

***Interactive comment on* “Soil carbon estimates by Yasso15 model improved with state data assimilation” by Toni Viskari et al.**

Anonymous Referee #1

Received and published: 16 July 2020

The manuscript “Soil carbon estimates by Yasso15 model improved with state data assimilation” by Viskari et al. summarizes the results of incorporating state data assimilation routine (Ensemble Adjustment Kalman filter) into Yasso15 model. The authors demonstrate that assimilating multidecadal observations of soil carbon (C) stocks from bare fallow fields substantially improves model performance. The manuscript aligns well with the aims and scope of Geoscientific Model Development journal, and I would recommend it for publication after minor revisions.

Although given the journal’s aims and scope it is not a major issue, the manuscript did not address the mechanistic underpinnings of the observed soil C dynamics in great detail. Posterior soil C dynamics revealed that faster decomposing pools are not in constant decline, and increased after 20 years of no C input. What is the underlying

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ing mechanism that could cause this? Is this mechanism accounted for in Yasso15 model structure (e.g. is there C transfer from humus pool to acid-, water-, ethanol-, and nonsoluble pools)? Insights into potential shifts in soil C dynamics may be more easily interpreted when the error between model output and observations is used to also inform model parameters (by evaluating temporal dynamics in the values of the calibrated parameters). However, it is a non-trivial amount of work to incorporate this aspect into the study and analyze the findings, and perhaps should be the focus of another paper.

For the manuscript to be reproducible and more accessible to the reader, I suggest adding a few details. First, it is not completely clear what data was assimilated into the model: was it bulk soil C observations or was it observations of all five soil C pools as in the initial state? These details need to be added to section 2.2. Second, it was not completely clear how the parameters associated with each process and the inputs were estimated. In lines 103-106 authors state that Adaptive Metropolis MCMC (which, unlike EnAKF, is a batch data assimilation technique) to inform model parameters using a suite of observations of litter decay. Was this work done in this study or a prior study? If it's the former, including the results of assimilation of litter decay parameters would be useful, and if it's the latter, then I suggest including a reference to that work. Regarding the pre-agriculture soil C input estimation, were the estimates included in the z vector? Or was soil C input estimated outside of the data assimilation routine? I think including a conceptual figure describing the steps in the analysis as well as writing out the elements in the vectors listed in the equation 1 and 2 would clarify these aspects of the analysis.

Below, please see the detailed list of suggestions:

L45-46: it is not clear to me what message this sentence is trying to communicate. Does it mean that a lot of samples are needed to reliably estimate SOC?

L100: is there a partitioning matrix for soil C input b that distributes it among the five

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soil C pools? Also, I'd suggest writing out A explicitly for the reader to understand C transfer pathways between the pools better.

L102-103: I suggest writing out the environmental limitation functions.

L127: a comma is needed between "observation" and "and"

L130: Please provide full matrix A.

L133: Please provide the calculation for Pf

L146-147: it is unclear what "all the associated challenges" are referring to

L275: I suggest removing "here" and adding a comma before "where"

L334: Please specify what should be the focus of the additional study. Also, I think there is a typo: should it be "simple", not "simply"?

Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2020-141>, 2020.

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