

Response to supplement comments on the manuscript “The coupling between hydrology, the development of the active layer and the chemical signature of surface water in a periglacial catchment in West Greenland”

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Dear Editor,

We like to thank both you and the two reviewers for the kind and constructive feedback. During the revision we have made a dedicated effort to increase the readability and make sure that text is grammatically correct. Below you will find detailed responses to each of the questions raised by you or the reviewers (in red). We hope that these responses, and the corresponding changes to the manuscript, will satisfactorily address all concerns. One thing that remains to be fixed is the links to the new Pangaea-datasets in SI-Table 1. The data have been uploaded to Pangaea, but we are still waiting to receive the doi-addresses for them. Hence, this information has to be added to the SI-Table at a later stage, we hope that this is not a problem.

Best regards,

Johan Rydberg

Comments from Svetlana Stuefer, handling editor

The authors have made significant progress in restructuring the manuscript. The reviewers still have concerns about typographical and grammatical errors. I encourage the authors to focus on improving readability and presentation quality and offer a few suggestions that could help with that.

1. Data use and availability: Consider improving the presentation of various datasets, their purpose, time periods, and data citations. I recommend adding a summary table (Supplemental File) that clearly lists each dataset (both used and produced), along with corresponding time periods, data availability (including data citation with DOI), and the purpose of each dataset for this study (e.g., field observations, model forcing, model calibration/validation, model outputs, statistical analysis). This table will enhance the readability of relevant sections (data, method, results, and discussion) and help ensure consistency. It will also assist others in replicating analyses and applying findings reported in the manuscript to future research.

AR: We have added such a table to the supplementary information

2. Snowmelt period: The research objectives largely focus on the snowmelt period and snowmelt water; however, the data on snow water equivalent, snow ablation, and snowmelt rates are minimal in the current version of the paper. What are the implications of relying on snowfall data only? Multiple studies have shown that snowfall measurements are extremely problematic in windy treeless locations. Snow sublimation can be quite significant. Please clarify the use of winter precipitation and snow water equivalent data for estimating overland flow and direct runoff during snowmelt.

AR: Yes, sublimation and spatial heterogeneity is tricky to constrain. We have added more information regarding how this was dealt with in the modelling. See further below

3. Conclusions: Consider framing your conclusions within the context of other northern hydrology studies and clearly highlight the unique contributions of your research in a broader context.

AR: We have considered the suggestion, but in our view the main purpose of the conclusions is to present the main findings of this particular study in a nutshell. A key feature of a nutshell is that it should be condensed and short, and hence, we have not added any additional parts to our conclusions. Instead, the unique aspects of this study as well as how it compares to a broader context can – hopefully – be found in the Abstract, Introduction and Discussion. We feel that this should be sufficient.

Specific comments:

Line 24: The term 'hydrological active season' – could you clarify what exactly is meant by this? Are you referring specifically to the month of September?

AR: Yes and no, the intention here is not to mention a specific month (because it varies between years). We have now changed this to “...the end of the thawed season.”

Line 44: Should it say “depends”?

AR: Yes, this was changed

Lines 116–119: Could you clarify question 3? What specific 'other important factors' are you referring to? Are you referring to factors such as groundwater, biological activity, or atmospheric deposition?

AR: We have rewritten the question to make it clear what we refer to with “other important factors”

Line 179: How were snow ablation and the associated snowmelt rates represented in the model?

AR: The model handles sublimation in the same way as it handles evaporation, that is, it is estimated based on the meteorological observations. We have added more information on this in the method section.

Line 222: How did you measure snow ablation during snowmelt? Did you conduct snow surveys?

AR: We didn't. On a catchment scale snow ablation was assumed to be equal to the accumulation of snow drifts, i.e., no net loss or gain of any water to the water balance. Of course, for a finer scale than the catchment or sub-catchment scale this is not a valid assumption. We have added more information regarding this in the methods

Line 296–297: Was snow sublimation considered here?

AR: Yes, with the addition of more information regarding sublimation in the methods and the reformulation here it should hopefully be clear that evapotranspiration includes sublimation.

Figure 2 and Figure 4: Figure 2B shows precipitation as snow and rain. Please add 'Snowmelt rates (mm/day)' to Figures 2B and 4C to indicate how much water leaves the snowpack daily.

AR: Adding the snowmelt rate is not as straight forward as it might seem at first glance. Yes, the snow melts and as this happens water is released in the hydrological model (and it is then

partitioned in the same way as water entering as precipitation). However, after it has melted it might (depending on the conditions) refreeze as ice on the ground surface or further down in the catchment. As the temperature then increases this ice will melt again (but this will not count as snowmelt). The problem is then to separate the different types of melting water based on if it comes from snow, ice or something else. Just looking at the initial melting of snow will underestimate the release of water in the catchment (or make it appear as if it produces runoff earlier), and including all types of melting water will just reproduce the total runoff during spring (which is driven by the melting of snow and ice in the catchment). Hence, we opted for including the accumulation of water in the form of snow in the catchment to the graphs in figure 2 and 4. In our opinion this better shows the illustrate the dynamics in the accumulation and release of water from the “snow pool” (rather than trying to separate the different types of melting water from each other).

Figure 3: Replace the comma with a period after Figure 3. The same comment applies to Figure 5.

AR: Fixed

Figure 3: Please use capital letters for the horizontal axis labels (Jan, Feb, Mar, etc) to ensure consistency with the labels in Figure 4.

AR: Fixed

Comments from Reviewer 1

No comments, publish as is

Comments from Reviewer 2

General comments:

This version is greatly improved. All of my comments/suggestions have been adequately addressed. I applaud the hard work addressing the comments from the two reviewers. The revised text still has a lot of typographical and grammatical errors that hopefully can be fixed by the Editorial process (?). I suggest this work is ready for publication. A few specific comments are provided below.

AR: We thank the reviewer for the kind comments. Regarding the language one reason for the typographical and grammatical errors might be that the track changes version of the resubmitted manuscript unfortunately hadn't gone through the final language check (we are sorry for this). Anyways, we have gone through the text once more to correct any remaining issues. We have, however, gone through the text and tried to make it as readable as we can (and tried to correct all grammatical errors)

Comments keyed to the text:

248-252: without permafrost there is groundwater flow as well

AR: We have rephrased this to make it clear that groundwater is present also without permafrost

414: any relationship

AR: Changed

418: or do our

AR: Changed

589: I realize Reviewer 1 suggested a reorganization but it is not clear to me why the modeling comes before the measurements. The data used to do the modeling should come before the modeling itself.'

AR: That is a valid point, however, in this case we argue that it still is more logical to put the modelling first. First, the modelling includes a longer time period than most of the measurements. We feel that the reader will benefit from first being presented with this longer time period and the seasonality of the system, before going into more detail with the samples from the snowmelt season. Second, the modelling builds on previously published data, and apart from the "Meteorology and ground temperature" none of the data presented under "Sample collection..." has been used for the modelling. Third, the modelling data is used to assess the chemical and isotopic data, and it would be difficult to write about the results from the sampling without referring forward to results from the modeling (and we like to retain the same order in both the methods and results).

775: "found" is not needed. Maybe say "located" instead?

AR: Changed

1260: suggests that

AR: Changed

1485: indicates

AR: Changed

1597: dominate runoff

AR: Changed

1672: The effects of fast shallow flow paths...

AR: Changed

1673: that have

AR: Changed

1678: moves through

AR: Changed