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Interactive comment on "Modeling radiocarbon dynamics in soils: SoilR version 1.1" *by* C. A. Sierra et al.

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We would like to thank Victor Brovkin for providing a review on our manuscript. The main comments of his review are provided below in italics, with our reply in normal font.

- *There are, of course, limitations of methods used in the study: for example, provided numerical package is based on linear and equilibrium assumptions. These assumptions, of course, do not cover all possible types of equations for soil carbon turnover, but provide a good start for the 14C modelling.*

  We indeed acknowledge that our approach has limitations such as the use of linear models, but we would like to clarify that this approach does not rely on the equilibrium assumption as mentioned by the reviewer. This is stated in the form

of the general radiocarbon model of equation (2):

$$\frac{d^{14}\vec{C}(t)}{dt} = \vec{I}_{^{14}C}(t) + A(t)^{14}\vec{C}(t) - \lambda^{14}\vec{C}(t) \tag{1}$$

where the inputs of radiocarbon to the soil $\vec{I}_{^{14}C}(t)$ and the decomposition operator $A(t)$ are time-dependent. We can therefore solve the model for any transient behavior of the inputs or the decomposition rates, which implies that we do not need to rely on the equilibrium assumption to solve our models. The assumption of equilibrium is only needed to calculate the mean transit time. This is explained in section 2.3.1.

- *I found notations in the equations in the section 2.3 confusing. In particular, I am confused with usage of term 'T' (it is used in section 2.3.1, but formally defined in section 2.3.2). T stays for the 'transit time' (p.3168, l. 14; p. 3169, l. 6), but also just for 'time' (p. 3169, l. 7). I would suggest always using small letter 't' for 'time'. Since the transit time T could be time-dependent, it would make sense to note it as T(t), e.g. T(t_0), and not use time as a lower index as in p. 3168, l. 14.*

  We acknowledge that the treatment of t and T in the text may be confusing, but it is actually correct the way it was originally written. The key point is that for linear time invariant systems the time solution for the output $O(t)$ is equal to the transit time distribution $\psi(T)$, as shown by Nir and Lewis (1975) and Manzoni et al. (2009). The implication of this remarkable result is that $t = T$. We made changes to the text to make this result more obvious and explicit, and avoid any confusion.

- *Eq. 13: please either provide an equation for calculating the transit time density psi_t_0 or explain it in words, because it is defined only in the next section.*

  The issue here is that the exact definition of the density function depends on the assumptions made about the system. For the assumption of a LTI system, the definition of this density function is provided in the subsequent paragraph. We expect to provide a more general definition in a forthcoming publication in which we can calculate the density function for any time t. In the text we tried to make this more explicit.

- *Eq.13: This form of integral notation confuses me. The right part is a function of t (time), but t is absent in the left part of the equation. Also, why the integral boundaries are from 0 to t-t_start? Should not they be from t_start to t_0? What is changing from 0 to t-t0: T or t? Should not it be psi_t and not psi_t_0?*

  There was indeed an error in equation (13). The upper limit of integration is not a variable but a constant, from the time the simulation start t_{start} until the time of observation t_{obs}. Originally we intended to used t_0 for this upper limit, but this was mistaken. We also realized that this notation may be confusing, so we changed t_0 to t_{obs} for clarity.

- *p.3169, l. 7: “**I**/I” is confusing, because symbols “**I**” and “I” look very similar. Could you use another symbol for the sum?*

  We changed to sum to the symbol $\Sigma\vec{I}$, which should be now more clear.

- *p.3169, l. 9: “Translated to the language of an ODE solver, an impulsive input becomes a vector of initial conditions I/I at time T = 0, and Sr the release flux of the solution of the initial value problem observed at time T” I cannot understand this sentence. See my comment on using T as time above.*

  We reworded this paragraph to make the point more clear. The main idea is that the time dependent solution of the system for the outputs after an inpulsive input (release or respiration flux) should be equivalent to the transit time density function. We hope the new version presents this idea clearly.

- *P. 3172, l. 17: Where is Table S3? I miss it in supplementary.*

  In the text we say Table S3 therein, referring to the paper Hua et al. (2013). In other words, this table is in the supplementary material of Hua et al. (2013). We made this more explicit in the new version of the manuscript.

- *p. 3172, l 14 replace ‘form’ with ‘from’*

  Done

- *Fig. 5 needs better explanation in the figure caption and more discussion in the text. E.g., what are units on axis? What do numbers in the matrix mean and what is a meaning of dots in the scatter diagrams?*

  We added more detail to the figure caption and expanded the description in section 3.3 as suggested.

References

Manzoni, S., Katul, G. G., and Porporato, A. (2009). Analysis of soil carbon transit times and age distributions using network theories. *J. Geophys. Res.*, 114.

Nir, A. and Lewis, S. (1975). On tracer theory in geophysical systems in the steady and non-steady state. part i. *Tellus*, 27(4):372–383.

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