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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Characterizing hillslope-stream connectivity with a joint event analysis of stream and groundwater levels" *by* Daniel Beiter et al.

Anonymous Referee #1

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General comment

This manuscript focuses on the characterization of hillslope-stream connectivity by using a novel joint event analysis of the response of stream and shallow groundwater levels. The authors examined the response timing of 18 groundwater sites located in five different footslopes in Luxembourg for 706 runoff events. The applied methodology included event detection, the quantification of response timing of groundwater compared to stream water level, the analysis of the relations between pre-event groundwater level with pre-event stream water level and runoff coefficient. The authors concluded that the joint analysis of groundwater and stream water levels provided information on the

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presence or absence, and on the degree of subsurface hillslope-stream connectivity. The found threshold relations between groundwater and stream water levels were interpreted as transmissivity feedback in the marls study sites, and fill-and-spill in the schist areas. The topic of this manuscript is of interest for the readers of the journal, and overall the paper is well written and structured. The presented analysis for such a large time series of groundwater levels is quite rare, and therefore is particularly important to advance our comprehension of hillslope-stream subsurface connectivity. Nonetheless, I have some specific questions/comments for the authors, and I would like to see integrated in the manuscript some more methodological details.

Specific comments

1) I suggest to the authors to clearly provide in the introduction the definition of subsurface hydrologic connectivity, that they considered (currently such a definition can only be guessed by the readers).

2) The authors mentioned in the abstract that they performed their joint analysis for rainfall-runoff events, but throughout the manuscript there is no description of the rainfall characteristics (e.g., total rainfall, intensities and duration of the selected events) and where they were monitored (are the weather stations located in the study catchments?). I suggest to report such details in the text. Furthermore, I would like to see a table presenting the main summary statistics for rainfall, runoff and groundwater characteristics of the considered events.

3) Since the analysis was carried out for the whole time series (winters and early spring included), I am wondering whether there were snowfalls, and if the authors considered snowmelt-induced runoff events and rain-on-snow events in the analysis. If such events were discarded, I suggest to integrate the description of the methodological approach for event detection. Otherwise, the authors should clearly state that they focused only on rainfall-runoff events.

4) In Table 1 (or in a new table), I suggest to provide the topographic characteristics

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of the groundwater sites together with their depth. These details could help to understand whether the topography is very similar (or very different) among the monitored locations, and to support the discussion at page 17, lines 15-19. Moreover, what is the extension of the riparian zone compared to the hillslopes in the study sites?

5) Have the authors considered their analysis of subsurface connectivity in light of recent findings by Klaus and Jackson (2018) and Gabrielli and McDonnell (2020)? Are there bedrock permeability data for the selected study sites?

6) In the section "2.4 Event detection" and Fig. 4, it is not clear which response timings were considered for complex events with multiple peaks (both in stream and groundwater level). Furthermore, which peak in stream water level is considered if there is only one peak for the groundwater level?

7) Page 11, line 5: Please provide a reference for the method used for the stormflow calculation.

8) Page 20, line 5: "No pronounced differences. . .": could the authors report the results of the applied statistical test?

9) Page 21, lines 3-4: Please provide more details about the investigated relations between rainfall characteristics and event responses.

10) Page 22, lines 8-10: Please remove these details from the available literature, and report them in a table. Please consider that other recent studies examined almost or more than 100 events (e.g., Rinderer et al., 2016; Zuecco et al., 2019).

11) Page 23, line 13-16: The example of considering just two events in the data analysis is a very extreme case, and so far I have never seen it. Therefore, please revise the sentence. The main question is how many events and piezometers do we need to capture the temporal and spatial variability of subsurface connectivity?

Technical corrections

1) Page 2, line 25: “assess”.

2) Page 3, line 1: “hillslope” instead of “slope”.

3) Page 4, line 2: “July”.

4) Page 23, line 4: “these” instead of “this”.

5) Figure 11: Based on the caption, the label of the y axis should be “Normalised pre-event groundwater level”.

References

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