

# ***Interactive comment on “Predicting subsurface storm flow response of a forested hillslope: the role of connected flow paths and bedrock topography” by J. Wienhöfer and E. Zehe***

## **Anonymous Referee #2**

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This paper focuses on the explicit representation of preferential flow pathways in a physically based hydrological model. The authors created different realizations of these preferential flow structures and tested if these models could represent the outflow during sprinkling experiments and rainfall events. They also test if the models can represent the breakthrough during a tracer test. They show that only a few realizations can simulate the outflow correctly; these simulations had vertical and preferential flowpaths or vertical preferential flowpaths in combination with a soil-bedrock interface. These models could also simulate the observed tracer breakthrough, although the modeled response was slower and the recovery rate was higher than observed. From this, the

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authors conclude that preferential flow pathways are important and need to be included in a model for this hillslope.

This work is certainly of interest to the readers of HP. However, some of the data used in this modeling study are not described very clearly (see comment 3). The different models were probably tested in a systematic way but this is not clear from the text as the model results are not presented in a systematic way (a suggestion to improve this by adding additional figures/tables is given below – see comment 8). It is furthermore unclear why in addition to the 64 models that systematically test the variables given in table 1, there are also other model simulations that are not part of the systematic test and it is especially not clear why these model variants were not part of the test from the start. Instead they seem to be an ad-hoc addition, which makes the presentation of the result a bit messy and the testing of the model structures appear a bit unstructured (see comment 6).

One of the conclusions of this modeling work is that bedrock topography has a secondary influence on modeled hillslope outflow. However, the effect of bedrock topography was not tested in a systematic way and therefore one cannot conclude this based on this study. Only two model runs (uniform soil depth and variable soil depth) are compared. Soil depth may have exerted a larger control on modeled hillslope outflow if the variability in soil depth was larger (and the bedrock topography thus rougher) than in this model (see comment 1 and comment 10).

The discussion focuses on the implementation of the structures in the model, which is very useful. However, more discussion on how this work and how these results compare with other hillslope model studies (e.g. the Weiler 2004, 2007, 2008, Hopp 2009, James 2010, Ebel 2007 studies) or a discussion on what was learned from a hydrological process point of view would be useful as well.

The figures and tables are all clear and necessary but the text could be improved. Some suggestions to improve the text are given below.

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Specific comments:

1.) P6474L25: The effect of spatial variability on hillslope runoff is not shown in this study. Only two models are compared. There was no systematic study of the effects of variable soil depth on modeled runoff and this statement thus overstretches the results (see also comment 10).

2.) P6480L11: Give some information on the size of these soil columns. How big is big and how many different columns were used for the measurements?

3.) Section 2.1.2: Give more information on the tracer and rainfall simulation experiments and refer to figure 1 when needed (e.g. P6480L27 and P6481L10). L 27: How big are the rainfall simulation plots? L4: How wide is this seep? How deep is the cut-bank? Does it extend all the way down to the bedrock? Is it possible that not all water was captured there and some flowed underneath the trail, explaining the low recovery of the tracer? L5: How much water was applied in total/how long did the simulations last? What was the time between the two simulations? L20: What tracer was used? Were these conservative salt tracers applied in the same tests? If so, why is only the data for the Uranine test shown? L23: How long did the first stage of the experiments last? L26: more information on this correction is needed. Now it seems a bit like a fudge factor.

4.) P6485L9: Why was 0.9 m chosen as the final depth? Is this based on observations or literature values? Give a justification, also for why this standard deviation was chosen.

5.) P6485L20: How variable is this variable soil depth? What is the standard deviation of the variable soil depth? And what is the mean? Is it comparable to 0.85 m or more?

6.) P6485L25-28: It is not clear why these additional setups weren't part of the systematic analysis of the different setups. Explain this better in the text. On P6486L1, homogeneous setups (several?) are mentioned but on L25, there is just one. On

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P6489, it appears that there were 3 homogenous model setups (one with the soil parameters, one with the whole model similar to the litter layer, and one with the whole model similar to the structures). Explain the number of models better to avoid confusion. On P6488L16, 65 models are compared (64 + 1 homogeneous?) and only 5 fulfilled the model criteria - it appears from the remainder of the section that the other configurations (nr 66-122?) don't change the simulations a lot. But on P6474L10 only 5 of the 122 models fulfilled the model criteria. In Table 3 and 4, it may appear that the simulations that fulfilled the model criteria were not part of the initial 64 systematically studied model setups as their number is >65. This makes it seem that the simulations were not carried out in a systematic way. Improve the description of the simulations.

7.) P647L23-27: It is unclear what these three different runs are. Did you run the model with the width of the experimental sites twice as the set up run to determine the initial conditions and then with the variable width as the real run? Are only the results of the simulations with the variable width shown? Explain this better.

8.) Section 3.1: It would be helpful to present the model results of the 64 model structures in a more systematic way. One way would be to create a matrix that shows the 12 variables (from table 1) on both axes and then to use a color or a symbol to indicate which models fulfilled a criteria and which did not. That way it becomes clearer what models did not fulfill a criteria and which did. Now it is only shown that 5 models fulfilled all criteria and the other information is not shown.

9.) P6489L26: Explain why solute transport was only simulated for 51 of the 65 structures. This is not clear.

10.) P6492L26-29 and P6499L20-22: I don't see where you tested the effects of evapotranspiration. Also, the effect of the litter layer and bedrock topography were not systematically tested. For the litter layer, it was only a comparison of models with a thin litter layer and models without a litter layer and for bedrock topography only a constant soil depth and a variable soil depth are compared (see also comment 1 and comment

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5). These conclusions thus have to be rewritten.

11.) P6498L8: The word 'similar' is not right here as the timing was quiet different. Rephrase this conclusion.

Minor comments:

1. Chapter 1: It doesn't seem necessary to divide the introduction chapter 1 into three sections. These sections can easily be merged into one well-flowing section.
2. P6479L26: Fix units of bulk density (cm-3 instead of cm-1)
3. P6480L6-7: Did you really measure the depths up to the mm?
4. P6487L19: How far is the Heumosser station?
5. P6491L9-10: Add a reference for this.
6. P6498L3-5: Speculate on what other field evidence would be useful to narrow this selection. What do your model results suggest and what do other hillslope modeling studies say about this.

Editorial suggestions:

P6474L3: replace 'for' by ' in the'; P6474L6: replace 'flows' by 'flow'; P6474L14 , P6494L22 and P6499L21: the word 'spread' is not clear. Duration of the breakthrough or duration of the response?; P6474L23: replace 'bound' by 'related'; P6474L27: remove 'as a potential determinant'; P6475L18: insert a comma after 'hydrology'; P6475L10: replace 'flows' by 'flow'; P6475L11: replace 'had' by 'has'; P6475L12: insert 'the' before 'bedrock'; P6475L26: replace 'fates' by 'fate'; P6475L28: replace 'flows have' by 'flow has'; P6476L9: long sentence. Perhaps break up and replace 'and' by ' . As a result' and in L10 replace 'These' by ', which'; P6477L10: remove 'at the majority of study sites'; P6477L14: reword 'above the profile scale'; P6477L20: replace 'has been' by 'was'; P6477L23: replace 'for representing' by 'to represent'; P6478L9 and L15: remove 'both'; P6478L17: replace 'each other' by 'them'; P6478L17-19: remove

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sentence; P6478L23: replace 'forested' by 'forest'; P6478L23-24: replace 'pertains to' by 'is located in'; P6479L16: replace 'movements' by 'movement'; P6479L18: replace 'with the help of' by 'using'; P6479L20: replace 'our' by 'this'; P6479L27: replace 'textures are' by 'texture is'; P6480L2: replace 'depths' by 'depth'; P6480L3: replace 'measuring' by 'measurement'; P6480L6: remove 'values in the range of'; P6480L9: replace 'has been' by 'was'; P6480L11 and L13: replace 'have been' by 'were'; P6480L17: replace 'evidenced' by 'supported'; P6480L19 and 21: move 'in the low horizons' after '4.8 cm'; P6481L3: remove 'parts of'; P6481L7: insert 'a' before 'much' and L8: replace 'discharges' by 'discharge'; P6481L11: remove 'generally'; P6481L17: remove 'away'; P6481L19: remove 'tracer'; P6483L11: remove 'For the present attempt'; P6483L12: replace 'seek' by 'sought'; P6483L24: replace 'on' by 'of'; P6483L28: insert space after 'connected'; P6484L3: replace 'interconnect' by 'connect'; Section 2.2.2: move this section at the end of section 2.1.2; P6484L7: remove 'basically'; P6484L21: replace 'facilitating' by 'to facilitate'; P6484L22: insert 'for' after 'parameters'; P6484L5: insert 'the' before 'density'; P6485L24: insert reference to Table 1; P6486L14: avoid 1-sentence paragraphs; P6486L27: add reference to Table 2. ; P6487L4: remove 'to be'; P6487L7: remove 'for'; P6487L13: reword 'was effected'; P6488L1: move 'individually' to end of the sentence; P6488L12: replace 'to the peak' by 'peak concentration'; P6489L3-4: replace 'and...with' by 'but these setups had'; P6490L8: replace 'found' by 'that were'; P6490L11: which modifications?; P6491L18-21: rewrite sentence; P6492L8: remove 'in' and 'fact'; P6492L11: replace 'in the case of' by 'for the' ; P6492L14: insert 'was' before 'used'; P6492L22: remove 'which had been'; P6493L26: replace 'lightened up' by 'illuminated'; P6494L1: move 'as well' to the end of the sentence; P6494L9: replace 'soul' by 'soil'; P6494L11: replace 'have been' by 'were' ; P6496L15: remove 'over'; P6500L1: replace 'leaded' by 'led'; Caption figure 1: replace 'inlet' by 'insert'

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