

## ***Interactive comment on “Event and seasonal hydrologic connectivity patterns in an agricultural headwater catchment” by Lovrenc Pavlin et al.***

### **Anonymous Referee #1**

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#### General comment

In this manuscript, the authors analysed the hydrologic connectivity of an agricultural headwater catchment in Lower Austria, by comparing the temporal dynamics of groundwater table and soil moisture measured at different sites (i.e., riparian zone, lower, mid and upper hillslope) with the streamflow response. Spearman correlation coefficient, a hysteresis index and peak-to-peak time were used for the analysis of the similarity of the response of the various groundwater and soil moisture sites with the streamflow time series. Results showed a similarity of groundwater to streamflow, with a spatial organisation suggesting a decreasing degree of connectivity to the stream from the riparian zone up to the hillslope. The soil moisture similarity pattern was spatially more homogeneous. Event characteristics were found to be a secondary control

C1

for groundwater, but a primary control for the soil moisture similarity to streamflow. The authors also showed that the seasonal and the event similarity patterns can be quite different, indicating that hydrologic connectivity might change depending on the temporal scale used for the observations. The topic of this manuscript is potentially interesting for the readers of this journal. Overall, the paper is well structured, but I think that there are too many figures and some of them could be merged (e.g., Figs. 7, 8 and 9 or Figs. 10 and 11). Furthermore, some methodological details are not clear (e.g., a sketch/scheme for the hysteresis analysis would be helpful to understand how the index was computed) and should be better explained.

#### Specific comments

- Page 5, lines 117-124 and Table 1: The installation depths of the various piezometers vary a lot; do the piezometers reach the bedrock or an impermeable layer? Are there any conductivity data for the various soil layers and for the bedrock?

- Pages 6 and 7: I suggest to provide more details about soil moisture sensors (e.g., brand and model), and how the authors performed an interpolation of soil moisture data at a 15 min interval when the recording interval was 1 hour (line 132). In addition, I am wondering about the sensitivity of the average soil moisture to the number of sensors used for the computation (I would be careful when calculating average values using a different number of sensors every time, particularly if there is a high variability in soil moisture along the profile). Were soil moisture data calibrated based on the soil type?

- Pages 7 and 8, lines 168-173: The fourth condition is not very clear, and I do not understand why the authors considered a specific recession period of 48 hours (why not 24 hours or more than 48?). Furthermore, it is not clear whether the authors also analysed the streamflow response (e.g., larger than a certain threshold) or just focused on the rainfall characteristics and the groundwater/soil moisture response. I also suggest to clarify whether all the mentioned conditions should be met for the identification of the rainfall-runoff events.

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- Page 10, lines 209-220: It is not clear which variable is x and which one is y; the authors should consider adding a sketch of the event hysteresis in the supplementary material along with the value of HI. Did the authors consider complex loops, such as eight-shaped hysteresis? If so, how did the authors identify the complex loops?
- Page 12, lines 260-271: I think these lines about the response types belong to the Results; I suggest to move them to the following sections.
- Figures 10 and 11: Details about the computation of the local regression fits (e.g., software used for the fits and statistical significance of the regressions) should be reported in the Methods.
- Page 18, section 3.2.1: An explanation of the term co-occurrence would be useful to understand the findings reported in this section. I also suggest to report all the co-occurrence values as percentages, in order to be consistent with Fig. 12.
- Tables 3 and 4: It is not clear which Pearson correlation coefficients are statistically significant and which are not. The authors should integrate this information in the tables and the captions.
- Page 24, lines 461-464: I suggest to the authors to consider the recent findings by Klaus and Jackson (2018) and Gabrielli and McDonnell (2020), and, if possible, check whether they can really consider their riparian and hillslope sites connected to the stream. Are there bedrock permeability data for this agricultural catchment?
- Figures 7, 8, 9, 12, 14, 15 and 16: These plots are very nice and colourful, but some of them (particularly the ones reporting the hysteresis index values) are quite confusing because the same relations are reported twice with a different colour. To improve the readability of these figures, I suggest to remove the lower or the upper part of the figures.

#### Technical corrections

- Page 1, line 22: “hydrologic” instead of “hydraulic”.

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- Page 2, lines 45-48: I suggest to modify as follows: “Penna et al. (2015) and Detty and McGuire (2010) found that wetter antecedent conditions and higher rainfall depth increased groundwater peaks, the number of activated wells and the spatial extent of the subsurface flow network in a steep catchment in the Italian Alps and in a forested catchment in New Hampshire, respectively.”
- Page 3, line 69: missing space in “moistureand”.
- Page 4, caption of Figure 1: Please report a brief description of the Topographic Position Index in the caption.
- Page 7, line 168: I suggest to change “by following five rules as follows” with “based on the following five conditions”.
- Page 10, line 218: I think that the magnitude of HI indicates more the “fatness” than the “shape” of the loop.
- Figure 5: I suggest to increase the resolution and size of the figure.
- Page 15, line 313: It should be “compared” and not “compare”.
- Page 16, line 322: the symbol  $\pm$  is missing between 2.7 and 14 hours.
- Page 27, line 568: Please replace “similarly” or “similarity”.

#### References

- Gabrielli C.P., McDonnell J.J., 2020. Modifying the Jackson index to quantify the relationship between geology, landscape structure and water transit time in steep wet headwaters. *Hydrological Processes*, early view. DOI: 10.1002/hyp.13700
- Klaus J., Jackson C.R., 2018. Interflow is not binary: a continuous shallow perched layer does not imply continuous connectivity. *Water Resources Research*, 54, 5921-5932. DOI: 10.1029/2018WR022920

