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Hydrology and Earth System Sciences Discussions

Interactive comment on "The effect of spatial throughfall patterns on soil moisture patterns at the hillslope scale" *by* A. M. J. Coenders-Gerrits et al.

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Summary and Evaluation: This is interesting study that explores concurring controls of spatial throughfall, soil depth and bedrock topography on spatial variability of soil moisture and subsurface storm flow (SSF) at the Panola experimental watershed. The authors transfer a stationary through-fall pattern observed at the Huewellerbach /Luxembourg to drive a 3 D numerical model of the Panola hillslope and explore temporal dynamics of the soil moisture patterns by means of a variogram analysis. They clearly show that effective range of soil moisture is in early stages of the simulation close to the

value range of the through fall, but evolve towards the much longer range of bedrock topography during later stages of the numerical experiment.

The proposed study is based on sound methods, a sound data set and provides potentially interesting insights in concurring controls on soil moisture variability. Nevertheless, despite my sympathy for the study, I suggest that a few major points that should be addressed to extract the optimum from the study, important technical points to improve methodological rigour and minor technical points.

Major points:

- I have problems with changing the slope and assuming the spatial pattern of interception and through-fall stay the same. Trees grow upright with respect to the gravity vector, not with respect to inclination angle of a slope. Steepening you slope means to reduce the angle between the stem and the slope, this affects the correlation structure and the range of the through-fall pattern. You could account easily for this by transforming the length scale by multiplying the lag distances in your variogram calculations with the cosine of the slope angle. In fact this will reduce the range by the same factor.

- The proposed way to scale the through-fall pattern to the Panola hillslope is a quick fix! You have the range, the mean and the variance. So you could easily employ geostatistical simulation method (Turning Band, Sequential Gaussian) to generate input patterns, including several possible realizations. This way you could account for the change in correlation length with changing slope. If you want to fix part of the pattern, you can assume virtual observations of interception and condition your simulated input fields to these locations. From a methodological point of view this is a weakness of the study.

- How would temporal dynamics of the effective range change, when using a different realisation of the through-fall pattern? When regarding the ranges of the through-fall pattern, the bedrock topography pattern and the extent to the model domain, I doubt that you already reach ergodic conditions (which would justify a single realisation study). Again this could easily be explored when using a sound method for generating the through-fall pattern.

- In principle you find what you put into the experiment, as soil hydraulic properties are assumed to be homogeneous. This is a very strong and questionable assumption: both ksat and porosity are known to be spatially variable, also in forests. Correlation lengths are often short (e.g. Zimmerman et al. 2008). This could be easily explored with Hydrus and would affect the "balance" of controls. Maybe the authors can explain why they neglected this aspect in the revised manuscript?

Minor technical points:

- Page 8632 Eq. 3, this could be named as through-fall anomaly.

- Page 8633: I do not understand why neglecting the nugget saves computation time, please explain this.

- Figure 4a, lower left panel: Please use a larger line width.

- Figure 5: y- and x axis of the pseudo colour plots have no units, I assume this is meter and they mark the upslope and lateral extent of the plot? If so, please mention this in the figure caption. Please explain what 5h, 10h ? 25 h means, as the figure shall be understandable without refering to the text.

- Figure 6: maybe it is more appropriate to show the confidence intervals for the mean values instead of the standard deviation within the entire domain.

- Page 8637 and Figure 9: I am not sure what panel 2 b shows: the correlation structure of vertically averaged soil moisture for each time step? Does average mean vertically averaged in this passage?

- Wouldn't it be interesting to define an anomaly in bedrock topography, by defining an average at a constant upslope distance. This is an indicator for the deviation of a "uniform slope". I expect this to be highly anti correlated with soil moisture at the

bedrock interface.

- Page 8638: I do not think that an increasing range of the soil moisture with increasing storm depth is an inherence of a method. Maby it reflects that the precipitation pattern exerts a more and more dominant control on the soil moisture pattern, with increasing strom depth?

- Figure 8: I am wondering whether the temporal dynamics of anisotropy in soil moisture at the bedrock interface could be related to different parts of the SSF hydrograph?

- Figure 11. Sorry but I find these figures very difficult to interpret. What is the colour code, the effective range in meter?

- Please explain how you derived the R2 to estimate the variogram performance? Is this the averaged sum of the squared residuals?

Best regards,

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