Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2020-49-RC1, 2020

Biogeosciences Discussions
Open Access
EGU

Interactive comment on "Reviews and syntheses: The mechanisms underlying carbon storage in soil" *by* Isabelle Basile-Doelsch et al.

Anonymous Referee #1

Received and published: 24 March 2020

Authors present an interesting review of mechanisms underlying carbon storage. I think it is a potentially interesing paper that however still requires considerable changes before I could recommend it for publication in Biogeosciences.

The main shortcomings that I currently see is that I miss appropriate referencing (detailed below) and I find the text somewhat inconsistent, e.g. in that some conclusions are not supported by sufficient parts of main text (more below), the overall structure is sometimes confusing, linking/aligning different parts of the text needs to be improved. Some parts of text seem to apply only to cropland but from title/abstract/introduction it is not clear whether authors aim at all soils or only cropland or agricultural soil including grasslands. In general, manuscript could benefit from proofreading by a native speaker – I tried to suggest improvements myself but I am not a native speaker either. I'd like to

Printer-friendly version

Discussion paper

suggest that the structure of manuscript would maybe benefit from a section or a group of sections on "outputs“ (following the logic of figure 2). this could include erosion as well as mineralization (where related terminology could be discussed maybe more briefly than now), followed by (de)stabilization mechanisms (which influence mineralization rate), this could again be referred to in the section about non-linear processes (Table 1) and factors (Table 2) influencing mineralization/mean residence time. In general, I like most Figures and Tables proposed by authors. I struggle a bit with Figure 5 and 6. In Figure 6, I think the text nor the caption does not explain well enough how were these data obtained. Also the figure is a bit overwhelming becase it shows differences between grassland, forest and cropland but this aspect is not really leveraged in the main text so I suggest that authors think about what is the main message of this figure and either keep just one land use or discuss the differences more. Authors offer some interesting conclusions but some of them are introduced for the first time in the Conclusions section and they are not well supported by the main text. E.g. in second sentence of Conclusions, authors mention that carbon inputs in croplands are often higher than in grasslands and forests, but main text (2.1.1) contains only discussion of a hypothetical example of C input calculation for a crop of certain yield. Discussion of the range of yields (and inputs) observed in croplands as well as a comparison with C inputs estimated for grasslands and forests is missing. Therefore I would recommend authors to carefully review the whole conclusions section and see if the main text is supporting/explaining well all they are referring to. I struggle with Figure 5, especially the table part, was the last column calculated as “pool size after 30 years of input fluxes from first column with MRT in second column? Does this representation assume any fluxes between the pools? In the figure why does the slow pool first seem to be lower than 0.75 tC/ha/yr In Table 2, I miss effects of aggregation and erosion In main text, I am missing also a part discussing the effect of nutrient availability/stoichiometry on SOM dynamics, maybe this could be discussed in section about chemical nature of OM In the introduction I think authors should try to report on the on-going discussion of soil C sequestration potential in a more balanced way (since authors are not submitting an

Printer-friendly version

Discussion paper

opinion paper but a review paper), see my suggestions below.

Page 1 L32 Add also references to replies from camp number 1: (Minasny et al., 2018; Loisel et al., 2019) L33 please explain what you mean by "most of the criticism is focused on the political opportunity of the initiative“ and at the minimum provide references to support this statement so that the author(s) of such criticism are clear L38-39 this sentence is rather vague and "recent findings are not always considered“ and "misuse of the concepts“ are strong statements, please support them by reference to paper(s) that expand further how Minasny et al. is guilty of either of those. Also please provide more details or reference to your example "e.g. confusion between soil C equilibrium and soil C saturation“ this way it may not be clear what you mean. L40-L41 "Moreover, current soil C stocks are spatially highly variable, and factors that could explain this variability are not fully understood, although it would be essential to clarify this aspect prior to any attempt to increase soil C stocks.” This is a very strong opinion and it should be made clear that this is a point of view of authors or only part of the "critical“ part of scientific community. Possibly authors should also voice the opposing "camp“ who think that waiting until “we understand it fully” is definitely not required, because they think that the gathered evidence is significant enough to take action. I understand authors wanted to explain why their contribution is needed but the danger of writing introductions in reviews like this in the "we still know too little to take any action“ manner is that the people outside science read this and interpret this as a consensus of a scientic community

L42-43 "Apart from practices based on additional C inputs...“ – are all these references related to reduced tillage? If yes, provide a comparable number of references to first part of sentence about additional C inputs and also consider to start the sentence in a more balanced way, e.g. "Although consensus exists on practices based on additional C inputs, such as ... (refs), the outcome of other strategies, such as...., is more unclear. What other strategies other than reduced tillage do you think there is no consensus on, please be specific.

What is described in 2.i (btw. Numbering of paragraphs should be double-checked) is true for carbon fluxes in agricultural soils, this should be either emphasized in the beginning of the paragraph or even the title of the paper or the content should be generalized to apply also to other ecosystems... 58 Lower plants (algae, mosses, lichens), microbial and faunal necromass also contribute to C input 59 please define here well what you mean by "restitution", e.g. "surface retention or incorporation through tillage" because the term is later used a lot and is not a common one in biogeosciences 60 this sentence is true only for cropland and ecosystems in which you assume constant standing plant biomass 60 assuming you mean respiration of herbivores, is it better to say something like "losses by herbivory (production and respiration)" instead of "herbivore production and respiration" because this way it's not that clear which respiration you mean Page 3 65 explain what do you mean by "estimators of soil restitution fluxes" would "Soil carbon input can be estimated based on" work too? 66 the phrasing of the definition of harvest index (HI) is a bit unclear, would this work better? "(HI) is the percentage of aboveground net primary production that is harvested" 67 please provide reference for these values 73 please provide reference for these values, missing bracket, also consider giving values as true ratios (0.1-0.3), in general please revise and be consistent about terms and corresponding values of ratios, proportion 76 exsudates should be "exudates", please check throughout the manuscript (also figures and tables) 92 what do you mean by OM mobilization, priming? What do 78 please explain the term "net root production" and its relationship with rhizodeposition and belowground net primary production, this formulation implies that rhizodeposition is not part of net root production 82 better "aboveground restitution" instead of "soil returns" 83 specify in brackets which assumption you used for calculating the rhizodeposition (to comply with the structure of sentence 86 maybe better "Chemical nature of soil carbon inputs" or "Chemical nature of soil organic matter inputs" Page 4 87 better "soil" than "ground" 86-04 this whole section contains only one reference and that is after a sentence that needs the least support by reference 93 maybe better "reallocates" 95 specify how green manure differs from other plant inputs in terms of chemistry 95 "same molecules"

as what? 99 give examples of non-industrial organic waste products 99-00 please rephrase, both these sentences carry the same information (that waste products are enriched in microbial products compared to plant matter) but they are connected with contrasting conjunction “while” 01 consider using “In addition to fresh/recently-derived organic matter described above, byproducts of incomplete combustion may also enter the soil, such as” 01-02 double check phrasing and categorization, this way it seems that pyrolysis products belong to incomplete combustion byproducts, also it is not clear what you mean by mentioning coal mines? If you mean coal entering the soil (which is totally valid) that is not a product of pyrolysis 03 you may want to mention here the term “geogenic carbon”, under this term coal and rock-derived C can be grouped 08 specify whether you mean soil fauna or consider also microbiota associated with large herbivore 14 whose stability is altered? 19 better “bacteria-feeding” instead of “bacterial” 23 I recommend to use “belonging to” instead of “representing” 24 I recommend switching the sentence structure of the part about fungi to match that about bacteria,.i.e. dozens of meters of filaments belonging to 1000 fungal species Page 5 32 better “produced by” instead of “due to the activity of” 36 leave out “carried out by”, because depolymerization is a type of degradation reaction 38 better “represent” instead of “form” 45 better “electron acceptors” instead of “oxidation-reduction reactions” 46 better “can” instead of “could” 48-49 revise the logical structure of sentence, unexpected usage of “while” maybe mention more reasons why are the costs higher (transport of enzymes through membrane, loss/dilution of both enzymes and degradation products outside the cell. . .) 51 add “with each other” before “to form” Page 6 61 maybe better “taken up from” instead from “in” 66 maybe better “rate” than “performance” 60-67 can you provide some reference? 68 better “carbon use efficiency” than “efficiency of C use” to match the abbreviation 68 better just “is” instead of “can serve to estimate” 69 “material” “flux” can be left out, use “to be” instead of “at” 70 leave out “flux” 78-79 repetition of defining supramolecular structures (with line 51, page 5) 81 problematic usage of the word “source” (plants are the original source of the building blocks but these have to undergo microbial transformation), consider using “producers” instead 84 there is no section 1.4,

Printer-friendly version

Discussion paper

check all similar references throughout the manuscript 85-89 provide reference(s) Page 7 91 consider using “which contains” instead of “i.e.” In Figure 4, specify that you start off with 2-mm soil, also discuss 93 say “fauna” instead of “microfauna” not to exclude mesofauna 94 reference to Figure 1 seems irrelevant 98 consider acknowledging that humification theory also worked with the contribution of decomposition products to OM pool (similar to progressive decomposition concept) 04 consider leaving out “regarding some organic compounds” 08-09 2x “its” instead of “their” (OM) 09 leftover “Organic matter transfers” 11 did you mean “within” instead of “to”. Also consider adding a connecting sentence between sentence 1 and 2 to frame the whole section, saying that transfer occurs mainly via pedoturbation or water transport. 13 consider replacing “. Otherwise bioturbation is” by “(bioturbation). Bioturbation occurs” to clarify that bioturbation is a subcategory of pedoturbation 17 the study by Jagercikova et al. 2017 does not support this statement 19 better “mineral particles” than “minerals” 19 provide reference to statement “mix several dozen tonnes/ha/year” Page 8 24 “pore” instead of “poral” 25 provide reference for the 2 μm cutoff and for this definition of leaching, I thought leaching is the transport of DOM (i.e. lixiviation in your definition which I am not familiar with at all) 26 I don’t think OM co-precipitated with oxy-hydroxides counts as DOM (something is either dissolved or precipitated) 27-28 consider rephrasing this sentence to fit the whole paragraph better, I think translocation is movement of a particle or colloid or DOM within the soil profile, described is eluviation and is only one type of translocation, again citing Jagercikova et al. here seems irrelevant 29 in Figure 4, I’d recommend to denote the DOM cutoff 34 consider leaving out “depending on the site” and explain how did you obtain the value 0.7 Gt year-1 35 maybe better “OM transfer along the soil surface: erosion:” 35 I’d recommend choosing a different intro sentence. Indeed enhanced erosion contributes to soil degradation but this sentence implies that erosion is always a bad thing. This sentence can come later when you discuss that some level of erosion (which is balanced out by pedogenesis/weathering, actually some level of erosion promotes weathering and is a good thing which enables the mineralogy/nutrient availability of soil to be rejuvenated 43-45 this sentence feels

clumsy, rephrase 47 rephrase, it is not that clear what you mean by “results in C budgets that often generate debate regarding C sinks and sources” 51 leftover “.” Page 9 57 better “crystalline” than “crystallized”, correct throughout manuscript 62 what do you mean by “organic function”? Do you mean functional group? 62 replace “on the” by “for a” and “the active” by “an active” 63 not sure what is mean by "localized“, would "unevenly“ work too? 63 better "in patches“ than "by patches“ 65 better “is” than “leads to” 68 it doesn′t seem correct to include chelates in “mineral phases” 70 maybe better “dissolved” than “destructured” 71 better “can also play” instead of “also plays” 74 again, not clear what you mean by “organic function” 76 “bonds” or “associations” instead of “bounds” 77-81 given its great importance I think authors should expand this part on saturation concept. This comes out now as “saturation concept works only when we consider adsorption but now we know about other mechanisms so maybe saturation is not a real thing” but actually all organo-mineral associations require a mineral counterpart and the sources of mineral phases suitable for those associations is not infinite in soil so therefore saturation still should apply Page 10 3 explain why these models cannot be used at the plot level 8 Maybe better “Soil carbon pool” than “Soil carbon” to fit better with the following sentence 10 can you provide reference(s) for this equation 14 here you define “carbon turnover time”, then on page 13 section 3.4 you refer to “renewal rates”, and on page 13, line 98 you define mean residence time, please unify the terminology/move all terms to when you mention turnover for the first time Page 11 26 what is "hypercomplex functioning"? 27 delete “that” 26-28 these two sentences seems to be duplicates of each other and 33 I found the whole section a bit out of context here and somehow confusing, I’m not sure about its usefulness, I must say I haven’t encountered the term mineralization (flux) too much, usually I think respiration is the prevailing term used, I’m also not sure about interpreting biological activity as “efficiency” and also using the term “efficient” decomposing organisms, with possible confusion with CUE. I agree biological activity is a vague term but I view it more as “how much microbes there are and how active (and growing) they are”. How this translates into mineralization flux is a matter of CUE. 44 again, here you talk about k, but

Printer-friendly version

Discussion paper

call it in several ways, but on page 10 you introduced it as mineralization rate, please unify Page 12 55 better just “Non-linear“ processes ?? 59 here you repeat Equation 1 from section 3.1, can you somehow refer to it to frame it better 60 what do you mean by “change regimes”? 61-72 can you provide more references or is this all based on Vogel et al 2015? Also Table 1 does not contain any references 63 I don’t understand how the first implies the second, would “driver” work better instead of “implication”? 68 better “help to gain” than “help gain” 70 what do you mean by “less determined and reversible changes” 73 better just “Priming effect” 75 this is confusing since priming studies typically use glucose as the source of labile C to induce priming effect (e,g, Bastida et al. 2019 Nat. Comm) please correct/explain, please also mention we distinguish positive and negative priming effect Page 13 02 refer to the number of section rather than the name 03 explain how nature of incoming C affects organomineral interactions 05 better use “texture” or “particle size distribution” 8 better “caused by” than “in relation to” 8 better “drying-rewetting cycles” Page 14 13 really there are no studies showing accelerated respiration after tillage? 14-16 please provide references for all sentences 17 what do you mean by second sentence? 24 refer to the section where you discuss Ca2+ bridges previously 24-25 provide references on each statement about Al and Na 26 section 2.5.2 doesn’t exist 26-31 please provide references 32 mycorrhiza should be mention in this section (actually sentence in line 33 seems to be about mycorrhiza(?), but should also mention bacteria (who also participate in priming) 35 give examples of such interactions 41 maybe “limited” is better than “very confusing” Page 15 60-61 explain how? This should be expanded on in the main text 64 would this work better “predation and competition between fungi and bacteria”? 70 delete “of” 74 maybe better “understood” instead of “explained”

Page 30 65 “dashed” instead of “dotted”

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-49, 2020.