

Dear Dr. Lei Cai et al.,

Thank you for your responses to the Author's Comments. I recommend that you submit a revised manuscript according to address the referee's comments and few more that I have made that stem from their comments.

Re: Referee #2

Referee #2 seems generally satisfied with the revised version of the manuscript, but offers a few major points and several minor points that you have indicated will be addressed in your next revision. Your replies seem to address the questions adequately, with the exception of the reply to R2's comment about your assumption on Line 220:

"Line 220: "Have the same area fraction of low ice landunit", You may add "(20%" to make it clearer. What is the reason behind this assumption?"

- Please make the reason behind this assumption clear in the revised version of the manuscript. I do not fully understand the logic as written in your Author's Reply.

Re: Referee #1

Referee #1 was not that satisfied with the revised version of the manuscript, and did not provide comments on the Results and Discussion as a consequence. R1's major criticisms still stem from initial concerns raised in the first round of reviews that there was (i) not enough demonstration of the empirical basis for the parameterization of excess ice, and (ii) that knowledge and understanding gained from empirical ground ice studies needs to be made clearer to the reader. R1 provided several detailed points to help crystalize the issues.

Having read through your Author's Reply to R1, I have the following suggestions for you to incorporate into your next revision:

- As you say you intend to, please ensure that you state early on a clear scope and what the great limitations are.
- Regarding terminology around ground ice content, I hope that it is made clear in the revised version. In the Author's Reply you say "we emphasize that volumetric ice content in this study refers only to excess ice bodies", but this is not how most readers think of volumetric ice content. Volumetric ice content is pore ice + excess ice. If you use the term "volumetric excess ice", it must always mean the volume ice in excess of the pore ice. The terminology must be reconciled, made clear to the reader, and agree with how the terms are commonly defined.
- Regarding excess ice content outside of the Yedoma Region, I suggest that you try to follow R1's comment and develop a way to better initialize wedge ice types that are not within Yedoma deposits. R1 makes a good suggestion to "overlay CAPS and Yedoma areas in a GIS and examine the overlap within chf, chr, and dhf to better inform and substantiate landunit parameterizations/area weights", which should be follow up on in the revised manuscript. Perhaps also have a look at O'Neill et al. (The Cryosphere, 13, 753–773, 2019, <https://doi.org/10.5194/tc-13-753-2019>).

- In your response to R1's comment 3, you state a caveat about the availability of ground ice information helpful to your sub-grid representation:

“As we mentioned, there is a lack of dataset on ground excess ice with enough information helpful for our sub-grid excess ice representation. For this reason, this is our best effort to make a possible scenario of excess ice distribution based on the best dataset (the CAPS data) at this time, even though it only provides generalized information and has been released for more than 20 years. Due to the lack of adequate information in excess ice distributions, the purpose of this study is not to make an accurate estimate of excess ice melt and surface subsidence in the 21st century, but rather to develop a functionable process within a land surface model on a global scale. Once there is a new generation of excess ice dataset, the CLM with sub-grid excess ice representation is able to be operational and give more accurate projections of excess ice melt and surface subsidences.”

 - Please make sure that you state something to this effect in the introduction. Stating the clear purpose will set up clear expectations from the reader. This caveat should also be echoed in the Discussion. Given all of the uncertainty, and the goal of making a functioning process within the land surface model, it would be instructive to include a sensitivity analysis of the effects of differing sub-grid excess ice representation.
- Regarding R1's point 4, I don't follow the calculation in your example. If the original soil layer is 7.5 m thick (between 1 and 8.5 m), and you increase it's volume by 70%, 7.5×1.70 is 12.75. adding back the first 1 m of ground gives 13.75 m of hydrologically active soil, no? Not sure how one arrives at 18.5 m of hydrologically active soil. In any case, please make sure that the added content in the main text makes the model design clearer.
- Regarding R1's point 5, it perhaps stems from the initial set up of the reader's expectations. You have indicated that you have added clarification in the new text to address this point. I additionally suggest that if the purpose of the manuscript is “not to retrieve realistic excess ice melt, but rather to compare the model results from this study and from Westermann et al. (2016)”, then this purpose needs to be stated explicitly, and the inclusion of comparisons to empirical studies should be carefully done so as not to give the wrong impression.
- Regarding R1's point 6, I agree that the schematic should show how the model actually represents ground ice in the grid point. Show the “squeezing”. If the added ice is “evenly distributed within each soil layer”, please show this distribution. It is expected that this representation is an abstraction, and not reality.
- Please note the references kindly provided by R1 and incorporate where appropriate.

I look forward to receiving your revised manuscript in the near future.

Best regards,

Peter