Biogeosciences Discuss.,
doi:10.5194/bg-2016-545-RC1, 2017

Biogeosciences
Discussions

Interactive comment on "Modelling the genesis of equatorial podzols: age and implications on carbon fluxes" *by* Cédric Doupoux et al.

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Received and published: 17 February 2017

This manuscript presents an analysis on the magnitude of vertical and lateral transfers of carbon in a set of Amazon podzols, as well as estimations of the time required to obtain steady-state values in the Bh horizon. The authors used a simulation model to make these predictions, incorporating not only C stock data but also radiocarbon. This study is important for two main reasons: 1) it helps to clarify previous estimates on the amount of vertical and lateral C transfers for these systems, and 2) it contributes to improve our understanding on the carbon cycle of one of the most important, yet understudied, tropical ecosystems. Despite the importance of the manuscript, I found a number of issues in the model setup and interpretation of radiocarbon data. I will elaborate on these issues below, but I believe that if these issues are adequately addressed, the manuscript will make an important contribution.

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My main concern is with the use and interpretation of radiocarbon data. The authors used specific atmospheric radiocarbon curves and standard age calculation procedures to determine the age for the topsoil and Bh horizons. This is a main misinterpretation of the radiocarbon dating method and its application to soils. Standard radiocarbon dating relies on the assumption of a closed system that does not exchange carbon with the surrounding environment, but in soils this assumption does not hold because the system is constantly mixing young and old carbon (Trumbore, 2000). Modeling radiocarbon in soil organic matter usually consists on finding the appropriate value of the decomposition rate that matches both the C stock and the radiocarbon value. The authors have a modeling setup that goes in this direction, but instead of using the radiocarbon data they used an age value to match the decomposition rate. My main concern is in the extra step of finding a ^{14}C age value and using it for the optimization of the decomposition rates. You do not meet the assumptions for the calculation of a radiocarbon age, however this step is not needed. You can just simply use the radiocarbon data in the F_a notation to match the decomposition rate. For details on the approach see Trumbore et al. (2016); Sierra et al. (2014).

A second concern is related to the arbitrary definitions of the 'minimum time' and the 'genesis time'. For minimum time, the authors use an arbitrary low decomposition constant β, and for the genesis time an arbitrary proportion of the steady-state value. The problem with these quantities is that they can change dramatically if one changes, for example, β from 10^{-10} to 10^{-20}, or the proportion of the steady-state value from 99 to 95%. I understand that these measures are useful to compare the different soils within the context of this analysis, but they may not be very useful to obtain the desired information about the time for soil horizon formation. I would favor instead a less arbitrary definition such as the mean age or the mean transit time (Manzoni et al., 2009).

Technical comments

- The ^{14}C ages presented in the abstract are misleading because you do not meet the closed system assumption. I would rather not present these values, or if you decide to present them, mention that you calculated them even though you do not meet the assumptions of the dating method.
- Line 63. What database? Is it publicly available? Can you provide a reference or a doi?
- Line 75. 'Conventional age calibration' is a contradiction. Conventional radiocarbon age is the age assuming Libby's half life, and does not use a calibration curve. What you probably mean is 'age calibration', but as I mentioned above, this step is not needed for your modeling setup so you may consider eliminating this section from your methods.
- Line 112. I had problems understanding this step and the corresponding Fig 5. You may need to provide additional details.
- Section 2.3. It is not clear from the description of the simulation setup what is the calendar year corresponding to $t = 0$. In other words, did you always started your simulations at a specific calendar year or did this varied for the different soils. This information is important because the atmospheric radiocarbon value corresponding to $t = 0$ influence the forward trajectories for the soil radiocarbon values.
- Equation 8. Why is P a subscript of β and C? Is this a typo?
- Line 171. These numbers are in reverse order. Curve 1 in Fig 7 has a time required to reach 99% of the steady state of 43 10^3, while curve 2, 345 10^3. This also makes sense since Montes et al. suggests a much higher value of vertical C

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transfers than Sierra et al., therefore the values from Montes et al. should reach the steady-state faster.

- Line 184. This is a very arbitrary definition of minimum time. if β_{Bh} is 10^{-20}, or 10^{-30}, the 'minimum time' would change drastically, and there is not any relevant reason for why it should be 10^{-10}. I would recommend not using this concept of minimum time.
- Line 189. What is this maximum absolute error propagation? Did you define this before?
- Lines 247 and 252. Are these decimal numbers? Change comma for point.
- Tables. I'm missing a table with the obtained values of the parameters of the model of Fig 4 obtained for the four different soils. This information is somehow imbedded in Fig 12, but as total stocks and fluxes, and not with the values of the parameters used to obtain these numbers.
- Figures. Figure captions are very poor. Please provide enough information in the caption to better interpret the figures.

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.

Sierra, C. A., Müller, M., and Trumbore, S. E. (2014). Modeling radiocarbon dynamics in soils: Soilr version 1.1. *Geoscientific Model Development*, 7(5):1919–1931.

Trumbore, S. E., Sierra, C. A., and Hicks Pries, C. E. (2016). *Radiocarbon and Climate Change: Mechanisms, Applications and Laboratory Techniques*, chapter Radiocarbon Nomenclature, Theory, Models, and Interpretation: Measuring Age, Determining Cycling Rates, and Tracing Source Pools, pages 45–82. Springer International Publishing.

Trumbore, S. (2000). Age of soil organic matter and soil respiration: radiocarbon constraints on belowground c dynamics. *Ecological Applications*, 10(2):399–411.

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-545, 2017.