**Hydrology and
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Interactive comment on "Iterative approach to modeling subsurface stormflow based on nonlinear, hillslope-scale physics" *by* J. H. Spaaks et al.

Anonymous Referee #2

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This paper presents an iterative approach to model development and calibration starting with a simple lumped model and increasing its complexity. This is an interesting approach to modeling and the results, especially from the spatially distributed models (model 4; figure 6) are interesting. Unfortunately, the models are not described very clearly and the discussion of the results is insufficient. There is no discussion of how these models and model results compare to other studies that look at the complexity required to represent hillslopes or other modeling studies for the hillslope under consideration. Furthermore, there is little discussion of how the authors dealt with common modeling issues such as initial conditions or macropore flow and how the parameter

ranges were chosen.

Major comments:

1.) There is no discussion of how the results of this study compare with other hillslope modeling studies or other studies that looked at the complexity required to represent hillslopes. There is also no comparison of the results with those from other modeling studies for the Panola hillslope (e.g. Lehmann et al, Tromp-van Meerveld and Weiler, and Hopp et al). In fact there is no mention of these previous modeling studies at all. Therefore it is not clear, how the results of this study compare to or are different from the previous studies and how this study compliments the previous studies. There should be some discussion of how the results of these model simulations compare to those of the previous studies. This could be done in the discussion sections for each model simulation.

2.) The description of the models is not clear. For example on P5209L25-26 and P5217L1-4 a lumped model with spatially discontinuous groundwater is described. Is it an actual lumped model? If so, how can there be spatially discontinuous groundwater? Or is it a spatially distributed model with the same parameters for each element? Similarly it is not clear how for the lumped model described on P5213L4 water is routed from one element to another element or how for the lumped model on P5220L6 and P5227L23 there are different spatial elements or patches of saturation. The different models should be described better and the term lumped model shouldn't be used if the model consists of spatial elements.

3.) P5217: Is this not a lumped model where water reaches the saturated zone over time (using the travel time distribution) instead of instantaneously? It is not clear to me how this variable travel time to reach the saturated zone (which I assume accounts for variable time through the unsaturated zone) is the same as a model with spatially discontinuous transient saturation. Describe this model in more detail using clearer terminology.

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4.) P5222L11: Do you see this inflection point for all events? Is the inflection point caused by macropore flow shutting off? Field and modeling studies have shown that macropore flow is important for this hillslope. Or can you not represent it because you do not include a decrease in Ksat with depth in the model? Discuss other possibilities for this inflection as well.

5.) P5226L1: Many modeling studies, including those for Panola, have shown the importance of initial conditions and the importance of modeling a period longer than one storm. How did you take care of these antecedent moisture conditions and how did you check that the moisture conditions are well represented? The values given in table 3 for field capacity and initial moisture content seem really low. Are these really reasonable (for winter)? Where did you get these values from?

6.) Table 1: What are these parameter ranges based on? Are they the same as those used by Hopp et al. and Tromp-van Meerveld and Weiler?

Other specific comments:

*) P5207L8: Replace "impermeable" by "lower permeability" as recent research has shown that the bedrock is not necessarily impermeable. This has also been shown for the Panola watershed.

*) P5209L10 and elsewhere in the text: Don't use the term virtual experiments here. These model simulations are not virtual experiments as per Weiler and McDonnell 2004 but rather model simulations to test model structures and model suitability.

*) P5213L1: Precipitation or throughfall?

*) P5215L23: How many model parameterizations were used in total?

*) P5219L14: How much is this influenced by the objective function? If it is influenced so much by the objective function, wouldn't it be better to try a different objective function first rather than changing the model?

*) P5220L1: Reference papers that describe this.

*) P5222L12: Do you have any field evidence for that? If so include or include references.

*) P5224L3 and P5225L1: What is the Nash-Sutcliff efficiency for these models?

*) P5526L1-5: If the model results are so dependent on these initial conditions, errors and choice of where to position the transect how can these models be applied in other cases? Please discuss or describe the importance of this issue in more detail and give suggestions for how to deal with this.

*) P5226L6: Be more specific about what the 'more effective experimental design" should entail? Based on the results of this study, what should an effective experimental design look like or what should it include?

*) P5226L15-19: This sentence is not clear to me. What do you mean by "unjustified to continue the iterative research cycle"? And why is it unjustified? Rewrite this section and explain better.

Minor editorial suggestions:

*) P5206L2: replace "soil water transport" by "runoff"?

*) P5206L17: "discharge being too steep" replace by "hydrograph being too steep"

*) P5207L9-10: rewrite this sentence. It isn't right to say that these regions have steep slopes because of the unconsolidated nature of the materials.

*) P5207L24: move reference to the end of the sentence?

*) P5208L9: replace "organically" by "organic"

*) P5208L26: replace "with" by "for"?

*) P5210L11: You should reference the WRR 2008 Panola dataset here, assuming that that is where you obtained the data from.

*) P5210L14: replace "Our streamflow" by "The subsurface flow"

*) P5210L22: replace "sum of squares" by "sum of squared errors"?

*) P5211L8: replace "steep increase" by "sharp increase"

*) P5213L14: describe what "Vm" stands for here instead of on P5214L2.

*) P5216L9: do you mean "observation times" instead of "observation points"?

*) P5216L16: insert ", as observed for many field studies" at the end of the sentence?

*) P5218L19-20: reword this sentence. "Discharge becomes less steep"?

*) P5224L4-6: the repetition of this sentence at the end of each paragraph is a bit awkward. Can you not just mention that it is given for all (subsequent) model simulations when you first introduce table 2?

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