HESS-2022-173 Reviewer 4

The reviewer comments are in *italics*, the reply in regular font.

This manuscript presents the improved parameterization of SWRC in the dry range based on the author's previously developed logarithmic-sigmoid SWRC model (published in HESS). Specifically, as formulated in the previous paper is expressed as a function of other parameters that were fitted, this may lead to the obtained not in the reasonable range. To solve this issue, the author focuses on regarding the shape parameter instead of as a derived parameter. By using the positive characteristic of and the minimum value of for any through the partial derivative of with respect to , the author quantified the corresponding upper and lower limits imposed on , then as a fitting parameter is eliminated and replaced by its upper limit that is determined by both and , given all fit points fell on the upper limit. As such, the obtained entire parameter space is valid, which is quite good. On the other hand, the author found that the sigmoid branch of the SWRC could be simplified to the commonly used power law as is very large. This further guarantees the rationality of emphasizing on fitting and the newly found parametric relationship.

This correctly summarizes the line of thought of the paper. Thank you for your positive appraisal of the work.

The reviewer thinks that the SWRC formulated with the parameters that are suggested being better fitted or derived, are useful to be applied in soil moisture and temperature and land surface fluxes modeling especially for arid and semi-arid regions. On the other hand, the calculated fractions of capillary-bound water and adsorption water using functions in this paper may be useful in investigating microwave dielectric properties of dry soil and associated soil backscatter. The paper is well written and organized. The reviewer appreciates the author making the hand-on script and manual public, which is encouraging and makes readers and peers benefit. The reviewer suggests the acceptance of this paper with minor revisions, especially improving the resolutions of Figures 5-8. For other minor comments please see them in the pdf.

I had not thought of the potential applications of this work and I appreciate that this reviewer brings them up, as they explain why SWRCs without corresponding hydraulic conductivity curves have merit.

It pleases me that the reviewer examined the repository with the Fortran code and the user manual, as they are an integral part of this publication.

If the editor allows the paper to be revised, the figures submitted for publication will have resolutions as required by HESS.

Please also note the supplement to this comment: https://hess.copernicus.org/preprints/hess-2022-173/hess-2022-173-RC4-supplement.pdf

Reply to minor comments of reviewer 4.

p. 1

I used the SCE method because it is well established and flexible. This has the advantage that there is literature available that established the most effective settings of the search parameters. I also liked the fact that it is a global search algorithm and therefore less sensitive to local minima because the search steps have a random element in them that forces the code to explore the parameter space more fully.

In the Introduction I want to explain the rationale of the study. The behavior of alpha is one element of that rationale, which is why I bring it up here. The full explanation and analysis of this behavior is treated in detail in later sections of the paper.

p. 2

L, L^{-1}, etc. are the dimensions of the variables and parameters I use. I have been doing this for years (after a reviewer objected against the use of units instead of dimensions), and I frequently encounter it in papers I read. This is the first time it drew a comment. I am not sure if an explanation is really necessary.

p. 3

I derived Eq. (3) as indicated in the paper, but the reviewer is correct, it can also be found by rearranging Eq. (9) of de Rooij et al. (2021). Interesting. I will mention this in the text if the Editor allows me to revise the paper. I propose to add the following line above Eq. (3): "The expression can also be found by rearranging Eq. (9) of de Rooij et al., (2021)."

p. 4

Typo corrected, thanks.

A rectangle in Fig. 1 will not do the job, because the critical region is located very close to the boundary of the blacked-out region. I cannot find a way to draw something into the figure with the software I used to create, but am looking at another way, of which I do not yet know how it will affect the resolution of the figure. In case I am not successful, I propose the following addition to the text: '...where h_j is very close to its maximum allowed value, *i.e. very close to the blacked-out region in Fig. 1.*'

p. 6

Typo corrected.

p. 7

The following explanation will be added above Eq. (11) if a revision is allowed:

The correction factor c is defined by the following expression, which is found by replacing h_d in Eq. (1) by $(1+c)h_d$, requiring the logarithmic and sigmoid branches of Eq. (1) to be equal at h_j, and replacing the ratio h_d/h_j in the resulting equality by $\exp[1/(n-1)]$ according to Eq. (8).

p. 15

I agree the resolution of the figures in the current version is low. I do not know why, because the figures on which they are based adhere to the specifications for HESS. These are the figures that will be submitted to Copernicus for processing, so if the paper will be accepted, the figures in the published version will meet the HESS requirements.