Response to Reviewer's Comments

1. *Also include a performance comparison with a bucket-type model of the vadose zone to demonstrate the conditions under which the dual-porosity model is warranted (also suggested by reviewer 3). The authors have elected not to pursue my first suggestion. I find this puzzling as the effort required would not be much, and the results have the potential to greatly increase the scientific impact of the work. Instead, the authors articulate that the comparison is not made "because of the advantages and merits of the dual-pore structure as discussed," such as that hydrologic processes can act "separately on the dual reservoirs." This may indeed be an advantage, but my point is that it has not been demonstrated as such – only claimed. Thus, I still think the paper would be strengthened with a comparison against a bucket-type model. Even if the bucket and the dual-porosity models gave the same results for soil-moisture dynamics, I think that would be valuable information. In such as case, the argument for the dual-porosity model could be made on the basis of other characteristics, such as modeling for transport and mixing – for example for stable isotopes.*

   Response:

   The manuscript is based on the main author's Ph.D. dissertation. As the main author is already working in the industry (not research or academia), the additional work to pursue the suggestion of the reviewer is actually higher than it seems to the reviewer. An additional comparison with a single-bucket model would require among other things, selection of a benchmark single-bucket model, model calibration, revision of all figures, and revision/augmentation of much of the text of the manuscript. This additional comparison can be pursued as extension of the current work. It is expected however, subject to the selection of a good benchmark single-bucket model, that a single-bucket model will also be able to capture the temporal range and dynamics of soil moisture as accurate as that of MOBIDIC and SHAW.

   This manuscript is the first in a series of 3 research papers. With respect to this, one of the primary goals of the current manuscript, as mentioned in p.7 line 10-13, is to demonstrate that MOBIDIC (using a dual-pore soil representation) can simulate the magnitude range and dynamics of soil moisture, as accurately as models, such as SHAW, that use detailed soil physics relations. This then becomes a basis for application of MOBIDIC for catchment hydrologic modeling.

2. *I also found the last sentence of the added paragraph on p. 7, which claims that bucket models do not capture hysteresis, a bit odd. I do not see bucket models as fundamentally different from the dual-porosity model in this regard. The inclusion of hysteretic or non-unique behavior simply requires an inclusion of history-dependence, which could be incorporated in either type of model.*

Response:

The added last sentence which mentions hysteresis has been removed. However, for the advance information of the reviewers, we are currently finalizing another manuscript that shows that although hysteresis is not coded in MOBIDIC, simulated soil moisture fields for a number of catchments exhibit this phenomenon. The hysteretic behavior is hypothesized to have emerged as a result of MOBIDIC's use of a dual-compartmentalized soil, which realistically captures the different roles of capillary & gravity-driven processes, as well as the threshold dependent nature of lateral subsurface runoff. Nonetheless, we agree that such "claim" cannot be made in this current manuscript so the added last sentence has been removed.

3. *Clarify the description of the equations that represent the soil-moisture dynamics in the MOBIDIC model.*

With respect to my second suggestion, I found the paper to be improved with respect to the articulation of the equations, but I still think the clarity could be improved. In particular, my recommendation is to present the balance equations for the water stores, Wg and Wc in particular, followed by the expressions for the flux terms. e.g.,

dWg/dt = I1 + I2 – Rr + QL,up – QL,down – Qper – Qas

I =

Qper =

By including only the expressions for the flux terms, I think clarity suffers.

The authors have added an expression for the updated storage in the gravity reservoir (Wgu), which helps with respect to Qper. The expression for QL, however, needs to be revisited – should that depend on Wg or Wgu? Also, one of the Qas terms in eq 7 should be Qper.

Response:

Following your recommendation, the balance equations for the 4 water reservoirs (Wc, Wg, Wp, and Ws) are now presented, see Eqs. 4 to 7. Next, the hydrologic fluxes (I, Qper, …) are defined in Eqs. 8 to 13.

4. *Lastly, a minor point, the authors refer to the dual-reservoir model in MOBIDIC as being 1D. In fact, it is a dual-reservoir model (zero-D). There is only one soil layer – there is no spatial discretization in any dimension.*

Response:

We originally referred to it as “a 1-D version of MOBIDIC” because it can be used to model a soil column and the soil depth is explicitly parameterized in MOBIDIC. For clarity, the term "1-D version of MOBIDIC" has been replaced by "1-pixel version of MOBIDIC". The new term has the added implication that it is the elementary unit of a distributed catchment hydrologic model.