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Hydrology and Earth System Sciences
Discussions

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

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General comments:

This manuscript addresses an important topic in hydrologic modeling by comparing two types of model structures for simulating soil moisture. The choice of an appropriate model structure for a given location is a critical component of the hydrologic modeling process, and this manuscript provides some insights into how a lumped single-layer soil representation compares to a multi-layer Richards equation solver. The model comparisons are conducted for vertical profiles of soil moisture observed in two locations with different climates. While model performance comparisons are inherently interesting, I would recommend that the analyses be framed within a broader context of address-

ing key questions about distributed modeling structure. This would help readers relate the model comparison results to their implications for model choice in future studies. Specific suggestions for relating the study to this broader context follow.

Specific comments:

1.Title: The title gives the impression that the paper will examine a wide range of models, with a focus on the difference between gravitational and capillary soil moisture dynamics. A title better representing the paper content might be "Comparison of simulated gravitational and capillary soil moisture between single and multi-layer soil moisture models". The term "hillslope-resolving" is unclear.

2.Introduction: The introduction provides background on distributed models, introducing the motivation for using alternatives to the Richards equation for unsaturated flow modeling. Yet the model tests conducted in the study are not spatially distributed and are instead 1-D single location model applications. I would suggest either focusing the introduction on model representations of vertical soil moisture movement or expanding the model comparison to consider lateral flow as well. Expansion to a lateral flow test would enhance understanding of how the MOBIDIC structure compares to a Richards equation approach when applied in distributed mode.

3.Calibration: Please document the parameter values used for each model, and indicate which parameters were fixed and which were calibrated. The information about parameterization and choice of layer depth is vague (see for example p.7146 lines 14-15; p. 7149 line 11-12). Presumably some information about soil properties like Ks and porosity are available from the study sites – were any such measurements used to inform parameterization? The models have some parameters in common and some that differ, so it is important to know which combination of values produced similar results between the two models. Experiments with different combinations of parameter values could be one potential area for expanding the analysis to better inform model choice in future studies. For example the calibration of SHAW uses depth-varying Ks

– how do these values compare to the Ks used to calibrate MOBIDIC? Do the rate coefficient parameters in MOBIDIC relate in any way to the structure or parameterization of SHAW?

4.Performance evaluation: The correlation coefficient is not often used for performance evaluation of hydrologic models because it can produce high correlations for models that systematically over- or under-predict. I suggest using alternate or additional performance metrics to help expand a more in-depth analysis of model performance. p.7151 line 23-24 suggests good SHAW performance, but the magnitudes of soil moisture fluctuations are quite different between measurements and simulations in Fig 5.

Technical corrections:

p. 7127 line 14: Fine discretization does not necessarily increase the numbers of parameters to calibrate; typically applications of Richards equation models do not assign separate parameter values to each computational node.

p. 7138-9: The study is introduced in three separate paragraphs ("in this study we test. . ."; "the goal of the paper. . ."). I suggest restructuring these paragraphs so that introduction of the study is consolidated at the end of the introduction.

p.7139 line 24: Rather than "demonstrate that" consider a statement that does not imply a fixed outcome such as "test whether" or "compare how".

Table 1: See previous comment about introduction focus on distributed modeling. This table does not connect clearly with the study conducted, which only includes 1D modeling.

Table 2: Specify which parameter values were calibrated and which were fixed. Indicate whether there were measurements available to help constrain parameter values. Please explain and justify why Ks and theta_s were calibrated separately for each measurement depth.

Figure 6: Include legend for Precip and ET.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 7133, 2014.