

***Interactive comment on* “Soil Moisture and Hydrology Projections of the Permafrost Region: A Model Intercomparison” by Christian G. Andresen et al.**

Anonymous Referee #2

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Review of manuscript tc-2019-144 “Soil Moisture and Hydrology Projections of the Permafrost Region: A Model Intercomparison”

Overall comments

This paper presents an analysis and comparison of eight model simulations of changes to hydrology and soil moisture under changing permafrost conditions. The question of how Arctic landscapes will change in hydrological terms is both important and largely unresolved, so this is an relevant topic where a model intercomparison is useful.

The paper is well written and easy to understand. I think figures are mostly appropriate although some adjustments could improve clarity. I have some remarks on a number

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of science points where I think the paper could be improved. With some clarifications and improvements, I think the paper could be a more useful contribution.

Major points

Abstract. The last sentence is quite general and states things that are very well known already. Could the abstract instead finish with a more interesting statement pointing out specific knowledge gaps or recommended directions of research?

106 Although method specifics can (hopefully) be obtained in the cited papers, I'd like a few more details here, for clarity. For one thing, it's not clear when the break point between historical, model-specific climate forcing and the common forcing took place. Was this at 1960 or at 2006?

114-117 Along the same lines, for clarity here: On what timescale did the historical CCSM4 climate forcing repeat?

134 Just to be clear, specify what years of model simulations were used for the comparison with 1970-1999 observations. I assume this is also long-term but is it the exact same period, or some other length?

157 Here the authors refer to the "permafrost domain", but this is not clearly defined in methods. Please clarify in the methods sections whether the study domain is, for each model, all cells with near-surface permafrost above 45 degrees N, as suggested on lines 121-123, or something else.

168-171 I am a bit dubious as to whether these patterns hold over longer-term analysis. If this statement is supported by the comparison of 10-year averages shown in Figure 3, I am unconvinced. See comment on that below.

Figure 3. Here the authors use a ten-year period to illustrate long-term spatial changes. This is way too short as decadal variability is clearly substantial for some models (Figure 2c). This should be a 30-year period.

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191-193 I think this statement is not supported enough by the data. Either there is a relationship or not, and it would be easier to determine the likelihood of that with a simple x-y plot of the data rather than these box plots. As the authors note, the UWVIC model is not useful at all for this question due to its resolution. But for the box plots shown, I think the SIBCASA model clearly shows no tendency for more drying with ALT increase, which is not acknowledged. The statement should be modified to moderate this claim somewhat. Also, I am wondering at the use of short time periods again here, and would prefer a 30-year period comparison.

222-223 According to the text, JULES exhibits the highest runoff increase with 0.8 mm/day, but Figure 2g shows ORCHIDEE runoff increasing by 1.2 mm/day. Which is correct?

Minor and language points

110 The degree symbol seems to have been replaced by a 0 (zero character), at least on my computer.

161 Add “long-term” or “for the period after 2100” or similar to clarify that it’s only after 2100 that most models stay on the drying side for soil moisture – up till then, about half of the models are close to zero change or wetting. I guess this is implicit with the talking of 2299 in the preceding sentence but still, just to be clear.

303 Change “large-scales” to “large scales”.

392 Change “Study” to “The study”.

Fig 1. The figure seems to show depths to 3.5 m but the caption says 3 m.

Fig 2. The caption says “Figures d, e, f, and g are represented as relative change from 1960 values”. I think “relative change” implies a normalization which is not done here, so I suggest dropping “relative” from the above sentence.

Fig 7. At least in the pdf on my computer, the tick labels on the horizontal axis are

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misaligned and show up inside the plot instead of outside. Please check.

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