

Interactive comment on “The importance of spatio-temporal snowmelt variability for isotopic hydrograph separation in a high-elevation catchment” by J. Schmieder et al.

S. Pohl (Referee)

stefan.pohl@hydrology.uni-freiburg.de

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The authors present a study aimed at improving the reliability of isotopic hydrograph separation by including the spatial and temporal variability of snowmelt rates and isotopic composition in a high elevation basin. The authors use a very interesting dataset of isotopic measurements of a variety of components (snow, snow meltwater, stream water etc.) along with a state of the art hydrologic snowmelt model and some standard isotope hydrograph separation techniques to show the contribution of event and pre-event water to basin runoff during two snowmelt periods, one in early spring and one at the peak of snowmelt.

The topic is very interesting for a large research community as isotope studies of snow

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processes have just begun to show their usefulness for a variety of scientific purposes but especially for the separation of hydrographs and for estimating the amount of snow meltwater to the overall river runoff. It therefore presents a really nice and important contribution to the scientific knowledge in the field of snow and isotope hydrology. The paper is written very well. The methods and techniques are appropriate and well applied. The study objectives are outlined clearly and the analysis for the most part follows these objectives. The results are presented in great detail in well readable Figures and Tables. The conclusions are based on the presented results and therefore well supported. The discussion is appropriate and commendably includes a clear segment stating the limitations of the study. The topic falls well within the scope of the journal and as stated will be a very important source of information for other researchers especially if they are attempting similar studies. There are only a few general and some specific comments that I recommend to address before the paper could be published.

General Comments:

One of the stated study objectives is “the estimation of the spatio-temporal variability of snowmelt and its isotopic content”. I would argue that this part of the study could be enhanced and presented in more detail. The authors have acquired a quite unique dataset on the isotopic content at different times and at different places. The authors have acquired a quite unique dataset on the isotopic content at different times and at different places. Yet often the presented results are lumped together. This is the case for the spatial variability and for the temporal variability. For example, there are two north and two south facing sample points separated by roughly 400 m of elevation and 4000 m of horizontal distance. Yet unless I missed it all the isotope results are lumped together into “North” and “South”. I think it would be very useful to present the results separately so that the reader can get a feeling for how much spatial variability there is within similar land surface classes but at different elevations or parts of the basin. This would help tremendously if one were to set up a similar study in another basin. The same can be said for the temporal variability. All the “sub-daily” samples seem to have

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been lumped together into daily samples. Again a more detailed presentation of the data would be very interesting here.

The authors present and discuss the scenarios “North and South” in their IHS analysis. While I would agree that a short mention and presentation of the results of these two scenarios is helpful, I would keep this and any discussion of these scenarios very short, probably shorter than the authors have done. The reason is that no respectable researcher would or should attempt an IHS analysis using only samples from north or south facing slopes (certainly not after reading this study). The scenarios should therefore be considered purely theoretical and the authors should maybe focus the discussion more on the results obtained with the actually viable scenarios VWS, VWO, and VWE.

Specific Comments:

P.1 Line 21: I'm not sure I totally understand which methods are described here in respect to the north and south facing slopes.

P.1 Line 35: You might want to explain what water the term “pre event” refers to when it comes to studies of snowmelt contribution to runoff. Is this water stored in the soil or rock, i.e. is it purely groundwater or ground and soil water?

P.3 Line 34: Is the “Rofen valley area” identical to the Rofenach catchment? If so maybe use that term, otherwise restate the extent of glacial areas within the study catchment.

P. 4 line 8 If you want to refer to Figure 7 here you should reorder the sequence of Figures. I strongly believe that Figures should appear in the order in which they are addressed in the text of the paper.

P.4 Line 16 What are “sub daily grab samples” How many samples, temporal resolution and were the samples analyzed individually or combined as bulk samples?

P.4 Line 26 Were the snow pit layer samples used to eventually calculate weighted mean snow values using the layer thickness?

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P. 5 Line 14 You might want to refer the reader to the section where the results of the model validation are actually shown.

P.5 Line 30 You subdivide the whole basin in either north or south with no class in between. While you state, that the valley runs mostly east-west and therefore the slopes and the DEM grids are mostly south or north, it would be good to show this visually, maybe by providing a graph showing the distribution of the grid aspects.

P.7 Line 5 “reflect” should probably be “reflecting”

P.8 first paragraph: You should briefly describe what are the main findings of Figure 7.

P.8 Line 14-16 The differences in the melt rates on north facing slopes during the early melt event are quite large. You might want to spend a little more time explaining these as the modelled values are quite important for the following analyses.

P.8 Line 36 should be “and could not clearly be obtained”

p.9 line 28 The authors state: “The hydrological response followed the diurnal variations of air temperature Because the available net-shortwave energy mostly controls the magnitude of snowmelt” This statement is not correct as it is. The diurnal air temperature variations have no control on the amount of net shortwave energy. It just so happens that the diurnal variations of air temp are usually fairly similar to those of net shortwave, but they do not influence each other. Please restate.

p. 10 line 22. See general comments: Was there no altitudinal gradient or did the authors just not discuss it?

p.10 line 30 You might want to replace “through” with “due to”.

p.11 line 9 Maybe you should quickly list the assumptions (bullet points). They are all addressed in the following paragraph, but this would make it easier for the reader to understand what assumptions the authors are talking about.

p. 13 line 33. There are two definitions of the term “glacier melt”. Sometimes snow

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melting on a glacier is included in the term glacier melt, sometimes only ice melt is included. Please specify.

Figures 4 and 5: Maybe a boxplot graph would be a better idea to present the data.

Figure 8: There are fairly large differences in the observed vs. simulated snowmelt especially early on the north facing slope. In the text these differences are dealt with rather briefly. Maybe a slightly expanded discussion and explanation would be useful.

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