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

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Reviewer 3:

The authors studied the connectivity of hillslope to stream water using an impressive amount of data from 5 different catchments. The catchments studied were divided in two different geologies. The methodology they chose to use was focused in groundwater levels in piezometers near the streams and stream levels to try simplifying the hillslope approach that is often used when searching for connectivity with the stream. The study is interesting and I only have a few comments and questions to the authors adding to reviewers 1 and 2. I will now follow with some general comments and later

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into more specific comments: - One of the goals of the study was to test if assessing the connectivity between hillslope and stream could be done with a single shallow near stream piezometer. I see your results show the answer is yes, but you miss to discuss or analyse why it worked in some piezometers and why not in others. What could you do different? In the discussions you mention that it works if you use a single well-chosen piezometer, how did you manage to have badly chosen piezometers in your network?

Answer: We thank the reviewer for taking the time to review our manuscript and are happy to see this positive résumé. Considering an un-investigated hillslope one cannot know in advance which location would lead to a 'well-chosen' piezometer and which one to a 'badly-chosen' piezometer. Nonetheless, the analysis showed that local heterogeneity did not influence each piezometer to a degree where no similarity at all could be observed. Therefore, a small number of piezometers (e.g. 3-4) should be enough to identify the characteristic patterns and which piezometers do represent the hillslope and which ones are disturbed due to local impacts. From this point on, one piezometer would be enough to describe the hillslope response and you can remove the other sensors. The well-chosen one would be one that on the one hand is consistent in its response pattern with the majority of the piezometers at this site and on the other hand has the clearest threshold signal among these. We will add an additional explanation to elaborate this in the revised manuscript.

- Related to the previous comment, is there any information about the soil profiles of the piezometers? Or were they installed blindly with the cobra? What do you mean with refusal? Is that refusal as when you reach rocks/bedrock? Or would refusal count as well as when you reach a clayey layer that could divide two aquifers (valid for the sandy soils)? Is there information on the elevation of the piezometers related to the stream/streambed?

Answer: For two of the five sites detailed information about soil profiles can be found in Sprenger et al. (2016) who investigated the areas of interest in-depth in terms of

soil profiles. Indeed the piezometers were drilled with the cobra and we have roughly described the profiles based on the cobra cores. This information will be added in the supplement. Refusal was either defined as bedrock (in schist) or when a very dense layer of clay soil was reached (marls), which could not be further penetrated by the cobra. Elevations of piezometers will be added to the revised manuscript.

Following come some specific comments:

- Page 1 Line 7: I suggest modifying the text here or earlier, “Step two” comes as a surprise since there was never a step one.

Answer: We agree and will revise the text according to your suggestion.

- P 4 L 3-12: This paragraph could be friendlier and provide more information if it was shown as well in a set of tables for the piezometers in each catchment. Stating elevation over stream bed, well depth and distance from the stream among other things. Maybe just as supplementary data, but it would help the reader visualize the piezometers better.

Answer: We agree and will add this information as supplementary data.

- P 4 L 15: I mentioned it before, but does this mean that there is no information on the soil profiles?

Answer: The cobra cores were described roughly during the drilling process. We will add this information in the supplementary data.

- P 5 Figure 2: I like this Figure and the information it provides. But I do agree with reviewer 2, either add data here or on the tables I mentioned two comments ago.

Answer: Information will be added in the revised version. For a better topographic overview at the sites we will add elevation information to Figure 2 in the revised version. We will also consider adding a table to the mentioned paragraph.

- P 7 Figure 3: I suggest you improve the horizontal lines that come from ‘hfallThresh-

old' and 'hpostAmplitude' because they are hard to see in the current version.

Answer: Thank you for point this out. This will be adjusted in the revised version.

- P 8 L 9: "...are presumed to be rather short,". Is there any data on hydraulic conductivity?

Answer: Sprenger et al. (2016) obtained hydraulic conductivities for various sites within the catchment by inverse modelling. Average values for the two soil types spread from 293 – 675 cm per day (stagnosols) and 360 – 648 cm per day (cambisols). These information will be added in the revised version of the manuscript.

- P 8 L 34: I suggest changing All NA to allNA, as you used the term allNA in all other instances.

Answer: This will be adjusted in the revised version.

- P 10 L 9-10: I would suggest to rephrase this sentence and say directly what you did instead of saying first what you did not do. It would make it easier to read.

Answer: Thank you for pointing this out. This will be adjusted in the revised version.

- P 11 L 7: why did you consider it sufficiently representative? Could you provide more information to the reader? How far is it located? Similar elevation?

Answer: The location of Roodt station will be added to the map. It is located in the schist region at an elevation of about 400m. The marls sites are around 300m. Precipitation may vary to some extent over the entire catchment. However, there are indicators supporting the assumption for this analysis: Stream events without a previous precipitation event were removed. The number of removed stream events due to non-existing precipitation events was mostly below 10, indicating that rainfall events generally occurred across the entire catchment. As also mentioned in the answer to Reviewer 1, the analysis for the marls sites was rerun with a precipitation station <5km away from the monitoring sites and at the same elevation. No real changes in event detection

results could be observed, as well as no real changes in the runoff coefficient patterns. We therefore prefer to use the single reference rainfall station.

- P 12 L 2: Here you refer to Figure 9 before referring to Figure 8, maybe move Figure9 to position 8 or change the text.

Answer: Will be revised.

- P 12 L 3-4: "...low in summer and autumn." I don't see this generalization when I see Figure 7. There are several piezometers were autumn covers the whole spectrum. Or is there median values that we have no knowledge of?

Answer: We agree, the statement was not very precise. The wetting-up phase where groundwater levels start to rise on the seasonal time scale happens mostly in Autumn-Winter, which is why autumn events can also be found at higher groundwater levels. We will rewrite this statement.

- P 19 L 1-3: Any insights on why you had some exceptions? Because if those were your only wells this study would have completely different conclusions. If you have no insights, then that is valid as well, but it should be stated.

Answer: In case of M_D Piezo4 it is a road cut with a heavily disturbed soil (P 4 L 4). For the forested site (M_K Piezo3) it might be a strong influence of close biopores (tree roots) or an erratic sensor. We will add a discussion of these issues in the revised manuscript.

- P 22 Table 2: Use capital letters in each of the boxes, you used in some boxes but not all.

Answer: Thank you for pointing this out. We will make this consistent in the revised manuscript.

- P 22 L 1: "..single well chosen well..". I agree, but how did you choose well or bad? Assuming you had installed your piezometers.

Answer: Before having installed the piezometers one cannot tell which exact locations are most representative for the hillslope and which ones are influenced by very local heterogeneities. Only in hindsight is it possible to determine which piezometers at a site have a common characteristic response pattern. One of those would then be enough to monitor threshold behaviour. Choosing among them, we would choose the one with the clearest threshold signal.

- P 23 L 1: The closing) is missing after Figure 10.

Answer: We will correct this.

References

Article (Sprenger_2016) Sprenger, M.; Seeger, S.; Blume, T. & Weiler, M. Travel times in the vadose zone: Variability in space and time Water Resources Research, Wiley-Blackwell, 2016, 52, 5727-5754

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