

Interactive comment on “On the Configuration and Initialization of a Large Scale Hydrological Land Surface Model to Represent Permafrost” by M. E. Elshamy et al.

Anonymous Referee #1

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General comments

Elshamy et al. detail testing and resultant guidelines for the configuration and initialization (especially ‘spinning up’) of permafrost in large-scale hydrologic models, with a focus in this study of the Mackenzie River Basin. Permafrost exerts primary control on hydrologic routing in cold regions, and thus this topic is critical for Canada and other countries with high latitude regions that are experiencing high rates of warming. As such, the manuscript scope is a good fit for HESS, and the collective authorship team offers many decades of modeling experience and insight. I think the paper will be a useful contribution to HESS, but I think it needs some reworking.

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Major concerns

1. This is a vague concern, but this comes across as a bit of a high-end technical report in places, more than a research paper. Rather than detail why that is, I list a few specific concerns below that map to this general overarching theme.
2. This discussion on changing annual discharge is a bit overly simplified. I'd break this down a bit more into different seasons. There is a pretty consistent increase in minimum flows across the pan-Arctic (see, for example, the recent ECCO report, Canada's Changing Climate, or Walvoord and Striegl 2007 GRL, St Jacques and Sauchyn 2009 GRL, Duan et al. 2017 Water – for China)
3. The intro is quite long – it is 6 paragraphs, of which several are long. Also, the objectives section which follows is normally embedded in the intro in most papers. This would add about another 2 paragraphs. This needs to be trimmed. Paragraph 4 is especially wordy. Paragraphs 5 and 6 could be cut by 50%.
4. Lists or bulleted sections are not written very parallel in this paper, and they are hard to relate and read. L155-168, L459-467, and L686-691 are examples.
5. L205-210, this is very late in the paper to be delineating the focus
6. Because there are three sites, the site description is very long (Sections 3.2.1, 3.2.2, and 3.2.3. This takes up about 7 pages, which is similar in length to short paper on its own. Basically, some of this information (especially the inordinate focus on parameterization, when that is not the point of the study) needs to be moved to an electronic supplement. It detracts from the key messaging, and it's not a very invigorating read. I think the site description is key, but could be shorter, but I don't think the reader needs to wade through endless parameter justification, which could be built into tables in a supplement for interested readers.
7. Oct. 1979 is certainly late in history as a representative climate from which to base the model spin up. I realize this is briefly addressed later, but I suspect a permafrost

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modeler would object.

8. I think a small section on the thermal physics in the model (governing equations, soil freezing curves if any, etc.) would be far more useful to the reader than the emphasis on parameters.

9. This contribution is very qualitative and even anecdotal in places. For example 'seems' should up 7 times in the manuscript, while 'seem' shows up in 8 places. The difference in model runs are not compared via standard metrics like RMSE or something like that. The discussion seems to rather focus on apparent discrepancies and vague explanations. For examples of this, just consider any section on model comparisons or differences. Also, note recurring appearances of 'much more' and 'too small' – a few actual numbers would be nice.

10. The authors do not frame their permafrost modeling results in the discussion around past contributions. Cryosphere scientists have been modeling permafrost and considering spin up scenarios for a very long time. The authors' work is new and interesting (especially the focus on the inclusion of permafrost in large-scale hydrologic modeling), but the thermal physics under consideration are not overly new, and it would make sense to relate their study findings

Minor concerns

Many of these are quite trivial

L13, comma after 'average'

L33, shouldn't basin be capitalized here as elsewhere when preceded by Mackenzie or Mackenzie River?

L33, 'heating up by 4 degC' ...over what time period? 100,000 years? 50 years?

L36, 'American rivers' should just be 'America' and the subsequent semicolon should be a comma

L75, 'implied' should be 'inferred'

L119, 'In addition to...for spinning' is a fragment

L143 and elsewhere, 'etc.' occurs in the paper where it is entirely superfluous in a couple places. It tends to look choppy – 'such as' is sufficient.

L141, Land does not need to be capitalized

L152, does this mean that sandstone thermal properties are always used the for the bedrock conductivity everywhere? This seems less than ideal.

L161 'thus we use a thaw, rather than a freeze criterion' – I have no idea what this means

L167, This is more commonly called the 'seasonal penetration depth', at least in non-permafrost regions

L170, permafrost is not defined cryotically like this (frozen vs. unfrozen). It's a temperature definition – i.e. ground below 0C for two or more consecutive years – see, for example, Dobinski, 2011, Earth Science Reviews.

L173, "MESH/CLASS used to output" should change to 'Prior versions of MESH/CLASS outputted merely temperature profiles' or something like this

175, 'A CLASS typical' should be 'A typical CLASS'

L192, "these has' should be 'these have', and I'm not sure what 'to be carried back to the MRB scale' means

L197, 'North West' should be 'Northwest'

L216, 'with' should be 'by' and the rest of this sentence needs to be rewritten as it is confusing what it means

L220-221, Weather and North should not be capitalized

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L302, should not be semicolon

L304, why does deep permafrost imply no groundwater? It would make more sense to note that the cold climate prevents the formation of a lateral talik, and thus there is no perennial shallow groundwater. See Lamontagne-Halle et al. 2018 (Environmental Research Letters) or Connon et al. 2018, JGR-Earth Surface.

L316 (and elsewhere, do a word search), 'envelops' should be 'envelopes'

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