Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-132-RC2, 2019

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Simulating preferential soil water flow and tracer transport using the Lagrangian Soil Water and Solute Transport Model" *by* Alexander Sternagel et al.

Anonymous Referee #2

Received and published: 7 May 2019

In this work, the authors extend the model of Zehe and Jackish (2016) considering transport and linear mixing of solute in the soil matrix and introducing the concept of preferential flow through macropores. They used a Lagrangian approach in accordance with the Zehe and Jackish, modelling water infiltration in an effective 1-D soil domain. They take into account preferential flow in macropores, partitioning water into two domains (macropores and matrix), similarly to a double continuum model. They define a preferential flow domain, modeling infiltration into the macropores and the matrix and diffusive mixing from macropores into matrix. They perform a sensitivity analysis for some model parameters and they apply the model to a tracer experiment. In my opinion the object of this work is of interest for Hydrology and Earth System

Sciences Journal, however I suggest a major revision. The model is characterized by a large number of parameters, that, in my opinion, are not properly described. As a consequence, it is not clear, from my point of view, how the model has been applied to the only tracer experiment provided and how these parameters could be linked to some physical property. Sensitivity analysis has been shown only for few parameters, considered the most relevant, and only few words has been spent for some other parameters (e.g. the distribution factor: fbig, fmd fsml and the matrix potential). Some statements are not supported by evidences and some results are not commented, in the following my major and minor comments.

MAJOR COMMENTS

- As mentioned in the Introduction and in the Conclusions this model is similar to a double-continuum one. In my opinion, it would be interesting if you could elaborate this similitude, ideally linking the parameter of your model with the ones of a classical double approach (with appropriate references)

- Pag.4, line 23: here I am a bit confused about how do you compute the diffusive mixing: it is not the entire solute mass in a grid element given by the mass of all the present water particles?

- Pag.4, line 26: do you have some criteria to define a "sufficiently fine" grid?

- Pag.5 line 10: could you please list all the parameters of the model and do not only refer to Figure 2 in order to better clarify how many parameters the model counts? Is the pfd characterized by the 17 parameters given in the caption of Figure 2? Is the macropore diameter "dmac" (in the text) equal to "D_M" (in Figure 2 and in Section 2.3.i)? In Table 1 we have 16 parameter for the soil description (7 for the soil type and 9 for the macropores domain) + 8 for the experiment conditions + 4 for the numerical implementation.

- Pag. 6, line 6: how is the matrix potential gradient between the first two grid elements

computed?

- Pag. 7, line 11: why does your model “generally” divide the total amount of macropores into 3 parts? Could you please explain the meaning and the effect distribution factor?

- Pag. 7, line 20: why do you use the harmonic mean to compute a sort of “effective” hydraulic conductivity? Usually, the effective hydraulic conductivity for heterogeneous media in parallel configuration is computed as the arithmetic mean of the 2 conductivities . . . is your model sensitive to this choice ?

- Eq(7): is the number “2884.2” result of a calibration? Could you please provide some details about it? Have you calibrate some parameter of your model to fit the experimental data? Could you please provide some details about how to use the model to interprete experimental data?

- Pag.9, line 21: in my opinion, the way you describe your sensitivity analysis is a bit vague .. how do you conclude that ks, dmac (=Dm?), nmac are the most sensitive parameters ? How do you conclude that ks is “probably the most sensitive parameter” (Pag.9, line 31) ?

- Pag. 10: Result section: I am sorry, but for me it is not clear how do you select the parameters of your model to simulate the tracer mass in the respective depths, could you please state more clearly which observables you had, which parameters you compute from measurements etc.

- Pag. 10, line 23: do you have an explanation about the greatest difference in profiles between 0.15 and 0.35m depth?

- Pag. 10, line 32: here, as in Figure 9, it looks that the results are sensitively depending on the Configuration (1,2,3) . . . there is a way to parametrize the different configurations in order to study and quantify the sensitivity of the model to the different configurations?

- Pag.12, line 28: here, you conclude that macropore-matrix exchange should be mod-

elled deriving an “effective conductance”, even if it is the first time you introduce this term. I suppose you refer to the coefficient in Eq.6, but I would specify it.

- Pag. 13, line 3: I agree that “further field experiments on a variety of differently structured soil is necessary”, however, from my point of view, it is not clear how do you parametrize these differently structured soils as well as do you parametrize the spatial heterogeneity of the macropores network (Pag. 13, line 35)

- Pag. 13, line 13: in my opinion it is not so straightforward how do you transfer the concept of cubic particle storage and hydraulic radius to any kind of macropore geometry.

MINOR COMMENTS

- Eq. (1): please check this equation. I suppose a "+ z_i(t)" after the equal is missing and the format is different from the other equation in the manuscript.

- Pag. 4 line 5: could you provide some details about the soil water retention curve used to compute the diffusivity from the hydraulic conductivity?

- Pag. 4, line 6: I guess that Z is a random uniformly distributed number "between 0 and 1";

- Pag.4, line 21: could you please provide some details about the numerical implementation of the model (e.g. programming language etc)?

- Pag. 6, line 4: typo: please write consistently k_m1 with Eq.(3) as well as n_mac introduced in Pag.5, line 6.

- Pag 6, line 8: is the simulation time step “dt” or “Delta t”?

- Pag 7, line 22: please correct a typo: “matric” potential

- Pag. 12, line 33: Here you say that you need at least two million particles, but I suppose the minimum number of particles you need is proportional to the observation

area, isn't it?

- Pag. 13 line 38: you conclude that your model provides high computational efficiency with short simulation times, could you please provide further details?

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