

Interactive comment on “A porewater – based stable isotope approach for the investigation of subsurface hydrological processes” by J. Garvelmann et al.

Anonymous Referee #2

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General comments

The current paper presents deuterium data obtained from several vertical soil depth profiles along two hillslope transects of a small watershed in the Black Forest, Germany. The deuterium data was obtained using a new and innovative porewater extraction method developed by Wassenaar et.al 2008. The study aims at investigating subsurface hydrological processes through the interpretation of the shape and statistical parameters of these vertical depth profiles. The results indicate that vertical percolation persist in the upper parts of the hillslopes, while the lower and wetter near

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stream areas show mixing of laterally displaced water.

In general, the paper is well structured and written, follows a clear line of thought and contains adequate referencing. However, it has some limitations that should be addressed to warrant publication in HESS. While the paper is mainly focused on the interpretation of the vertical deuterium profiles through mixing processes and topographic features, it falls short of adequately presenting and interpreting the heterogeneity of encountered soils, soil hydraulic properties and the role of groundwater along these transects. This becomes evident in the very short catchment description and the complete lack of information about the encountered variability of soil and related soil hydraulic properties that could have been easily obtained from soil description and analysis of the drill cores. This is surprising since the subsurface structure can exert a strong control on the water displacement along the transects and might explain parts of the observed variability. In line with this, another major shortcoming of this study is the proper acknowledgement of the groundwater component. Although a value of groundwater is reported in this study and its isotopic value plots near the stream water, it remains unclear where this groundwater sample was collected and which overall effect the apparently important groundwater component has on the smoothing of the deuterium profiles at the base of the hillslope at transect T2. In this context the study also lacks a proper explanation why transect T1 appears to be less affected by mixing processes at the footslope.

Prior to publication in HESS the authors should elaborate and revise the paper according to the outlined shortcomings. Please find below also several specific comments for the authors:

Specific comments

P9092 L20 onwards: This sentence is misleading as an objective as it might appear that the authors developed an entirely new approach of establishing vertical deuterium soil profiles. In fact, traditional approaches are refined with new extraction methods that

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were developed elsewhere. This should be made clear through appropriate referencing in the introduction beforehand.

P9094 Study sites: This whole section is way too short and needs to be entirely rewritten as it lacks essential information about the encountered soils and soil hydraulic properties that are crucial for infiltration, percolation and lateral water movement through the unsaturated zone. This also holds for the description of the geologic background setting that is important for a better understanding of the groundwater component later on.

P9093 Fieldwork: It is nice to hear that the experimentalists had a "warm and sunny" field campaign with "no considerable precipitation". However, I would suggest rephrasing this sentence in more scientific terms. This whole section also lacks an adequate description about how long the field campaign took, how much of antecedent precipitation was observed prior to the extraction etc. However, such information is essential to answer the question if sampling conditions might have had an effect on the observed variability and might explain differences between the two transects.

P9093 L21: If soil cores were extracted every 8cm, why do these samples only represent about a meter of depth in transect T1 and about 2m in transect T2? What was the rationale behind the sampling strategy?

P9093 L24: Where and when was the groundwater and stream water exactly sampled? This is essential information that needs much more carefully explained!

P9094 Stable isotope analysis: It would be helpful to give a brief explanation why the study focused on deuterium values and not oxygen-18 values, although both were measured.

P9095 L1 onwards: This sentence sounds odd and is not clear, please rephrase!

P9096 L13 onwards: Why was the deuterium sampling only focused on the upper soil profile parts at transect T1? This allows almost only speculation about the deeper part

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of the profile, as a trend towards heavier deuterium values is hardly visible. At least this should be explained in more detail, including a short paragraph in the discussion section on the possible effects on the obtained interpretation results when dealing with this limited data series.

P9097 L3 onwards: There is no word on the much larger interquartile range that can be observed for transect T2 compared to transect T1. The larger scatter of values in transect T1 compared to transect T2 is also apparent when looking at figure 2 and when comparing standard deviations. What causes this? Are there different soil properties, measurement artefacts or is this just an effect of the limited sample size? Please elaborate on this in the discussion section!

P9098 L25 onwards: The conclusions that are drawn here completely neglect the actual soil hydraulic properties at the different vertical profiles that might vary considerably and might exert a strong control on the individual deuterium profiles. Please comment on this in detail!

P9099 L29 onwards: This groundwater is essential and its influence needs to be discussed in much more detail! It is not enough to just mention it with one "outlook sentence" for future studies. . . Here also cross-references to earlier studies about the importance of the shallow groundwater components in Black Forest hillslope studies are advised.

P9100 L15 onwards: This sentence sounds odd "...a good influence for the relative influence...". Please rephrase.

Figures

P9106 Fig: It would be helpful for the reader to show a figure of the seasonal deuterium dynamics in precipitation to allow a better interpretation of the vertical deuterium profiles and mixing processes. At least an indication of typical values encountered during winter and summer is required.

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P9105 Fig. 1: Please indicate where the groundwater and stream water was sampled.

P9107 Fig. 3: Isotope values of the vertical profiles appear extremely small in this figure and make it very hard to read. Please modify the figure that the “soildepth-deuterium box” is reduced or moved elsewhere (e.g., below), so that the actual figure has more space. Please also explain in the figure caption what the dashed line represents.

P9110 Fig. 6: This figure appears redundant as the statistical information about the correlation in the text might be sufficient.

P9112 Fig. 8: This figure appears to be only valid for the case of transect T2 as no clear evidence of mixing can be found in transect T1. Please discuss and comment on this! “presented findings” in the figure captions sounds odd, please revise or rephrase e.g., “Perceptual model of hillslope processes”.

Technical comments

P9094 L2: Please use a consistent way of referring to VSMOW or V-SMOW throughout the paper.

P9095 L 20: Please use a consistent way of proper labelling the isotope values throughout the paper e.g.: -12‰ $\delta^{18}\text{O}$

P9099 L20: “destroyed” is a strong word in this context, please revise.

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