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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Parametric soil water retention models: a critical evaluation of expressions for the full moisture range" *by* R. Madi et al.

Anonymous Referee #1

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This paper compares models of water retention and hydraulic conductivity for theoretical consistency, their ability to match measurements in four soils across a wide range of potentials from near saturation to very dry conditions and, from a functional point of view, in terms of simulated water balances in a dry climate.

The review of different hydraulic models approaches is comprehensive (at least for models based on the capillary bundle concept) as well as revealing, while the functional model comparison under dry climate conditions is also potentially very interesting. I only have a few concerns, which I think could easily be addressed by the authors:

1.) No information is given on the four soils. I checked in Schelle et al. (2013) and discovered that they investigated samples with these four textures taken from three

different sites in Germany and also for disturbed and undisturbed soil. The authors must give specific information on the location of the sampling sites, land use at the sites, whether the samples were disturbed (packed) or undisturbed, sample diameters and number of replicates.

2.) Looking at the figures, I am a little surprised by the apparent lack of structural pores that fill/drain in the tension range close to saturation, say < 10 cm (especially in the finer-textured soils). It does seem to me that throughout the paper the authors only consider the effects of textural pores and do not consider or acknowledge the existence of structural pores. Is this because you only looked at disturbed (packed) samples? Please discuss and clarify this point.

3.) The authors comprehensively present the equations of the models, but they write nothing about their conceptual basis. A few introductory sentences are needed to explain the concepts and assumptions underlying these capillary bundle models, including the fact, for example, that they assume a mono-modal size distribution. Alternative approaches could also be mentioned (e.g. bimodal models, fractal models etc.).

4.) A more extensive database than four soils would ideally be preferable to enable a reliable discrimination between alternative water retention models although I understand that few datasets include the very dry end of the range. The authors could discuss this.

5.) The simulation set-up does not appear to be optimal. My concern relates to the initial condition (hydrostatic equilibrium) in relation to both the bottom boundary condition (unit hydraulic gradient) and the length of the simulation, which was quite short (999 days). Judging from what the authors write (e.g. at lines 733-734), it appears that for this dry climate, this combination results in a simulated water balance that includes a non-negligible term for the change in profile water storage, which is not satisfactory. Water balances in the field should have a negligible change of storage in the long-term and scenario simulations with models should be set-up to mimic this as far as possible. As the authors note, the change of storage is different for the different models, which

makes it difficult to compare them with respect to the important terms in the water balance (i.e. recharge, evaporation).

The best way to deal with this is to run a 'spin-up' ('warm-up') period first (separately for each model), then use the final state variables (water contents, potentials) at the end of this period as the initial condition for the actual simulation period (using the same driving data for both periods). The water balances for the second simulation period should then be checked to make sure that the change of storage is negligible. If it is not, the warm-up and simulation periods should be extended until it is. Only then can the water balances simulated by the different models be properly compared. If the authors do this, I suspect the differences between the model formulations will be smaller, though probably not negligible.

It would also be a good idea to summarize the simulated water balances for the different models in a simple table (precipitation, evaporation, recharge, change of storage).

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