

## ***Interactive comment on “A particle based model for soil water dynamics: how to match and step beyond Richards’ equation?” by E. Zehe and C. Jackisch***

**Anonymous Referee #3**

Received and published: 1 June 2016

The paper deals with water flow in unsaturated soils simulated by a particle based model. The authors used the water content based formulation of the Richards equation to define an equivalent Fokker Planck equation. If the link between the PDE (eq. 1) and the stochastic equation (SE- eq.2) has been demonstrated for linear problems like the advection-dispersion equation, the analogy for highly nonlinear problem is fully intuitive, as well as the nice and smart implementations of the particle based method. Moreover, the easy way to extend the SE to preferential flow and mixing makes the particle based method very attractive as shown by the simulation of field data. As stated by the authors, this work is a first step in the development of this approach.

The paper needs some revisions according to the following comments:

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1. It should be clearly stated that the chosen Richards formulation cannot be applied to heterogeneous domains.
2. The time varying parameters are handled using a predictor-corrector scheme which consists in computing the parameters at time  $t+0.5 \Delta t$ . The parameters values at  $t+0.5 \Delta t$  are not representative of the equivalent parameters defined over  $\Delta t$  due to the strong non linearity of the parameters with respect to the variables. It may be a good approximation for small time steps. Since the optimal time step is not known a priori, this makes the scheme tricky from a numerical point of view.
3. The comparison with the three theoretical benchmarks is quite convincing for short times. However, the difference between the PDE formulation and SE increases with time (fig. 3, b&d, fig 5). Is it due to drainage? Is there a bias in the method? An additional simulation with drainage of an initial saturated soil may provide some information. This point is critical. It is probably not possible to demonstrate mathematically that PDE and SE are equivalent. Therefore, detailed numerical experiments are required. At least, the authors should also provide a long term simulation (over one year) with time varying boundary conditions (infiltration, evaporation) and compare the SE to a reference solution (fine time and space discretizations) obtained by Richards equation.
4. Both approaches are also compared on a set of field data. Since the full mixing particle model differs from the Richards model by its formulation only, one model cannot be better than the other as it is stated lines 359 to 366 (p. 12). The difference is only due to the mathematical and numerical approximations made to establish the SE and to solve it.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-107, 2016.

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