Biogeosciences
Discussions

Interactive comment on "Carbon losses from pyrolysed and original wood in a forest soil under natural and increased N deposition" *by* B. Maestrini et al.

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C: comment R: reply

C: I was glad to see this paper. Around the time you submitted your paper, colleagues and I published a review of PyOM (biochar) stability that you might find useful to cite (Gurwick et al. 2013. DOI: 10.1371/journal.pone.0075932). R: Thank you mentioning your recent review paper. It is particularly timely and interesting and will help us to potentially expand the literature we will consider in our revised paper.

C: For example, in your introduction you nicely summarize the different approaches that the few available field experiments have taken. In our paper, we looked for all published

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field experiments that had quantitatively assessed biochar stability and synthesized the approaches and findings of these experiments. Your study is more rigorous than many, and our synthesis provides a useful springboard from which to highlight your contribution. We found only 7 field experiments (published through the end of 2011 and summarized in our Table 1) with estimated turnover times ranging from 8 to almost 4000 years. Your paper provides a valuable additional data point to this synthesis, and you might consider pointing that out in the discussion. In addition, by measuring loss as CO_2 directly and using the 13C label, your study avoids the problem of distinguishing between C loss from mineralization and C loss from physical transport. From the point of view of terrestrial C storage, this distinction matters a great deal, and it is absent from a number of studies that claim to measure biochar stability. R:Thank you for this comment, We agree that this point is appropriate. In our final revision we will mention some of the papers that did not make use of stable isotopes, but used other methodologies to track the dynamics of PyOM in soil when appropriate.

C:Similarly, your discussion includes an illuminating comparison of MRTs from your study with those from other investigators. For example: "The PyOM mean residence time calculated here is closer to the values reported by Nguyen et al. (2008), who found a mean residence time of 264 yr under tropical climate and from Hammes et al. (2008) who found a mean residence time of 347 yr in a boreal steppe, indicating that irrespective of the climate, the quantification method and the length of the experiment PyOM has a mean residence time ranging in the centennials, when measured in field conditions." Here again I wonder if referencing Table 1 from our paper, which concisely synthesizes many of these figures, could be helpful. R:Your table 1 will be useful for our work, as it summarizes the literature that has addressed the issue of stability using different methodological approaches. One of the most crucial issues when discussing biochar dynamics, is reconciling the results from different PyOM quantification techniques (i.e., hand picking NMR spectroscopy, molecular markers, etc.) and the different models that assess MRT (as you nicely express it in your paper "using the same currency"). In our case, to compare our results with other studies we calculated

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mean residence time using the approach defined in Singh et al. (2013) "Due to its aromatic structure, PyOM has been hypothesized to be particularly resistant to microbial decomposition (Schmidt and Noack, 2000) and have a centennial mean residence time (Schmidt et al., 2011; Singh et al., 2012)." Some claim hundreds to thousands of years. Your study weighs in more on the hundreds. Setting out the larger range of claims in the introduction could help show how your study adds weight to one part of this range rather than another. We will expand the introduction to include a wider breadth of studies relevant to this work.

C:"However, only a few field experiments have been conducted: : :" As noted above, we looked for all field experiments we could find in the published literature and synthesized their results, providing a useful springboard for this study and discussion. In addition, even with the more complete and illuminating measurements you report, there are additional factors that need to be taken into account in assessing the potential effects or benefits of PyOM additions to soil. How these effects are taken into account might depend upon whether the source of PyOM is naturally-occurring fires or deliberate PyOM production in kilns. R:We agree that PyOM produced during natural fires ranges in composition due to the variability in pyrolysis conditions. However, we posit that PyOM formed at 450C under N2 is typical of PyOM produced during natural fire conditions (Hammes et al. 2006).

C: We addressed these decisions in the latter context, and it could be instructive to make this distinction more explicit in your discussion. "Singh et al. (2012) reviewed PyOM mean residence time by compiling a database with results from studies using different experimental designs. One clear message was that PyOM mean residence time was longer in field studies than in incubation studies, but the reason for that could not be reduced to one single factor." In our paper, we also include a supplementary table that categorizes field studies of PyOM by topic. Given the very cogent review of previous studies in your introduction, our table might also be of use/interest to your readers. R: We agree, and we will cite this literature summary in our revised paper.

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C: What additional information/data would be needed to drive a full Life Cycle Analysis of the influence of biochar on GHG budgets? Do you have any thoughts on whether your study (perhaps in combination with others like it) and other available, robust information would capture most of an LCA? You compare the wood decomposition rate and the PyOM decomposition rate (p. 13, lines 15-20 and at the top of p. 14). If you were to add C loss during the production of PyOM to the PyOM decomposition rate, then how long would it take for C loss from PyOM production + PyOM decomposition to equal C loss from wood decomposition? I raise this question because from the atmosphere's point of view, C loss from pyrolysis is as important as C loss later on. In fact, a pulse of C loss leads to more heat-trapping sooner, compared to more gradual C loss. So somehow pointing out that the PyOM already represents a large C loss helps to place the comparison of wood decomposition and PyOM decomposition in an appropriate systems context. This is also relevant to p.16 paragraph 1. R: This is an important point, especially when considering biochar or PyOM as a possible approach to store C and produce C credits. We will consider this approach in our revised paper.

C:Do other studies suggest that priming would be more important in any other settings vs. the low/minimal priming rates you observed? On the absence of measurements during winter, you might refer to work by Groffman, for example, on patterns of soil trace gas fluxes from forest soils during the winter. R:In our study priming was generally positive and could matter, however due to the high variability and the limited number of replicates did not allow us to conclude on that. Regarding this topic I would like to point you towards new works that recently came out by one of the co-authors (Maestrini et al. Soil Biology & Biochemistry 69 (2014) 291e301 and Maestrini et al. 2014, GCB- Bioenergy doi: 10.1111/gcbb.12194). In both cases a positive priming effect is observed on the short term. Nonetheless to conclude on the impact of priming effect on soil C storage in soils amended with biochar we still miss knowledge on the interaction with freshly released organic matter and studies on the long term impact of priming effect is still lacking. Unfortunately the present study does not allow a definitive conclusion on that. Thanks for indicating us the extensive work from Prof. Grossman

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on winter soil respiration, we particularly took into account his contribution in Brooks et al. (2011) that nicely summarise current knowledge on this topic. In this work he shows how across ecosystem types CO2 fluxes are poorly correlated to temperatures, nonetheless in our study we used a model that was tested specifically on that site in a previous work. We believe that using a model specific to the site is the best accurate estimates for the winter soil respiration we can have in the area. However we must recognize that a substantial uncertainty resides in the response of biochar decomposition to winter temperature.

C:"accepted if r of the regression line was higher than 0.9, if r2 < 0.9 the data were: : :" Is it r or r2? R: R2, this point will be corrected.

C:Regarding this paragraph: "The PyOM mineralization rate did not decrease significantly with time (Fig. 3): : :." and the paragraph that follows it, I'm glad to see you address the question of changing decomposition rates over time. It could be helpful to add one qualifying sentence acknowledging that because you report results from only the first year of the study, it's possible that decomposition rates will decrease over longer time scales. R: We will revise our discussion of PyOM decomposition rates after the first year. As you noted, a chronosequence approach would increase the temporal range of observations on biochar losses, but does not provide any information on the relative pathways of PyOM C and N losses, which was a major goal of this study. This field study will continue for at least 10 years, which will allow us to compare turnover rates during the first year with those after 5 and 10 years in situ.

C: There are a few places where word choice led me to stumble. For example, "did not allow concluding on the" – I would have written "did not allow conclusions about the: : :" You might consider giving the text a fresh read-through to catch points like this. Again, I congratulate you on this study and very much appreciate the way you describe the status of knowledge along several different axes in the introduction. R:We will carefully proof read the text again prior submission of the next version to check particularly for consistencies error and expressions.

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