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Interactive comment on "On the role of soil water retention characteristic on aerobic microbial respiration" *by* Teamrat A. Ghezzehei et al.

Anonymous Referee #1

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This manuscript proposes a mathematical model to account for the effects of water in the decomposition of soil organic matter. This is an important study, because it helps to disentangle the debate on whether soil water content or soil water potential is the most appropriate measure to account for the effects of water on soil microbial activity (Sierra et al., 2015; Vicca et al., 2012). The authors address this issue by proposing the use of soil water retention curves, which combine both metrics and have a very well stablished theory in soil physics and hydrology. To test the model, the authors use a number of datasets from published studies and show that the approach works well at fitting data from incubation experiments.

The idea presented in this study has the potential to have impact in the way the effects of soil water are accounted for in different ecological studies. However, there are prob-

lems in the presentation of the approach that need to be addressed before acceptance for publication.

1 Major comments

I have problems following the model description (mostly eqs. 11 to 14) because problems of mathematical notation and apparent misuse of assumptions. I will explain this on a point by point basis.

- Page 11, line 4. The authors state that the model of equation 5 can be solved under arbitrary fluctuations of soil water status, i.e. $\theta(t)$ and $\psi(t)$. However, this is not possible to do in close form unless you have a very specific function that shows how θ and ψ change over time; and if you have these functions, it is very unlikely that you will obtain an analytical solution. I would say that this assumption is wrongly stated here, and the authors should acknowledge that the analytical expressions they provide only apply for constant soil water status. Later on page 16, lines 16-17, the authors correctly point out that only numerical solutions are possible for the time-dependent case. This is obviously contradictory to what is stated on page 11.
- The upper limit of integration in equation 11 is with respect to time, but $K(\theta, \psi)$ is not time-dependent as expressed in equation 12. It seems to me that you may want to integrate over θ or ψ, but not t.
- The solution of equation 5 is $C(t) = C_0 \exp(-k \cdot t)$. I assume that your intention is to be able to replace equations 7 to 10 for k as expressed in equation 6. If so, then equation 11 is missing a minus sign and t.
- Why do you need C_0 in equation 12? I cannot trace it back from the previous equations. Also, what happened to λ? Shouldn't it go here?

- Equation 14 doesn't seem right to me. What you probably want is to compute the integral of the respired carbon, i.e. $C_{CO_2}(t) = \int_0^t R(t)dt = \int_0^t 1 - C(t)dt$.

These problems in the mathematical description are important, because you cannot propose a new model if you cannot describe it correctly. Since the authors do not provide the code used for their computations it is also impossible to test whether the mathematical description corresponds with the implementation.

Another limitation I see in this study is the lack of contrast with a related model that may perform poorly with respect to the newly proposed model. To my knowledge, the only model that can also deal with these multiple limitations is the DAMM model of Davidson et al. (2014). It would be very helpful if the new model is contrasted against DAMM or other model to more explicitly see the advantage of the new method.

It is my impression that this model requires the availability of water retention curves for its use. This obviously implies an extra effort in terms of data collection. Can the authors elaborate more on this potential limitation of the method?

2 Minor comments

- Page 6, lines 9-10. Which one is eq. 2 and 3 in fig. 1, i.e. red or blue?
- Page 6, line 16. Remove point.
- Equation 7. Here it may be good to remind the reader that matric potential is negative, and therefore k can't be higher than 1.
- Page 14, line 8. Can you provide a justification or a reference for this choice of parameter value?
- Fig 7. What is the difference between the red and the black lines?

References

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