Hydrology and Earth System Sciences Discussions

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# Comment on hess-2021-362

Anonymous Referee #2

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Referee comment on "Effects of spatial and temporal variability in surface water inputs on streamflow generation and cessation in the rain–snow transition zone" by Leonie Kiewiet et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-362-RC2, 2021

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HESS Review - Kiewiet et al.

In this study, the relation between precipitation input and discharge output is analyzed for a small headwater catchment located in the rain-to-snow transition zone in a semi-arid climate in the US. Specifically, the study aims to examine how differences in the partitioning of precipitation into snowfall and rainfall affects the spatial and temporal distribution of the sum of rainfall and snowmelt (SWI) and subsequently, how this affects discharge quantity and timing of dry-out of the stream. The analyses were done using a combination of a snowpack model and discharge and snow observations, and selecting four different hydro-climatological years and investigating their differences.

The paper covers an interesting topic. It focuses on snowmelt and discharge processes in the rain-to-snow transition zone and is therefore suitable for HESS. The paper is well structured and I found the existing figures well presented. However, I do have a few comments before I can recommend the paper for publication.

*Main finding and figures*: I agree with reviewer #1 that the text at some places in the results and discussion sections read clear and sound, but the figures do not always support the conclusions or findings. As mentioned by reviewer 1 especially the conclusion on the temporal distribution of SWI is not easy to extract from the figures. Figure 4 and 5 show SWI and discharge, but because the years differ in so many aspects (ratio of rain and snowmelt, timing of SWI, variability of SWI, Q), it is hard to tell which process caused the discharge response from the timeseries, i.e. to see a clear link between temporal distribution and discharge. The text describes these different aspects, but how to generalize these results more? Maybe some measures related to the timing of the center of volume for rainfall and snowmelt, antecedent conditions before spring or number and timing of melt/rainfall events could give some insights. Could also some measure on spatial and temporal distribution be combined? Probably the authors know best how they drew this particular conclusion and could use that to focus on that aspect in the

results/figures more explicitly.

*Study setup*: While going through the manuscript I was wondering why only four years were selected. Because of the many processes that influence the discharge signal, a larger sample of years may have provided stronger evidence how processes relate, i.e. avoid that for example the dry year that was analyzed had many rainfall events. From the data description it is a bit unclear to me what the maximum possible amount of years could have been for analyzing. The decision may have to do with the runtime of the model? At least I would expect some description how the selected years deviate from the mean hydro-climatology of the catchment. Maybe the discussion/limitations section could elaborate on the selection of the years and the intertwined processes when looking at observations and possibilities for future model experiments, isolating some of these aspects (for which discharge would needed to be simulated as well) – but this last point as the authors see fit.

*Argumentation in introduction*: Partly related to the comment of reviewer 1 on a better description of the novelty in the introduction, I think that the line of thoughts for this study and the research gap can be better described. In my opinion, the introduction mixes 1) changes in snowmelt generated streamflow, 2) differences between catchments seasonally snow covered and in the rain-to-snow transition zone, 3) rain-to-snow zones as a space-for-time substitution of catchments that are now seasonally snow covered and 4) changes that have occurred in the rain-to-snow transition zone and may occur in the future. Although all of these aspects may be important to put the study into context, I would suggest to clearly identify the research gap (how do yearly variations in rainfall and snowmelt influence discharge, relation with snowfall fraction not yet clear, rain-to-snow zone suitable to analyze 'extremes', i.e. snowy and rainy) and explain the implications for future changes and relations to observed changes in different type of catchments in a more structured way.

*Methods and data description*: Here I missed some details regarding the available data, the model and the choice of years. As indicated above, it is not mentioned how the four climatologically different years were selected. I was also a bit confused by the numbers in table 1, how come that in a rainy year, the SWIsnow is higher than in a snowy year? Are numbers switched here? And without knowing the range of snowfall fractions over a longer time period it is difficult to interpret the values of the different years. It would also be helpful to explain the reasoning and possible hypotheses of selecting rainy and snowy years and wet and dry years. Could temperatures also be given for the years? Regarding the data and model, what is needed as input for the model? And which of the stations do have this data available for which time period.

*Minor and technical corrections:*

Title + abstract: 'Snowfall fractions' – since you only clarify in the introduction, maybe another term could be used here, e.g. ratio of snowfall to precipitation. Regarding the title, maybe it needs to be adjusted depending on the changes, e.g. temporal distribution and total input? Or specify what is meant with temporal distribution. Stream discharge –

Annual (stream) discharge.

L13 '..spatial and temporal distribution of precipitation' – add phase of precipitation?

L68 which catchments?

L71-72: on an annual time-scale is this so different, apart from the effects of snow redistribution? Is this something interesting to show for you analyses, i.e. spatial distribution of rainfall and spatial distribution of snowmelt?

L94: 'However' – where does this refer to?

L116-117: did increased ET played a role here?

L195-196: 'this uncertainty…. Patterns' – double with few sentences above

Section 3.5 How do catchment precipitation and discharge compare? Are there estimations for ET?

L223 'this pattern was masked by the effects of other processes' – what is meant here? In general in the results section it would be helpful to indicate better when observations or when simulations are described.

L236-237 'differential melt-out patterns' – what was compared for that?

L267 'As a result, average daily SWI rates were higher' – as a result of what?

L274 'whereas roughly 30% of SWI….' – are delays taken into account, or is meant here the comparsion between SWI from month x to month y and discharge from month x to month y? Are the events where Q is higher than SWI also of interest?

L279 Have you tried plotting % of SWI translated into discharge against temperature

(annual, or during growing season?)

Section 5 – the subsections have no numbering

L357 'This highlights the importance of the temporal distribution of SWI' – also the importance of total water input?

L360 'events' – throughout the manuscript when using 'event' please check if it is clear why event is meant? Precipitation, rainfall, snowmelt, discharge?

L369 'catchment' – sub-catchment?

Discussion on simulated snow depts – could it be extended with a description of the reasons for varying performance for individual years and maybe a hypothesis how such 'bad' simulated years potentially could have influenced the results?

L419 '…, which influences' – should it be, which may influence? As for example one of your conclusions is that the spatial distribution of SWI stays rather stable over time?

L428 -429 Could a short explanation/hypothesis be added why Q was much higher in 2010?

Figure 2e – what do the light coloured pixels mean? Was there no snow cover in the simulations while there was around 0.5 in the satellite observations? Because of the comparison of different years?

For all figures it may be good to not only indicate the year but also its characteristic (i.e. snowy, rainy, wet and dry) in the figure itself instead of the legend.