

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2  
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## Comment on hess-2022-316

Anonymous Referee #2

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Referee comment on "Effects of dynamic changes of desiccation cracks on preferential flow: experimental investigation and numerical modeling" by Yi Luo et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-316-RC2>, 2022

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The present manuscript focuses on the experimental and modelling aspects of the hydrologic behavior of a shrinking soil under repeated wetting-drying cycles. In particular, the role of cracks and their dynamic behavior during the cycles are emphasized. The overall content of the paper is very interesting, relevant and fits within the aim and scope of the journal. Regarding the novelty aspects. Experimental: I am not an expert in the subject, but I am assuming (as it also transpires from the paper) that this type of experiments (e.g., setting, soil type, involved processes, scale of observation) are well-established; the experimental results are of quality. Modelling: the authors emphasize the novelty aspect of the proposed dynamic (i.e., varying with the saturation degree of the soil matrix) crack permeability, yet, going through the paper, it appears to me that the proposed model strongly leverages on previous formulations introducing then some assumptions. The reference to the literature seems appropriate and reach; Figures could be of a better quality; Writing: I am not a native English speaker, but there are several unclear parts in the text and several errors, I highly recommend a careful revision of the text.

I have a set of comments which I hope would help to improve the quality of the paper.

**Comment 1:** the authors define the novel dynamic dual permeability model DPMDy mainly by setting the relative permeability of the crack always equals to 1 (Eq. (28) and line287) while they leverage on Eq. (27) proposed by Steward et al., 2016b to determine the absolute value of the permeability of the crack. In this context, the DPMDy does not seem that novel, since it is mainly based on an assumption rather than a novel formulation/expression! Moreover, how reasonable it is to set the relative permeability of the crack always to 1? The less water there is in the crack the smaller the crack permeability should be.

In section 6.2.1 the authors compare the values of crack permeability for the DPMDy and dual permeability (DPM) models (see Eq. (25)), see Figure 17: The striking feature being that the crack permeability for DPM decreases over the drying cycle, while that for the DPMDy increases. I would expect a decreasing trend for the crack permeability as the soil gets dry: we are speaking of the crack permeability associated with water, thus as less water is present in the crack the harder it gets to let it flow under a given head gradient; this is the meaning of including the relative permeability in Eq. (25). At the same time, I do agree on the explanation provided by the author for the increasing trend of the DPMDy crack permeability: the drier the soil, the wider the crack, the easier it is to have water flowing ... if we are talking of a completely saturated crack (as they assume), while I imagine that the saturation of the crack decreases during the drying cycle. I am seeing a bit of confusion on the meaning of absolute permeability, relative permeability and the permeability for a flowing phase. Moreover, I am wondering what would be the results (e.g., crack permeability to water) if Eq. (25) is combined with Eq. (27) (that provides the dynamic aspect of the absolute crack permeability to water)? DPMDy is Eq. (25) + Eq. (27) under the assumption of relative permeability of the crack to water fixed at one.

**Comment 2:** Lines 596-597 "With regard to the water flux, while the three models all have acceptable errors to the measured data, the DPM overpredicted the water flux of PF-DC but underestimate the water exchange from cracks to soil matrix." It is my understanding that the DPM underestimates the water exchange from cracks to soil matrix w.r.t. to other models (e.g., see Figure 18 and Sec. 6.2.2), but not respect to the actual behavior which is not recorded in the experiment (it is a difficult task), please clarify.

**Comment 3:** What is depicted in Figure 16? The caption does not say it, a reader must search in the main text for it.

Use the same color legend for the two panels in Figure 8 (see measurements at 25 cm) and specify what are the additional data (red and blue curves), please. Figure 6: the legend is very small. General: I would avoid dashed (or dotted) curves when is not necessary (e.g., Fig. 6a; Fig. 12; Fig. 14; Fig. 15), the quality of the images is not very high and it gets quite hard to see dashed curves, please consider change them.

**Comment 4:** Unclear text parts. Line 48 "the effects of crack dynamics on the PF-DC through experiment studies" should not be experimental? Line 51 "However, other studies found that the PF-DC also leads water to rapidly infiltrate into deep soil even desiccation cracks" even WHEN dessication? Line 59 "An improve understanding of the PF-DC combined with theory methods is also needed" THEORETICAL methods? Lines 66-67 "The DPoM and DPM concepts belong to the dual-domain framework that assumes the soil pore system can be represented" that assumes THAT the soil? Line 84 "volume and hydrological properties keep constant" remain constant. Lines 89-90 "Later modification of SWAP incorporated the aforementioned process, but with a cost of neglecting shrink-swell behavior of soil." A later modification .... but AT THE cost; Line 92: "Coppola et al. (2012); (2015) took another step forward to allowed crack volume..." to ALLOW. And many more throughout the whole text, e.g., Line 516 "In addition, another interesting phenomenon is the transient decrease of  $\delta \square \square \times_{c,exp}$  and increase of  $5cm \delta \square \square \square_{exp}$  ..." are you referring to  $\delta \square \square \square_{exp}$  at 5 cm depth? It is not clear; Line 582 "It corresponds to some experimental results that the PF-DC also exists and leads water

rapidly infiltrate into soils even desiccation cracks are nearly closed during ... " leads water TO rapidly infiltrate .... even IF dessication cracks are nearly. Please revise it very carefully!!

**Comment 5:** SWRC at line 31 is not clear what it is. AOI in figure 3, what does it stand for?  $S_{e,c}$  in Eq. (25) is not defined.

**Comment 6:** After Eq. (1)-(4) the list of symbols is detailed by giving one line to each, this changes for Eq. (5)-(13), then again for Eq. (14) one line to each symbol. Be consistent!

**Comment 7:** Table 1 says statistical results, what statistics are involved here?

**Comment 8:** many parameters of the model(s) have been calibrated (see Table 3), but it is not clear how? Which calibration strategy has been used?