Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-75-RC1, 2016

Hydrology and Earth System Sciences
Discussions
Open Access

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

Anonymous Referee #1

Received and published: 8 April 2016

This manuscript presents a newly-developed hydrological model based on simple analytical solution, which is integrated with a probability distribution function to quantify the impacts of distributed saturated hydraulic conductivity (K_s) on soil moisture dynamics during the rain-event. The hydrological model considers the wetting front in the unsaturated soil as a piston-shape (similar to the concept of Kinematic Wave approximation for unsaturated flow), while the wetting front below the ponding soil surface is calculated with the Green-Ampt equation. The fractional Brownian field is used for parameterizing the saturated hydraulic conductivity (K_s) to account the soil heterogeneity. With the proposed model, a group of numerical tests is provided attempting to simulated soil moisture distribution before and after rainfall under different Hurst coefficients of the fractional Brownian field.

The paper is indeed within the scope of an important and interesting research topic

Printer-friendly version

Discussion paper

of quantifying the impact of soil heterogeneity on soil moisture distribution during rain-event. However, the authors did not clearly clarify the innovative insight and scientific findings from their numerical experiments. Besides, the content of the manuscript is not well-organized, and the manuscript needs significant revision to meet the requirement of publishing in an international journal.

Comments and suggestions related to each specific section:

In the abstract the authors discussed the disadvantage of rectangular profile method and Darcy-Richards equation, which is not the reason why the new model needs to be developed as many of existing hydrological models use analytical solution to describe the variably-saturated flow. The structure of the abstract needs to be refined, because after reading it the reader might still not be able to know what is the focus of this study.

The introduction lacks of a convincing clarification of the necessity to conduct this study. There are two paragraphs (Page2, Line 12-35) that criticize the assumptions and limitations of Richards' equation and Green-Ampt equation, while those knowledge are well-acknowledged and can be found in most of textbook in the field of hydrology. I would expect to see a more systematic review of how to represent the soil heterogeneity in hydrological modeling system. Most importantly, the authors should discuss the impact of using different distribution functions of K_s on the patterns of soil moisture dynamics.

The content of method in section 3.1 is not well-organized. The authors provide a benchmark study by comparing the solution of piston-shape wetting-front equation with the numerical solution of HYDRUS-1D, but it is already known that the solution of Richards' equation is quite similar to a piston shape for coarse soil texture. Moreover, the benchmark case only accounts the sandy soil, while the authors do not mention that the discrepancy between the simulation results of these two models will be much larger when it comes to fine-texture soil.

In section 3.2, Line 20, there is a confusing statement of "The transition may be ac-

Printer-friendly version

Discussion paper

complished through a linear model, such as rectangular profile, or through non linear dynamical equations such as Richards' equation, or the kinematic wave equation". The authors should either explicitly indicate what is the method adopted in your model to calculate the "transition back to the variably saturated profile" and provide numerical example, or clearly indicate that you did not consider the redistribution of soil moisture after rain-event.

In section 3.3, the assumptions of the proposed model should be more clearly clarified. If I am correct, in each computational block, the initial water content is a constant value along the vertical soil profile (uniform distribution), and similarly the K_s is also a constant value along the vertical direction. Therefore, the proposed model only accounts the soil heterogeneity at horizontal direction but not the vertical direction. At least, the authors should clearly state that soil heterogeneity at vertical direction is not accounted if I am correct. Besides, I did not find that the authors discuss why to use those assumptions.

Section 4, the authors should clarity why the Brownian field distribution is used rather than the Gaussian distribution. Besides, it is might necessary to clearly discuss why the Brownian field distribution can be more realist if there are some the field evidences to support your study. The content of this section is mainly describing the mathematical aspect of the fractional Brownian field, while I believe that the readers of HESS also eager to know the physical meaning of the formulation that you used.

The content of Section 5 is not clear in terms of initial condition setting and results description. The authors did not clarify what new insight we can get from the numerical simulations. The grid size of 1 mm (Page 10, Line 7) is small for a hydrological system. The author should clarify why such fine grid is used and what we can conclude from your numerical simulation.

In the conclusion section, the author state that the proposed approach can be easily "extended to account for additional phenomena". However, the current study only show the result of the soil moisture dynamics in sandy soil under very simple boundary condition (single rain event with constant rainfall intensity) and initial condition (initial soil moisture along the vertical profile might be a constant value). Those assumptions imply the numerical results are based on drastically simplified condition, which does not guarantee the propose approach can be used for more complex case study.

The results only show the moisture dynamics in sandy soil under simple condition. It is also favorable if authors can provide more systematic numerical results, such as using your model to calculate the soil moisture dynamics under more complex rainfall events, or more complex initial and boundary conditions in different soil types.

There are number of technical errors should be corrected, below gives a few examples:

Some of the terminologies used in this study is heavy-going and inconsistent. I guess the "the rate of hydraulic conductance" (Page 1 Line 14) means hydraulic conductivity, and the "ability of soil to absorb moisture" (Page 1, Line 20) means infiltration capacity. I would suggest that the manuscript should use widely-used terminologies, or the author should explain the special meanings of those uncommon terminologies.

The numbering of equation is incorrect: the first equation on page 4 was not labeled.

The author should clearly introduce the symbol of variable that used in this paper, for example, ϕ in Eq.(1), V in Eq.(20), and parameters of Brooks-Corey model.

The authors should consistently use academic writing style to write the manuscript and to avoid the technical mistakes that suggested above.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-75, 2016.