

Response to Anonymous Referee #1 to preprint egusphere-2026-4029:

“Linking moss cover, soil organic matter fractions, and carbon stabilization pathways in temperate forest ecosystems”

We sincerely thank you for the constructive and in-depth feedback to our manuscript. We also appreciate your positive assessment and helpful suggestions to further clarify and strengthen the manuscript. We are also grateful for the time and effort you have put for improving this manuscript. We have addressed each comment individually and will revise the manuscript accordingly. For clarity, the reviewer’s comments are shown in blue while our responses (R) have been provided in black.

Comments and responses

L34: What does "disproportionally" refer to in this context? The term needs clarification.

R: We agree that the words “disproportionally important” was unclear and therefore, we have removed the word “disproportionally” to improve the clarity of the sentence.

L69-70: “While most studies...” - please provide references to support this statement.

R: We agree that the original sentence was too broad and insufficiently supported by literatures. Hence, we have revised the sentence, added relevant recent literature and provided more precise description. For example, Huang et al. (2026) reported higher SOC and MAOC but comparatively lower particulate organic carbon (POC) in moss-covered soils along a subalpine forest gradient, with no significant direct pathway from POC to MAOC. We have cited the recent studies showing that moss cover can influence SOC stocks and individual C pools. And, we have also clarified the knowledge gap concerning the distribution and stabilization of physically distinct SOC fractions (fPOM, oPOM and MAOM), across contrasting forest-soil environments.

L76: The hypothesis regarding C:N ratios appears without prior justification. Please provide rationale earlier in the introduction to establish the basis for this hypothesis.

R: We agree and appreciate this suggestion and have added a concise paragraph before hypotheses, explaining the role of mosses in changing the C: N stoichiometry through variations in C and N inputs, transformations and C and N availability. We have also clarified that alteration in C:N ratio may reflect the changes in varied accumulation of soil C and N and that C:N ratio must not be taken as direct measure of decomposition. These will be mentioned with relevant references in the revised manuscript.

L170: I believe the mixed conifer forest is located “near” Tübingen rather than “in” Tübingen. Please check this geographical description.

R: Thank you for pointing this out. We have revised and included “the coniferous mixed forest in Schönbuch Nature Park, near Tübingen” on the first occurrence and “coniferous mixed forest” throughout the manuscript.

Figure 3: The x-axis should be labelled "SOC fractions" rather than "POM fractions." I believe, organic carbon - not organic matter - was determined; this should be clarified throughout the manuscript.

R: We thank the reviewer for this suggestion. We would like to clarify that the values presented in Figure 3 are the mass proportions (%) of the physically separated SOM fractions (fPOM, oPOM and MAOM) obtained through density fractionation rather than the relative C concentrations. The relative concentrations of C within these SOM fractions were determined separately. Therefore, we have revised the x-axis of Figure 3 from "POM fractions (%)" to "SOM fractions (%)". We have also clarified the caption of Figure 3 as "Fractional mass proportions (%) of free particulate organic matter (fPOM), occluded particulate organic matter (oPOM) and mineral-associated organic matter (MAOM) in moss-covered and no moss soils across two forest types." and have revised the relevant text accordingly which will be mentioned in the revised manuscript.

Table 1: This table is redundant with Figure 3 as it presents overlapping information. Consider a consolidation.

R: We agree that the data shown in figure have been duplicated in the table as well. We therefore, will revise the figure and table and keep the one with more information in the manuscript and another in the supplementary material.

Table 3: For the mixed conifer forest with moss cover under loess, MAOC increased as the labile organic carbon pools (fPOC + oPOC) decreased. To me, this suggests a potential redistribution between pools for these sites – as a transfer from labile to more stable pools due to other faction (e.g. moss species or microbial community). Perhaps, fine-textured soils have sufficient mineral surface area to bind additional OC inputs from the POC pool, promoted by mosses. In contrast, soils under sandstone do not appear to have the capacity for such redistribution as slope is positive. Just think about my interpretation of your data.

R: We thank the reviewer for this insightful interpretation in the contrasting relationships between labile and MAOM-C pools. We agree that the significant negative relationship observed under moss cover in the coniferous mixed-loess environment suggests an inverse relationship between these pools and may reflect variances in C partitioning under fine-textured soil conditions. This interpretation has been included in the revised "Discussion" where mineral surface occupancy, mineral reactivity, organic C inputs, and microbial processing have been considered as potential reasons for this phenomenon.

However, the positive relationship under moss cover in the coniferous mixed-sandstone environment has been interpreted as co-accumulation of labile and MAOM-C pools, rather than the direct transfer from POM-C to MAOM-C. Based on these, the "Discussion" has been revised. We have also mentioned that the proposed mechanisms were not directly measured in this research.

Figure 7: Regarding parent material (sand): since the effect was not estimated, this could be omitted in figure.

R: We thank you for this suggestion and agree to omit “Parent material: Sand” from Figure 7. We have also clarified this in the caption of Figure 7.

L317-18: The phrase “..slower decomposition ... N-limitation” would logically lead to increased carbon storage. Please clarify the intended meaning.

R: Thank you for pointing out this. We agree that the original sentence stating higher C: N ratios “predict slower decomposition and increased N limitation” was too strong. We have, therefore, omitted this statement and revised the discussion to explain that the higher C: N ratio represents a shift in soil C: N stoichiometry but, by itself, it does not indicate slower decomposition or increased N limitation. We have also mentioned that the mechanisms underlying the higher C:N ratios remain unresolved.

L320: “Stabilization dominated SOC fraction...” - This sentence is unclear and may be reworded.

R: We agree and have therefore, revised the text to clearly state that MAOM represented the dominant SOC fraction across both forest types, irrespective of moss cover. We also replaced the phrase “stabilization dominated...” with a more explicit description of SOC distribution.

L352-53: “These results... sandstone environments”. I would interpret this differently: labile POC increases alongside MAOC pools, suggesting no active redistribution (i.e., “movement of POM into persistent pools”), but rather that both pools increase simultaneously with specific site conditions.

R: Thank you for this constructive interpretation. The positive relationship between labile POC and MAOC in the sandstone environment may reflect concurrent increases in these pools, instead of direct transfer of POM-C into MAOM-C. Therefore, we have revised the text to define this pattern as co-accumulation of labile C and MAOM-C under moss cover, and have removed the initial statement which mentioned the direct transfer of labile C to MAOM-C. We have further clarified that the observed relationship does not indicate the direction or mechanism of C transfer.