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Discussions
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Interactive comment on "Investigating the impact of exit effects on solute transport in macropored porous media" *by* Jérôme Raimbault et al.

Anonymous Referee #2

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Manuscript HESS-2020-494 investigates the impact of a filter located at the end of a sand column with and without macropores on the flow field under steady-state transport experiments with inert solutes. The authors demonstrate that the filter modifies the flow field substantially in case that there are specific preferential flow paths present in the porous media. Bringing attention to this fact is important to avoid and address similar pitfalls in future experiments on water flow and solute transport through soils and rocks. It is therefore of interest to the readership of HESS.

I am thanking the authors for having delivered a very well developed manuscript. It is well structured and the English is on a very good level. The editor should note that I am not an expert in MRI and cannot say much about the description of the MRI setup other than that it looks like a typical description of an MRI setup (which still is a bit like

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magic for me). The equations in the manuscript appear to be correct to me, but I have to admit that I have no idea how equation 7 is derived and do not have access to Bruus (2007). In the following recommendation, I am assuming that everything is sound.

I only have a few general and specific remarks that the authors need to address carefully before the manuscript can be published. These are however minor.

General comment:

The impact of a filter under upward flow conditions is very similar to the presence of a seepage face at the bottom of soil columns or lysimeters that are open to the atmosphere (see Flury et al., 1999 in the reference list below). Your study implies that also the installation of a porous plate at the lysimeter's lower boundary will not result in a flow-field that is similar to the one that would be observed in the field. The authors might want to make this point, too. If experiments are conducted under unsaturated conditions on lysimeters or soil columns, the distortion of the flow field is expected to be even more extreme than under saturated conditions, because also the water content changes in the vicinity to the outlet. However, the phenomenon observed in HESS-2020-494 is also observed at a seepage face under (near-) saturated conditions as the study of Koestel and Larsbo (2014) shows.

Specific comments:

L2 and following uses of the term: "macropored porous media" is not used in the soil hydrology and solute transport community. I recommend using "porous media with (artificial) macropores" instead.

L43-44: this is not entirely true. See Flury et al. (1999) for discussions on the effect of the column exit and Kreft and Zuber (1978) for the effect of the entrance.

L53: please use past tense when describing your experiment

L61-62: Pore diameters derived from X-ray images are strongly influenced by the image resolution and image processing steps chosen to arrive at a binary image of the

pore space. Furthermore, the average pore size from X-ray images will always be overestimated, because the smaller pores are not visible in the image. If you mention the X-ray measurements, you need to elaborate on how you arrived at the pore diameter measurement. However, since you fitted the effective pore diameter anyway later on, so that it results in a good fit of the breakthrough curves, I recommend to remove all references to the X-ray measurements from the manuscript.

L94: conservative tracers

L97: better: “The columns were installed in an upright position..”

L126 the measurement time

Equations 2, 3, and 4: please decide for one way of writing the Laplace operator

L164: . . .Kozeny-Carman equation, assuming perfectly spherical sand grains.

L169: “holes of length” Should it not be: “holes of diameter”?

L174: please provide a justification for your choice of dispersivity and tortuosity

L223-227: Nice!

L285-286: the solute remains more concentrated within the macropore

L304: not the “presence of the filter” implies this but “the transport patterns in the presence of a filter”

L343-345: I do not agree. I am sure you would see a substantial effect of the inlet filter if you would model the transport without such a filter (see Kreft and Zuber, 1978).

L351-365: please remove. It repeats what has been very explicitly discussed in the section before.

Figure 4: please use a color scheme or invert the gray-scale. At the moment, the tracer plumes are difficult to discern.

References

Flury, M., Yates, M.V., Jury, W.A., 1999. Numerical analysis of the effect of the lower boundary condition on solute transport in lysimeters. Soil Sci. Soc. Am. J. 63(6), 1493-1499.

Koestel, J., Larsbo, M., 2014. Imaging and quantification of preferential solute transport in soil macropores. Water Resour. Res. 50(5), 4357-4378.

Kreft, A., Zuber, A., 1978. On the physical meaning of the dispersion equation and its solutions for different initial and boundary conditions. Chemical Engineering Science 33(11), 1471-1480.

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