EGUsphere, referee comment RC1
https://doi.org/10.5194/egusphere-2022-673-RC1, 2022

Comment on egusphere-2022-673

Anonymous Referee #1

Referee comment on "Semi-continuum modeling of unsaturated porous media flow to explain Bauters' paradox" by Jakub Kmec et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-673-RC1, 2022

The manuscript describes a modeling approach of the flow in unsaturated sand in order to explain so-called Bauters' paradox. A semi-continuum model approach is presented that can imitate the finger flow phenomena with the oversaturation in the tip and the whole transition towards a diffusion-type infiltration plume as function of the initial soil moisture condition. The model was successfully tested by description of the Bauters' experiment.

General Comments

The manuscript tackles an important problem that is in the focus of the journal. Methods and results are novel and can much contribute to progress in describing unsaturated flow phenomena. My main critical comment is that for in-depth understanding the physical basis of the modeling approach and finally also of the results, a better explanation of the semi-continuum's model concept would help.

In addition, I found the introduction is much too far reaching, of course, everything is somehow connected. The review on global water cycle, the flow phenomena, sample volume dependency, REV concepts and Richards' equations, and other aspects, all does not help much to better understand the problem, and are not discussed later any more.

What I did not understand was the semi-continuum model concept, especially what is different from a numerical discretization of a continuum model? Perhaps you did it already in other papers. It seems relatively simple and more empirical because of the block size selection and the scaling relations. Maybe it helps to include an illustration? The idea of scaling the retention function with block size is also unclear to me. I did not read the cited references, but the present paper seems to apply the previously developed model concept to describe the specific experiment, yes? It is suggested in the manuscript that the initial water saturation is the variable controlling the finger formation. What about the wettability

(i.e., surface tension), which is of course connected with water saturation but can change with time?

Overall, this valuable contribution could become even better if more focussed and with more specific explanations on the physical basis of the approaches.