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Interactive comment on "Variable Saturation Infiltration Model for Highly Vegetated Regions" *by* James Polsinelli and M. Levent Kavvas

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Response to Referee #2:

This model resembles the Green and Ampt model in the respect that it approximates the movement of water in a piston-like fashion. However, it differs and is applicable to situations where the Green and Ampt model cannot be used; any situation in which water does not pond on the surface, or does not saturate the soil. Certainly this situation occurs widely in both natural and engineered environments. That being said, in certain respects this model is not new: as referred to in the article, Chen et al. developed a variable saturation rectangular profile model in two 1994 publications. This model differs from the 1994 Chen model in its assumption and in that it is very accessible; indeed, its application is very similar to, and in some ways simpler than, the Green and

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Discussion paper

Ampt model. The novelty of the model is much more in its applicability than anything else. The simplicity of the model enables a modeler to apply it to situation in which the variability in the soil is extreme. Though I have only looked at horizontal heterogeneity in the soil, the model could be examined and extended by others to include vertical heterogeneity. Furthermore, the model has been presented to include both variability in the rainfall rates and the soil hydraulic conductivity. Although I did not include variable rainfall rates in the numerical simulations, they could be included. A numerical simulation with a single variable rainfall event will be included.

I agree that the idea that the variability in the rainfall rate controls the heterogeneity of the soil is interesting. The type of soil and factors that may increase the hydraulic conductivity of the soil must be considered along with stochasticity in the rainfall pattern; this is why I referred specifically to highly vegetated soils in the title and at parts of the article.

I neglected both variable rainfall patterns and vertical heterogeneity, both of which are extremely important in applications, because I did not want to couple the process to redistribution of soil moisture. This process could be incorporated in the same way as it is in Green and Ampt. I will make it clear that the redistribution phase of soil moisture is not considered in this paper.

The criticism that the stochastic model for Ks was not justified or commented on is valid. I chose fractional Brownian motion principally because of the inspirational works of Mandelbrot, Wallis, and Van Ness among others. Field experiments using fBM and similar stochastic processes have been done by researchers such as S. Painter. I will give the proper references and comments directing readers to these works in my revision. I picked the Hurst numbers 0.3 and 0.7 to correspond to anti-persistent and persistent random field respectively. The anti-persistent case produced extremely noisy and differences of several orders of magnitude in the Ks values of the soil cells. The persistent case produced large almost contiguous areas of similar Ks values (typically far from the average Ks value). The H = 0.5 case was standard Brownian motion has more familiar Gaussian behavior. I thought all of these cases may be of interest to researchers in representing highly heterogeneous soils. These cases are discussed by the authors listed above as well. The method in which the variability of Ks is represented makes little difference in the application of the method however. One could just as easily model Ks using a more common cell-wise-independent Log-Normal field if desired. I will make these statements in the revised paper and clearly explain why I have focused on fractional Brownian fields.

The method was compared to a relatively simple application of Richards equation for reasons similar to those listed, and due to the complications involved in simulation a highly horizontally heterogeneous aquifer with Richards equation. I will include simulations for finer grained soils.

I will reconsider the format, readability, and coherence of the Figures and the text in order to clarify the points discussed above.

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