia. The authors find that the model is able to reproduce long term evolution of the ground thermals regime and also the coupling of atmosphere-surface energy processes.

A parameterization is introduced that extends excess ice melt routine of Lee et al. 2014

to to include energy transfer in shallow ponds. Finally, future climate simulations are conducted that demonstrate that the hydrological regime can both accelerate and delay permafrost thawing.

Overall the paper is well written and structured (with one caveat below), addresses an important question and aims to permit the inclusion of poorly/non-represented sub-grid surface processes in climate model simulations. This is an important and emerging area of research and has the potential to greatly improve the representation of surface-atmosphere interactions with respect to permafrost thaw, particularly in high latitude regions.

MAIN COMMENTS

1. p.6935 l. 7. I don't think all aims are included in the "in this study..." section. E.g. climate simulations are not mentioned. I think this section could set the scene and introduce the structure of the paper better so the reader can follow more easily where you're going.

2. A table summarizing differences between CRYOGRID2 + 3 would be useful to quickly see main processes accounted for and where (which paper) to look for which description.

3. The aim to be a modular model is really interesting and goes in the direction of the Factorial Snow Model (Essery 2015) philosophy. These are great and very useful developments. However, (a) this needs to be stressed earlier in the paper I.e. in the Intro/Aims and not left just to p.6960 where it is then really clear what the ambition of this model is. (b) would it be possible to include a figure that schematically illustrates how such a modular model works – which components are targeted, options etc? I think this is quite a strength of CRYOGRID3 and would be great for this potential to be more explicitly presented. I think such a figure would also help in tuning the reader into exactly what this model focuses on.

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4. It would also be nice through this figure (+ short text) to get an idea of what foreseen limits to this modularity are e.g. could you plugin routines from other models which are currently superior in a non-target area of CRYOGRID3 such as the snowpack accumulation/ablation processes?

5. p. 6952 l.2 Any idea how good the ERA snow data is in your area? Limiting accumulation to height of polygon suggests you had too much snow from ERA, which is interesting as often it is found that ERA is negatively biased for precipitation.

6. What is the elevation difference between the ERA grid and surface elevation? Its probably not too much in your relatively flat domain – but still could have an influence on downscaling success so could be interesting to know. This is also relevant to p.6954 l.27: the elevation difference would have an effect on rain/snow threshold if using snow data directly and if CRYOGRID doesn't compute rain/snow based on the downscaled air temperature. Is this likely to have a significant effect on received phase of precip?

TECHNICAL COMMENTS

1. p. 6935 l.18 "up on" → upon

2. p.6946 l.1 mains → maintains

3. p.6947 l.18 if → is

4. p.6949 l.27 in → from

5. p.6951 l.28 months → month

6. p.6953 l.21 snowfall data is also capped to height of polygon as in the vaqlidation run?

7. p.6954 l.9 on → of

8. p.6954 l.15 despite of → despite

9. p.6954 l.17 remove second use of "snow"

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10. p.6958 l.14 despite → in despite

11. p.6959 l.12 an → until

12. p.6965 l12 use of 'hereby' sounds a bit awkward here. Perhaps just: "...excess ground ice and resulting hydrological processes..."

REFERENCES

Essery, R.: A Factorial Snowpack Model (FSM 1.0), Geosci. Model Dev. Discuss., 8, 6583-6609, doi:10.5194/gmdd-8-6583-2015, 2015.

Interactive comment on Geosci. Model Dev. Discuss., 8, 6931, 2015.