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Interactive comment on "Sigmoidal Water Retention Function with Improved Behavior in Dry and Wet Soils" *by* Gerrit H. de Rooij et al.

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HESS 2020-380. Sigmoidal Water Retention Function with Improved Behavior in Dry and Wet Soils.

Response to referee 1

The original review report:

In this manuscript, the authors report some new formulations for the soil water retention curve and hydraulic conductivity curve. The formulations work at different moisture conditions, from the dry condition to the fully saturated condition. The manuscript is generally well written and can be followed easily. Prior to a final recommendation, the authors should address the following comments. 1. In the literature, some existing

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formulations have comparable capabilities with the newly proposed formulations. The authors should explain the new contribution clearly. 2. Equation (4) plays a very important role in the manuscript, but there is no sufficient discussion about this equation. For example, how is this equation derived? What are its advantages compared to existing equations? 3. For many figures, the curves cannot be differentiated easily if printed in black and white.

Below, we address the points raised by the referee.

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Referee:

1. In the literature, some existing formulations have comparable capabilities with the newly proposed formulations. The authors should explain the new contribution clearly.

2. Equation (4) plays a very important role in the manuscript, but there is no suffcient discussion about this equation. For example, how is this equation derived? What are its advantages compared to existing equations?

Response:

The review is brief but constructive. Upon careful reading, we believe points 1 and 2 raised by the referee are related and can best be treated simultaneously. If we are permitted to revise the paper we intend to address these two points as follows:

In the Introduction in its current form we outline two lines of research: one devoted to the problems of the van Genuchten (1980) curve at the wet end, and one devoted to the problems that arise when a retention curve has an asymptote at the dry end (as the van Genuchten curve has). The introduction gives an equation (Eq. [3] that solves the problem at the wet end, but does not provide an equation that eliminates the problem in the dry end (the junction model of Rossi and Nimmo, 1994).

We can modify the Introduction by providing the equation of Rossi and Nimmo also.

The Introduction then proceeds as it does in its current form, by stating that we are going to combine both equations.

The Theory section shows the combination of both equations announced in the Introduction. When looking at Eq. [3] and Rossi and Nimmo's equation, it is easy to see how Eq. [4] arises from them. We will add some text that explains which elements of both equations were adopted and how we combined them, so that the origins and derivation of Eq. [4] are clarified (point 2 of the referee) and we can explain that the earlier equations only solved one of two problems (point 1 of the referee).

The advantages of the new equation are:

- the reciprocal of the slope is d theta / d h. At saturation, its value is zero, which stabilizes the hydraulic conductivity near saturation.

- no asymptote at the dry end, which keeps the area under the retention curve finite

- a sigmoidal shape, which allows an extension to a multimodal form

- more robust than previous van Genuchten-based sigmoidal curves when used in numerical simulations

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Referee:

3. For many figures, the curves cannot be differentiated easily if printed in black and white.

Response:

This problem only pertains to the figures in Appendix C. The graphs in that appendix serve to give the reader an idea about the shape of the curves corresponding to the parameter values provided, and we therefore expect that consultation of the figures on the screen (in color) will often suffice. In several cases there are only small differences

in the shape of the curves of different parameterizations, so they (nearly) overlap. In these cases, readers still have a good idea of the shape of their curve of choice. The tables with parameter values and the graphs of the corresponding curves in the appendix are provided as a service for readers who need soil hydraulic properties for areas where there is limited information available, or who need representations for broad soil categories. For these purposes, overlapping curves do not pose a problem. The idea is that readers choose a soil type and a parameterization and then use the corresponding parameters in their calculations. They will probably create their own graph for their particular parameter set.

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On behalf of all authors,

Gerrit de Rooij

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