

## ***Interactive comment on “Thaw processes in ice-rich permafrost landscapes represented with laterally coupled tiles in a Land Surface Model” by Kjetil S. Aas et al.***

### **Anonymous Referee #1**

Received and published: 19 December 2018

This paper describes how small-scale surface heterogeneity due to excess ice can be, in a relatively simple way, implemented in land surface models, in this case, the NoahMP LSM. A companion paper described a similar work with the Cryogrid model. The motivation of the work is clearly and convincingly laid out, the paper is well structured, easy to read and generally well written (except for frequent systematic grammatical errors). The spirit of the paper is that this work should be seen as a proof of concept, and it is made rather clear that the implementation of such an approach in ESMs will not be an easy task.

The methods are described very clearly, and they appear to me appropriate in terms

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of complexity in the sense that the proposed scheme appears to be on a similar level of complexity as the rest of the model this scheme was implemented in. One might wonder whether some effort should have been devoted to implementing excess ice formation; the possible long time scales involved in the excess ice aggradation could be an argument to discard that option, given that the type of models this approach is designed for is made for centennial-scale simulations, at best.

The discussion of the limitations of this work is honest. I would have liked to see a more thorough analysis of the sensitivity of the model to some critical parameters, in particular those linked to snow; maybe some sensitivity tests might be in order. In the discussion (sections 5.1 and 5.2), it would have been good to provide the reader with some more quantitative (if possible) estimates of the importance of neglected processes, and with corresponding priorities in future developments. Concerning the implementation in ESMs, it is clear that heterogeneity linked to excess ice is relevant only on a small part of the globe. In many other places, the most relevant heterogeneities are linked to vegetation, orography, or other factors. Can the authors think of a more general (globally relevant) tiling concept in which the tiling linked to excess ice could be integrated?

In conclusion, I definitely think that this paper should be published if the points above and some specific points mentioned below are addressed. This should only require minor modifications.

Specific points:

- P5 L28: FEXICE (and similar variable names in the text): In the figure, you use  $F_{EXICE}$  (EXICE as an index), so please do so in the main text, too.
- P6 L27: In the equation and in the text,  $K_{sat}$  is a constant. Call it  $K_{sat,0}$  for  $K_{sat}$  at the surface, to prevent confusion.
- P7 L10: "The lateral ground heat flux [ . . . ] between two grid cells with overlapping

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soil depth. . ." Cells or tiles? Probably tiles.

- P7 L17-18: Not clear why the elevated tile is used as a reference. In most models, there is no excess ice yet, so it might have been more appropriate to use the lower tile as a reference (especially because you do not use stagnant water at the surface anyway).
- By the way, it would have been nice, in the discussion, to spend a few lines on discussing how taking into account stagnant water could have changes the results. In my opinion, it could have very major impacts.
- P7 L29: "This expands the soil thickness of the RIM with 1.5 m". Wouldn't "by 1.5 m" be better English?
- P8 L2: "we additionally add excess ice to the bottom soil layer (in both coupled tiles)": In the figure it looks like the 35 cm excess ice are added to the lowest layer only in the lower tile. Please clarify.
- P8 L14: "but still show continued": -> shows. In many places, there are wrong or missing s's (wrong plurals, wrong conjugation). Please go through the text carefully.
- P8 L14: "making which makes"
- P9 L2: I understand why you introduce figure 7 here before figures 5 and 6, but I think that the figure numbers should be in order of appearance in the text nevertheless.
- P9 L20: "simulation.." (only one point needed)
- Same line: "become is": ?

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- P10 L19: Why do you call the sensible heat flux HFX? Doesn't make much sense to me.
- P11 L23: Replace whereas by while (I think)
- P12 L16: scarcely -> barely?
- P13 L26: "becoming in equilibrium": Are you sure that this is good English?
- P14 L3: replace instantaneously by instantaneous (and does by do on the same line)
- P14 L27: As said before, a sensitivity test showing the effect of the snow parameters would have been interesting. Or would that be too model-specific?
- P15 L23: "Simulating instead surface water in low-centered polygons, or water-filled troughs in the degraded, high-centered stage, would modify the results presented here." As said before, I'd like to see a discussion how this would modify the results (in your expert opinion)

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2018-210>, 2018.

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