

Author's Response to Reviewer 2

The authors would like to thank Dr. Flynn for carefully reading our manuscript and providing constructive criticisms. In our response below we address the expressed concerns. The reviewer's comments are in **bold text**. Our responses are in plain text.

In this paper, the authors present a model for the hysteretic relationship between the saturated hydraulic conductivity K_s and salinity C . Since K_s is an indicator of the degradation and rehabilitation of the soil and these changes can be reversible or irreversible depending on the history of the salinity or the sodicity. It makes sense to me that hysteresis should be accounted for. The Preisach model used to represent hysteresis in this paper is clear and well described. The supplemental interactive widgets would be helpful for the new-comer to this modelling approach. The Preisach model is quite a general phenomenological model, used in diverse fields such as magnetism, economics, and many others, as is evident in the book chapters in (). It should be noted that previous models based on the Preisach operator to model hysteresis between the moisture content θ and matric potential ψ of unsaturated soils. Those models did not include salinity and sodicity. In addition, K_s was taken to be fixed in those models, whereas it varies with C in this paper. I mention this, as both use the Preisach model but what is modelled is quite different.

We thank Dr. Flynn for his contextualization of the presented model in relation to other models that have used the Preisach framework to study soil processes. We will add the to the manuscript references to the following papers:

- Flynn, D., & Rasskazov, O. (2005). On the integration of an ODE involving the derivative of a Preisach nonlinearity. In *Journal of Physics: Conference Series* (Vol. 22, No. 1, p. 003). IOP Publishing.
- O'Kane, J. P., & Flynn, D. (2007). Thresholds, switches and hysteresis in hydrology from the pedon to the catchment scale: a non-linear systems theory. *Hydrology and Earth System Sciences*, 11(1), 443-459.

While this paper has many positive qualities, there is room for improvement. I have attached a pdf with annotations for the smaller issues. Please note that it displays best with Adobe reader.

We copied the comments made in the PDF to the end of this document and respond to them there.

I will start near the end of the paper, with the caption of Figure B1. I was initially concerned with the mention of "guesstimated" FORCs in first reading the paper. While I now understand that these "guesstimated" FORCS are there to demonstrate the

improvement to the model if hypothetical extra data were available, as shown in panel (b) of the figure. I would still be concerned that the term “guesstimated” might give the wrong impression, i.e. that a less rigorous approach was used, to improve the quality of the model. I would recommend that the caption be rewritten to reflect more clearly the intended meaning.

We agree with Dr. Flynn and we'll update the caption so that it refers to “interpolated” FORCs. The additional FORCs were developed by interpolating the existing data, so we believe that this change will avoid any negative connotation associated with guesstimated and give the reader a clearer understanding of how the new FORCs were produced.

I finally would like to note that () developed a numerical method for approximating the Preisach density function when there is not enough experimental data. It may help the authors to get the most out of their experimental data in producing their Preisach density.

We thank Dr. Flynn for this suggestion. We are currently collaborating on a project to measure FORCs on a broader level and for different soil types. As a part of this project, we hope to calculate corresponding weight functions and we believe the methods in the cited paper could be very helpful.

References

Bertotti G, Mayergoyz ID, editors. The Science of Hysteresis: Mathematical modeling and applications. Academic Press; 2006.

Iyer RV, Shirley ME. Hysteresis parameter identification with limited experimental data. IEEE Transactions on magnetics. 2004 Sep 13;40(5):3227-39.

Additional comments from PDF supplement:

Note: In addition to the comments copied here, the referee's notes in the PDF also pointed out some formatting and wording errors. We sincerely thank the reviewer for catching these and we will happily adopt his suggestions.

Page 2: Since the output changes on reaching alpha or beta, the inequalities should be strictly less than, rather than less than or equal to.

We agree with this correction.

Page 11: This doesn't read so well. Perhaps change the order to "indeed contains". Or remove the "indeed".

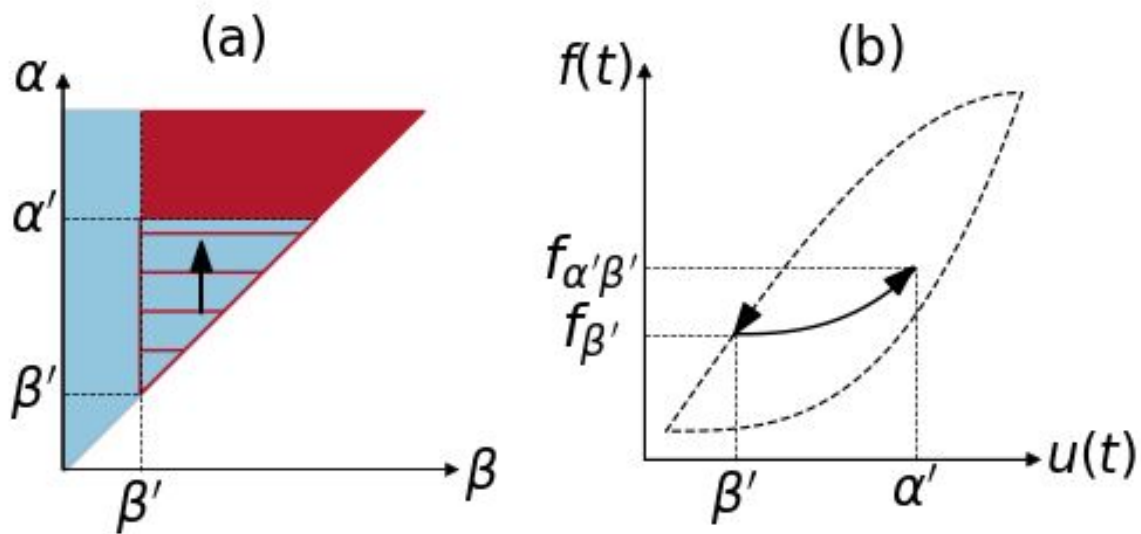
The word “indeed” should be removed from the referenced sentence. We thank Dr. Flynn for catching this mistake.

Page 13: Do the authors mean “these return points” or “there the return points”? The whole sentence should be improved as it could be clearer.

The text should be “these” return points. We thank Dr. Flynn for catching this mistake.

Page 14: The prime symbol is quite faint and close to the alpha and beta symbols in this figure. I would strongly recommend that this be improved for better readability.

An updated version of this figure is copied below.



Page 21: My reading of this, is that you provide an example of hypothetical measured FORCs that give rise to better defined weight function, which in turn improves the modeled FORCs. However, in first reading I got the impression that this was a procedure to improve the model by “guesstimated” FORCs, which gave me concern. I think it would be better for your paper to change the caption to clarify this.

Addressed above.