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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Spatially Distributed Characterization of Soil Dynamics Using Travel-Time Distributions" *by* F. Heße et al.

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This paper describes postprocessing of the state and flux data from the distributed hydrological model mHM, to calculate modelled transit time distributions of water in each model grid cell, in a catchment in Germany. The authors are then able to analyse the temporal and spatial variation in modelled transit time distributions, and relate this to variations in model inputs and parameters.

In its current form, the paper provides an investigation of mHM model behaviour that has not previously been studied, however there is no comparison to measured data to show whether or not the described model behaviour might be realistic, and as highlighted in my comments 2 and 3 below, there are aspects of the model which could be expected to disagree with field data. I therefore believe there is more work to do



to convince the reader of the scientific contribution of the paper, and why we should believe these model results.

In particular, I have the following major comments:

1. The introduction reads as though no previous studies have done what this paper sets out to do, i.e. to use the states and fluxes of a hydrological model to gain additional information about transit time behaviour that cannot be directly extracted from field measurements (also referred to as the "virtual experiment" approach). However, this is not the case, and previous studies have done exactly this including Hrachowitz et al (2013), Fenicia et al (2010), my own McMillan et al (2012), and Sayama et al (2009) who include an analysis of grid size sensitivity and effect of soil properties on transit time, both analysed here. The novel aspect of this paper is that a distributed rather than lumped model is used, and I suggest that the introduction is changed to make this point.

2. The method used in the paper implicitly assumes instantaneous total mixing of the water in each model grid cell, without any partial mixing behaviour or inactive storage component. However, this type of process description is widely considered to be not representative of field conditions, and typically does not give model estimates comparable with field data estimates of mean residence time (see McDonnell et al 2010 and the previous references I gave). The authors need to discuss this point and justify the use of model results that rely on this assumption.

3. The paper analyses transit time distributions within each model cell. Because the model then routes water between cells in a downstream direction, I infer that the larger the catchment, the greater the modelled transit time because water must pass through a series of cells. However, transit time is not generally found to have a clear relationship with catchment scale (e.g. Hrachowitz et al., 2009). Again, the authors need to discuss and justify this point.

References:

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