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Comment on hess-2021-238

Anonymous Referee #2

Referee comment on "Feedback mechanisms between precipitation and dissolution reactions across randomly heterogeneous conductivity fields" by Yaniv Edery et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-238-RC2, 2021

The manuscript, by Edery et al., addresses a significant topic of reactive transport in heterogenous porous media, with precipitation/dissolution scenario. The main contributions of this paper are variation/changes in the spatial-statistical moments of the velocity field during the transport of reactive species, and how different flow zones (i.e., preferential paths and low conductivity zones) are contributing (differently) to precipitation/dissolution.

The manuscript deals with a timely and relevant topic, well-written and presented, and its results have a general contribution for various systems in hydrology and earth science. Therefore, it is suitable for publication in HESS, with a few minor revisions.

General comments:

- The authors use a Darcy scale model to solve the velocity field, and thus the transport, while the system is “only” 60*24 cm (Lab scale). More important, for Darcy scale, I would expect the use if dispersion coefficient and not diffusion (Eq. 4). Although understanding the authors choice here, in order to use particle tracking approach, they should discuss their choice (i.e, diffusion over dispersion), and emphasis the relevance of their results for larger scale systems (adding references).

- The chemical model (sec. 2.1). I am not sure that “infinite Damkholer number” (line

98) is the correct definition. How much the reaction products are sensitive to the choice of numerical parameters (time interval for reaction), overall particles and the grid size?

- The relation between the non-Fickian transport behavior and the CTRW pdf TPL. Although the fits of psi(t) are reasonable (Fig. 2), the authors might add a fit to the breakthrough curve, for a selected realization, to show that the transport in a non-reactive system follows the ctrw model (TPL). Also, how the authors find the TPL parameters (table. 1)? Are they related to the statistical moments (i.e., particle mean velocity and variance)?

In this context, maybe to add the mean velocity value to table. 1.

- What is the magnitude of Pe. Seems that the transport is at (relatively) high Pe (advactive dominant), and thus the occurence of preferential paths is more relevant. However, many water resources are usually under low Pe value.

- The system seems to be sensitive to the choice of the boundary conditions, where the low velocity sampling (which contributes most to the non-Fickian behavior) is only around the inlet boundary. The authors should discuss that in more details and add more references (e.g., Kang et al., 2020 **https://doi.org/10.1029/2020WR027378**)

Specific comments:

- In the Kozeny-Carmen model, the authors might add the formula for the porosity evolution.
- Lines 171-172: what will be the effect of different boundary constrains?
- Are 20 realizations being significant for a robust statistic? What is the variability within realizations?
- How the pore volume is defined? By the initial condition? As the overall flux is evolving during the simulations.
- For larger pore volumes, are the monotonic behavior in Fig. 4 might shifts? And therefore, precipitation becomes more dominant.
- Line 153, please check the random walk formula for 2D

Technical corrections:

- Figure 3. Missing space "d and f Panels…."