Hydrology and Earth System Sciences Discussions

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Comment on hess-2021-512

Anonymous Referee #2

Referee comment on "Quantifying the glacial meltwater contribution to streams in mountainous regions using highly resolved stable water isotope measurements" by Philipp Wanner et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-512-RC2, 2021

General comments

The authors of this manuscript analyzed the temporal variability in the isotopic composition of rain water and snow samples, and quantified the contribution of glacial melt water to stream runoff, by means of stable water isotopes, in three study catchments in the Swiss Alps.

The topic of this manuscript is potentially interesting for the readers of Hydrology and Earth System Sciences. In general, I think that more studies investigating the contribution of snowmelt and glacier melt to stream runoff in high elevation catchments are needed to improve our understanding of hydrological processes in such complex areas. Overall, the paper is well structured and well written, but I have several (major) concerns about the methodological approach.

Firstly, the authors have not considered the contribution of groundwater to runoff both in the accumulation and the ablation period. Groundwater is expected to be the dominant end-member during the accumulation period, but a large contribution of groundwater to runoff may be possible from the glacier-free areas of the catchments during the ablation period.

Secondly, more details are needed in the section 2.4 about the hydrograph separation.

The authors should explain the choice of the end members, provide the assumptions at the base of the hydrograph separation technique (please see Klaus and McDonnell, 2013), and describe how uncertainty was estimated (it is mentioned only at lines 420-423).

Thirdly, the authors should consider more and discuss the temporal and spatial variability in the isotopic composition of the end members. Previous studies conducted in Alpine catchments (e.g., Schmieder et al., 2016; Schmieder et al., 2018; Zuecco et al., 2019) have already shown that a high spatial and temporal variability in the tracer composition of the end members can greatly affect the results of the hydrograph separation and/or hamper its application. In this study, the authors used only three samples of glacier ice (and from only one of the glaciers) to characterize the glacier-melt end member. This sample size is too small for making any consideration on hydrograph separation.

Finally, the authors have not described which approach was used to assess the end of the snowmelt period in the three catchments (using snow cover data collected at only one station at 2063 m a.s.l. is not sufficient).

Specific comments

- The introduction is mainly focussed on the role of hydropower in Alpine catchments, whereas there is too little attention towards the application of tracers in high-elevation catchments to quantify the contribution of glacier-melt water to stream runoff.
- Lines 47-48: This concept repeats the text at lines 32-35.
- Line 54: I would not describe the tracer-based methods as low cost compared to other methods, such as hydrological modelling.
- In the legend of Figure 1, I suggest indicating the glacierized area.
- Line 123: 19 snow samples is not a high sample size.
- Line 131: I suggest indicating the number of ice samples that were collected.
- Lines 132-133: Three samples collected at the glacier fronts cannot be representative of the whole ablation zone. Additional samples are needed to support the main findings of this manuscript.
- Lines 274-276: These two sentences are not supported by rain samples collected during the accumulation period.
- Lines 363-371 and Figure 6: I suggest comparing discharge values after normalization by catchment areas.
- Lines 410-411: The author should provide evidence about the presence/absence of snowmelt in all three catchments during the ablation period.
- Lines 420-423: These sentences belong to section 2.4.
- Figure 8: This figure could be interesting if more catchments were considered; is it possible to gather data from other Alpine catchments? If not, I suggest deleting the figure.

Technical corrections

- Line 172: It is unclear what the authors mean with "binary mixing approach". I suggest using another term, such as "two-component hydrograph separation".
- Line 223: Please indicate the water source for "heavy isotopes".
- Lines 225-226: Please mention the water source considered in the sentence.
- Figure 4: Please indicate in the caption what the error bars represent.
- Figure 5: Please indicate in the caption what the error bars represent.

References

Klaus, J., & McDonnell, J.J. (2013). Hydrograph separation using stable isotopes: Review and evaluation. Journal of Hydrology, 505, 47-64. DOI: 10.1016/j.jhydrol.2013.09.006

Schmieder, J., Garvelmann, J., Marke, T., & Strasser, U. (2018). Spatio-temporal tracer variability in the glacier melt end-member – How does it affect hydrograph separation results? Hydrological Processes, 32, 1828–1843. DOI: 10.1002/hyp.11628

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