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Hydrology and Earth System Sciences Discussions

Interactive comment on "Estimation of permafrost thawing rates in a sub-arctic catchment using recession flow analysis" *by* S. W. Lyon et al.

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The authors have used the recession flow analysis based on a long-term flow records for detection the rate of permafrost thawing. The main assumption was that the depth of the aquifer is proportional to the depth of active layer (thawing of permafrost), so that “thawing of permafrost extends the depth of the active groundwater system layers…” (P. 4, lines 20-21). The next assumption was that the linear relationship exists between the rate of flow recession and the depth of the aquifer (as it follows from the linearized solution of the Bousinessq equation). Following these assumptions, the authors have obtained the corresponding linear relationship between the rate of flow recession and the depth of thawing of permafrost. The authors have analyzed streamflow records in sub-arctic catchment in northern Sweden, found in-

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Interactive Discussion

Discussion Paper

creasing the rate of flow recession during the long-term period, concluded that thawing of permafrost increases, and calculated the rate of this increasing as 0.9 cm/yr from the obtained relationship.

There are major concerns that the authors should address before the possible publication of the manuscript.

1. The assumption that thawing of permafrost implies increasing recession coefficient because of thickening suprapermafrost aquifer looks questionable for me by the same reasons as it looks questionable for the 1st Reviewer. There are many studies showing that, quite the contrary, subsurface flow becomes slower in the process of thawing because of several reasons, e.g. decay in hydraulic conductivity with depth of the active layer, increase of evaporation from thawed soil, etc. However review of these studies is absent in the paper and the references underpinned the main authors assumptions are not related to the permafrost hydrology. I suggest paying attention to the existing researches on recession flow for permafrost regions and showing peculiarities of the Abiskojokken catchment which could result in the discovered increasing the rate of flow recession and decreasing winter flow.

2. I agree with the authors that small changes in maximum depth of the active layer have lead to small changes in the depth-averaged hydraulic conductivity. However subsurface flow usually occurs within the relatively thin layer, near the lower boundary of the active layer (above the permafrost surface), so the rate of the subsurface flow is sensitive to small changes of the thawing depth. Thus, for me, the assumption that there are no changes in the hydraulic conductivity needs further consideration and testing.

3. The recession analysis should be shown in more detail. The most important question is: what are the errors of estimates of the recession coefficient for separate years? I suggest showing these errors in Fig. 3 in order to allow a reader to assess significance of the discoverdyear-to year changes of the recession coefficient. In addition,

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I suggest showing hydrograph for any one season as an illustration of the recession analysis.

The minor comment: Eq. 4 is not well written. Indeed, it follows from Eq. 4 that dD/dt depends on time while this is not the case. The point is that in this equation (a-ar)/(t-tr)=da/dt=const=0.0006 and, as a result, dD/dt=Dr/ar*da/dt= Dr/ar*0.0006. Thus, I suggest re-writing Eq. (4).

All comments made by the referees should be taken into consideration by the authors and addressed while preparing the revised versions of the manuscripts.

1. Does the paper address relevant scientific questions within the scope of HESS? YES 2. Does the paper present novel concepts, ideas, tools or data? PARTLY 3. Are substantial conclusions reached? PARTLY 4. Are the results sufficient to support the interpretations and conclusions? NO 5. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientific (traceability of results)? YES 6. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? NO 7. Does the title clearly reflect the contents of the paper? YES 8. Does the abstract provide a concise and complete summary? YES 9. Is the overall presentation well structured and clear? YES 10. Is the language fluent and precise? YES 11. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? NOT COMPLETELY 12. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? NO 13. Are the number and quality of references appropriate? NO 14. Is the amount and quality of supplementary material appropriate? NOT COMPLETELY

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