**Hydrology and
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Discussions

Interactive comment on "Gravitational and capillary soil moisture dynamics for hillslope-resolving models" *by* A. Castillo et al.

Anonymous Referee #3

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Interactive Discussion

Discussion Paper

Review of HESS-2014-271
"Gravitational and capillary soil moisture dynamics for hillslope-resolving models" by Castillo et al.,

2 September 2014

General comments

In this study, authors examine model structural uncertainty in simulating soil moisture dynamics. Authors incorporated a dual-porosity parameterization (DPP) within the MOBIDIC model, which is a single-layer bucket to simulate soil moisture dynamics. The DPP scheme divides the pore space into gravitational and capillary compartments with different sources/sinks fluxes for each component. The gravitational compartment gains water through infiltration and loses water via percolation and return flow runoff. The lateral flux can be a source/sink to gravitational compartment. For capillary compartment, capillary rise and transpiration act as water source and sink, respectively. Additionally, a unidirectional absorption flow from gravitational to capillary compartment is incorporated. The results of soil moisture dynamics from the MOBIDIC with dual-porosity parameterization (MOBIDIC-DPP) are compared against a traditional 1D vertically discretized Richards equation formulation from the SHAW

model.

The two modeling approaches are applied for study sites in two different climatic conditions: (i) Walnut Gulch Experimental Watershed, AZ (semi-arid), and (ii) USDA Soil Climate Analysis Network (SCAN) station "Mayday" in Mississippi (sub-humid). Both modeling approaches are able of capturing soil moisture dynamics during the validation time period. This study shows that a parsimonious representation of soil within a hydrologic model that includes a single bucket with DPP is equally capable of capturing soil moisture as obtained from a traditional 1D vertically resolve Richards equation without DPP.

This study fails to make a convincing case for the use of DPP in a hydrologic models for the following reasons:

- The current comparison of MOBIDIC-DPP and SHAW is not a fair comparison because:
  - One model includes DPP and other does not, and
  - One model is vertically resolved and other is not.

- Authors should consider including following additional experiments to meet the objectives of this study, which are (i) Demonstrating the importance of DPP in simulating soil moisture dynamics; and (ii) The ability of single-bucket model to accurately capture vertically averaged temporal evolution of soil moisture.

	Description	
Experiment-1	MOBIDIC-DPP	Already performed
Experiment-2	SHAW without DPP	Already performed
Experiment-3	MOBIDIC without DPP	Suggested simulation
Experiment-4	SHAW-DPP	Suggested simulation

The importance of DPP can be quantified by comparing results of experiments 1 and 3; and 2 and 4. While, comparison of experiments 2 and 3; and 4 and 1 will quantify the importance of vertical resolution on simulated soil moisture dynamics.

I acknowledge that additional simulations would require substantial effort, but without those simulations the study fails to meet the curent research objectives of this study.

Specific comments

- Title

  - The tile includes the term "hillslope-resolving", but the study only examines 1D model. Thus, authors should consider revising the tile.

- Abstract/Introduction

  - Shortcoming of current hydrologic models in using subsurface grids with large (10^4) aspect ratio between horizontal and vertical discretization is mentioned in detail. But, since this study uses a 1D formulation, it does not address the shortcoming arising due to large aspect ratio. Thus, authors should consider reducing or completely removing discussion regarding errors associated with large aspect ratios.

- Calibration

  – The text describing calibration of SHAW and MOBIDIC model requires editing to improve clarity.

- Results

  – Authors should include results showing magnitude of simulated fluxes in and out of the two compartments in MOBIDIC-DPP model, even though observations for such fluxes may not be available. Additionally, comparison of those fluxes between MOBIDIC-DPP and SHAW should be included.