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Interactive comment on "Relevance of aboveground litter for soil organic matter formation – a soil profile perspective" *by* Patrick Liebmann et al.

Patrick Liebmann et al.

liebmann@ifbk.uni-hannover.de

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RC2 Comments by Referee #2, 15.01.2020

Introduction

This is an interesting analysis estimating the contribution of leaf litter on soil organic matter formation of each soil layers. Generally, this is a well performed field study on a relevant subject. The manuscript is quite interesting and decently written, although some descriptions and conclusions are inaccurate. I suggest revisions to address some of the issues I raise below.

Author response

We thank the referee for his positive feedback and the constructive comments.

1. Comment

This description is inaccurate. 0-10-cm soil sequestrated 0.99 g C m-2 yr-1 from labeled litter, 0.37 g C m-2 yr-1 in the 10-50-cm soil layers. It is not surprising, compared to the considerably large contribution of 0-10 cm soil C pools. 48% of the SOC stocks (0-180 cm) were sequestrated in the top 10 cm soil layer (Table 2).

Author response

We cannot follow this comment, as we do not see the inaccuracy of this statement. The recovered label in the MAOM fraction was calculated to average annual litter inputs (see RC5, comment #8) into the different soil compartments. Inputs were, as stated in the manuscript, highest in the topsoil, and lower in the subsoil compartments. We agree that this depth pattern is not surprising and can be expected, since it is known that highest DOC inputs occur in the mineral topsoil with a strong decline with soil depth (Leinemann et al. 2016). The same is true for inputs from a recent litter layer (Fröberg et al. 2007). We did not make changes to the statement in the original manuscript.

Leinemann, T., Mikutta, R., Kalbitz, K., Schaarschmidt, F. and Guggenberger, G.: Small scale variability of vertical water and dissolved organic matter fluxes in sandy Cambisol subsoils as revealed by segmented suction plates, Biogeochemistry, 131(1–2), 1–15, doi:10.1007/s10533-016-0259-8, 2016.

Fröberg, M., Jardine, P. M., Hanson, P. J., Swanston, C. W., Todd, D. E., Tarver, J. R. and Garten, C. T.: Low Dissolved Organic Carbon Input from Fresh Litter to Deep Mineral Soils, Soil Sci. Soc. Am. J., 71(2), 347, doi:10.2136/sssaj2006.0188, 2007

2. Comment

Lines 34-36: Most studies focused on SOC dynamics only in 0-10 cm soil layers? The concepts of “topsoil” and “subsoil” are confusing throughout the text. According to my understanding, the authors described the soils in the 10-to-180-cm layers as “subsoil” involving their own results. But the topsoil described here is obviously not 0-10 cm only.

Author response

It is true that the soil at our study site only has a shallow topsoil horizon, which was classified as such by using the guidelines of the International WRB and the German soil classification. Topsoil horizons are defined as surface mineral soil horizons that are either enriched in organic materials or depleted in inorganic materials (i.e. by podsolization or lessivation). In the soils under study, this refers to the genetic soil horizons AE (0-to 10 cm soil depth, see Table 1). Hence, indeed the topsoil is shallow and does not exceed 10 cm. For our study site and the soil cores, it was reasonable to define the increments 0-10 cm as the topsoil increments based on the soil horizon classification. The subsoil increments (horizons B and C in our case) were divided in 3 subsections for practical reasons. The deep mineral subsoil was defined as the soil > 100 cm soil depth, since classic soil C surveys usually draw the line at 100 cm (Jobbagy and Jackson, 2000). Reversely, we considered the increments from 10 to 50 cm as the upper subsoil. Additionally, the bulk data allowed the presentation of results from the increments in between (50 to 100 cm), which were accordingly summarized as mid subsoil. This definition was given in lines 108 to 110 of the original manuscript, and reads: “Depth increments of the soil cores taken from 0-5 and 5-10 cm are defined as “topsoil”, increments between 10 and 50 cm as “upper subsoil”, those between 50 to 100 cm as “mid subsoil”, and increments below 100 cm as “deep subsoil”.

We mentioned studies on topsoil C inventories in lines 34 to 36 to introduce the reader to the topic. But of cause the topsoils in the given studies are not restricted to a soil depth of 0-10 cm, as it is a genetic criterion, dependent on the study site. Thus, it is not correct to draw the conclusion that the term “topsoil” always implies a soil depth of 0-10 cm.

Jobbagy, E. G. and Jackson, R. B.: The Vertical Distribution of Soil Organic Carbon and Its Relation to Climate and Vegetation, Ecol. Appl., 10(2), 423–436, doi:10.2307/2641104, 2000.

3. Comment

Lines 38-41: This statement is not correct. Below-ground inputs may more important contribution than the litter for SOC accumulation (Nadelhoffer and Raich, 1992; Majdi, 2001; Pausch and Kuzyakov, 2018). Nadelhoffer, K. J., and Raich, J. W.: Fine root production estimates and belowground carbon allocation in forest ecosystems. Ecology, 73, 1139–1147, 1992. Majdi, H.: Changes in fine root production and longevity in relation to water and nutrient availability in a Norway spruce stand in northern Sweden. Tree Physiol., 21, 1057–1061, 2001. Pausch, J., and Kuzyakov, Y.: Carbon input by roots into the soil: quantification of rhizodeposition from root to ecosystem scale. Glob. Change Biol., 24, 1–12, 2018.

Author response

We agree and modified the sentence from line 39 to 41 in the original manuscript as follows: “Dissolved organic matter was estimated to contribute about 19 to 50 % to the total mineral soil C stock in forest soils (Kalbitz and Kaiser, 2008, Sanderman and Amundson, 2008) and is considered as a main source of subsoil OM in temperate forest soils (Kaiser and Guggenberger, 2000), next to belowground inputs (Nadelhoffer and Raich, 1992; Majdi, 2001) .” We did not include the Pausch and Kuzyakov (2018) suggestion, because they had their main focus on crop- and grasslands and not on forest soils.

4. Comment

Lines 64-66: I noticed and agreed with the comments from Paul Hanson. And: Guelland K, Esperschütz J, Bornhauser D, et al. Mineralisation and leaching of C from 13C labelled plant litter along an initial soil chronosequence of a glacier forefield. Soil Biology and Biochemistry, 2013, 57: 237-247. Kammer A, Schmidt M W I, Hagedorn F. Decomposition pathways of 13 C-depleted leaf litter in forest soils of the Swiss Jura. Biogeochemistry, 2012, 108: 395-411.

Author response

We thank the referee for the additional references. As described in our reply to Paul Hanson's comment, we included the references in the manuscripts. In line 63 to 64 of the original manuscript. The detailed response can be found in the reply to Paul Hanson's comment.

5. Comment

Line 116: It's important to measure the mass of litter (both for initial and after 22-months) for estimating the relative contribution of the sequestrated C from litter? This is my primary concern.

Author response

We agree with the referee's opinion that the masses of the labeled litter for both time points are useful information. We already addressed this issue in RC1, comment #2 and #9.

6. Comment

Line 217: SOC content in 0-10 cm soil (8.2% here) is largely different (> 5 times) from that given in Table 1 (1.5%, the same forest plot or stand, their previous study). Is there any special on the location of the soil sampling in this study?

Author response

We agree that the discrepancy between the data in Table 1 and the soil core bulk data is confusing to the reader. To clarify this, it should be noted that the 8.2 % in our study is actually the value for the increment 0-5 cm only (visible in Fig. 1a). We recognize the misunderstanding, since we stated in line 217 " ... from about 82$\pm$57 mg g-1 in

the topsoil to ...". We corrected this sentence in the following way: "Soil OC contents decreased strongly from about 82$\pm$57 mg g-1 in the upper topsoil increment (0-5 cm) to 3$\pm$1 mg g-1 in the upper subsoil at 50 cm soil depth (Fig. 1a)."

When comparing the soil core bulk data with Table 1, the mean of both increments, 0-5 and 5-10 cm should be used, which would be 5.2$\pm$3.5 % SOC compared to the 1.5 % for 10 cm thick topsoil horizon from Table 1. However, this is still a 3-fold higher SOC content for the same study site, which suggests a high spatial variability and the not very well defined border between the thin organic layer and the mineral soil.

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