

Interactive comment on “Information content of incubation experiments for inverse estimation of pools sizes in the Rothamsted carbon model: a Bayesian approach” *by* B. Scharnagl et al.

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Reply to comments of Anonymous Referee #1

Major concerns

(1.1) [...] Therefore, their estimates of the initial pool sizes are conditioned on the known carbon components (carbon pools) and known SOC decomposition processes (decomposition rates, partitioning coefficients, temperature sensitivities, and other parameters). [...]

In this study we tested the feasibility of inversely estimating the pool sizes from a suitable data set. This approach is especially appealing because it makes use of the conceptual definition of the various pools to estimate their size. We fully agree with Anonymous Referee #1 in that the resulting pool size estimates are conditioned on the model parameters. This is also stated formally in Eq. (6). Moreover, we agree in that the estimates are also conditioned on the model structure (which we define here as the number of carbon pools considered, the possible paths of carbon flow, and the governing equations that describe the decomposition process). This conditioning is usually not explicitly stated but implicit in the application of a particular model. An underlying assumption in any kind of feasibility study is, of course, that the model in use is a valid approximation of real-world processes. We think that if this basic assumption is justified, the results can in principle be transferred to reality and may help to better understand the results of related laboratory and field studies. In the revised manuscript we will present results from simultaneous estimation of pool sizes and decomposition rate constants. This approach accounts for part of model parameter uncertainty in the estimation process leading to even larger uncertainties (again most pronounced for the more resistant pools). These results, in fact, have changed our conclusions about the feasibility of the inverse approach. Moreover, the effect of model structural uncertainty on the robustness of the inverse approach will be discussed and the results will be put in context of some real-world studies.

(1.2) The authors may try another model (e.g., a two carbon pool model, labile and recalcitrant carbon, with unknown decomposition rates and temperature sensitivities) in inversion to check what they can get.

The modeling exercise suggested by Anonymous Referee #1 would indeed make a very interesting case study. It would resolve the question of how many pools and parameters we can actually estimate from an incubation experiment. However, we think that this is beyond the scope of our feasibility study which focuses on the inverse

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identifiability of pools in a particular SOC model.

(1.3) Using a model to generate a set of data and then using these data to inverse the parameters in the same model can only test the reliability of the model and the inversion approach.

The present study aims to test the feasibility of inversely estimating the various pools considered in RothC from a suitable data set. It is motivated by the ongoing difficulty with the measurement of these pools by classical fractionation methods. In this context, knowledge of the true values is a prerequisite to test the robustness of the inverse approach. This knowledge is only given in a virtual setting (using synthetic data).

Minor concerns

(2.1) In abstract (Lines 11~12, Page 9332), “this methodology has not yet been tested for assessing carbon pools in multi-compartment SOC models.” Actually, inversion approaches have been often used by the community. [. . .]

The sentence is indeed misleading and will be removed from the revised manuscript. We acknowledge pointing our attention to the two references (Xu et al., 2006 and Fox et al., 2009). We will put our work in the context of these (and other) references in the revised manuscript and discuss the implications of our findings for real-world studies.

(2.2) Lines 20, Page 9336: “2.2 Incubation experiment”. This part tells us how to generate synthetic data, rather than an incubation experiment.

We will change that accordingly.

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(2.3) Lines 24~26, Page 9336: It should be stated as “In simulations, the temperature was set to 20C ...”.

We will change that accordingly.

(2.4) The manuscript should have a figure showing their data of mineralization rates derived from RothC model. The readers may want to know what the data look like.

We will provide this figure in the revised manuscript.

(2.5) Page 9351: Table 1. I’m wondering if all parameters were inversed, could they still constrain the three initial carbon pool values?

We conducted additional experiments of this kind and will report the results in the manuscript. However, we did not inverse all model parameters simultaneously but focused on the rate constants. These results also indicate that inversion of all parameters is not possible. Please see also reply to comment (1.1).

(2.6) Lines 16, Page 934, ~ Line 24, Page 9344: “informative prior for the microbial biomass pool” just means one more parameter is known, let’s inverse the other three.

This is not exactly true. The specification of an informative prior for the BIO pool is not equivalent to fixing it to measured biomass C in the inversion. The use of an informative prior is advantageous for two reasons. First, the informative prior reflects the uncertainty in the biomass C measurement, which is – if no additional information is provided by the data – simply propagated into the uncertainty of the remaining pool size estimates (because of correlation between estimated pool sizes, see Fig. 4). This preserves the correlation structure and results in more realistic posterior distributions for all pools. Second, if the measurement is biased, the information in the data may (partially) correct for this bias resulting in a BIO posterior that is closer to its true value

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than the prior – provided the data contain sufficient information (which is not really fulfilled in the present case, see Fig. 6).

(2.7) Page 9346: Conclusions: I don't think these results have shown that the mineralization rate data (or, incubation data) have enough information to estimate the carbon pools. [...]

See reply to comment (1.1).

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