

REVIEWER 1

Overall I found that the quality of the article improved significantly, especially the discussion, and I think that it is scientifically quite strong now.

However, I think the amount of different things that the article addresses can be a bit overwhelming and having it more focused on the four stated main objectives would help guiding the reader.

One example: I truly appreciate the effort of investigating in detail the similarities and differences between the 2005 and 2019 sampling campaigns, and I think this was very important as a background check. However, from a readers perspective, I would almost recommend having these comparisons (including the methods for them) moved to the supplement and only focus only on the comparable areas in the main articles (i.e., the 2005 campaign with the reduced field not the whole field). I think this would make the story and message of the main article cleaner.

We thank the reviewer for this suggestion, which we followed. We have moved the details of these investigations in two new sections of the supplementary material (lines 19-109): The section “1 – Spatial comparison between 2005 and 2019 sampling campaigns” includes the elements of the material and methods section that were moved there, while the section “2 – Statistics of soil properties in the reduced and complete fields” includes the elements of the results section that were moved there. We kept a paragraph on these aspects in the discussion section relating to the uncertainties (4.3 Uncertainties in soil carbon stock changes).

Apart from that, I think the introduction could be shortened a bit and focused more on the objectives of the study. I think it would be good to state the research gaps that your study addresses very clearly and to focus on them. On the other hand, topics that distract from your main focus can be removed or significantly shortened. For example, the first paragraph about the relevance of SOC, could be shortened and merged with the second paragraph. I think it is not necessary to recite the same articles as almost any study about SOC in that detail (but this is only a minor point). In the second paragraph, you could omit or shorten the sentences that deal with the general issue of SOC and GHG but are not directly addressed in your study (e.g., N₂O, deep inversion tillage).

We have followed this suggestion and shortened the introduction to 2 pages and clarified the objectives of the study more clearly (see the introduction section in track changes document).

Finally, I think there are a number of small issues such as incomplete Figure and Table captions (missing panel descriptions, etc.) make the article a bit hard to follow. Therefore, from a readers perspective, I recommend polishing the article with a focus on understandability and small issues (line specific comments) these before publication.

We thank the reviewer for these comments which we have all addressed. We have also read through the manuscript to improve the understandability.

Line-specific comments:

L33 Are the 0.65% annual decrease in percent of the initial stocks (not fully clear)?

Yes it is in percent of the initial stock. Clarified.

L41 Larger “exports”?

We added exports

L75 This sentence is a bit confusing, since the two cited studies seem to contradict each other a bit.

This sentence has been withdrawn in the reduced introduction

L79 CO₂ etc. miss subscripts.

All subscripts have been checked throughout the text

L96 to 103 The section about PTF is too long in my opinion – it almost creates the impression that PTF are a major focus of your study.

We have reduced this section now focussing mainly on the potential biases introduced by PTF-based bulk density computation.

L180ff the yr⁻¹ etc. are not superscripted

All superscripts have been checked throughout the text.

L194 I guess if the sampling is systematic with a regular grid, it cannot be random?

Good point indeed. We have suppressed random in the sentence.

L407 Not clear what the portion of C input is. Is this EOM?

We have proposed a clarification by rephrasing as (L345-346 in the track change manuscript):

“A proportion (h_a) of all the C inputs to the soil is allocated to the active C pool, while the remaining proportion ($1 - h_a$) is considered mineralised.”

L416 “aabove” remove one a

Done

L426 This part is not clear to me. Did you have different weather input in different scenarios? If yes, where were the baseline scenario weather conditions from (especially past 2025).

We have rephrased the part on sensitivity to explicit what was the baseline scenario and what were the weather conditions in this scenario. These were those measured at the FR-Gri site during the period 2005-2019. The new sentence reads (L356-369 in the track change manuscript):

“The SOC stock changes were simulated on an annual timestep over the period 2005–2040, considering the 0-30 cm depth layer, which generally corresponds to the managed soil layer in cropland systems, where most crop roots and residue inputs occur. The baseline SOC stock in the 0-30 cm layer was set to 8.25 kg C m⁻², based on measurements from 2005. The proportion of stable organic carbon pool was set to 65% ($C_s = 0.65$), as Clivot et al. (2019) proposed for agricultural fields with a long-term history of cultivation. To assess model sensitivity, we performed additional simulations by varying key management and environmental factors and comparing to a base scenario: (1) residue returns to the soil were increased to 100% of the available residues, (2) organic amendments were either eliminated (set to zero) or doubled (multiplied by two), (3) meteorological conditions were set to the pre-2005 period by repeating the 1987–2004 weather data for the 2005–2040 period, and (4) the proportion of stable organic carbon pool (C_s) was set to

0.63 and 0.75 as independent estimates on a nearby soil reported by Kanari et al (2022) to illustrate the model's response to this critical soil carbon parameter. In the base scenario, (1) the residue returns and (2) the organic amendments were set according to Table 1, (3) the meteorological conditions where those measured at the site between 2005 and 2019, and then repeated to 2040, and (4) Cs was set to 0.65."

L429 The heading is somewhat not clear to me. Do you mean comparing the ICOS approach to carbon flux balances from EC?

The heading was changed to clarify:

"2.10 Carbon flux balance derived from Eddy Covariance measurements "

Figure 4 I recommend to label the y axis by the depths (e.g., 0-5 cm . . .). Additionally it should be specified whether the SOC stocks are FD or ESM (I assume FD).

It corresponds to the ESM method. And therefore, the difficulty is that with the ESM method, the layers have varying depths with time. We propose to add the layers because it is easier to understand and explicate in the legend that these depths are varying according to Figure 5B.

Figure 5 There is a mismatch between the panel labelling (A-D) and the panel description (only A and B). I think the correct labelling should be: Panel A and B) solid lines . . . for 2005 and 2019, respectively., Panel C and D) cumulative . . . for 2005 and 2019, respectively.

Yes, you are right. We have updated the legend to match all panels.

L489 The reference must be to another Table, not Table 1.

Yes, indeed it is Table 2.

Figure 6. Panel B is not described in the caption and there are no asterisks showing significant differences, despite the text (and errorbars) suggesting that there were some differences.

Figure 6 and legend has been updated and significance has been added (now Figure 5 in revised manuscript)

L512-514 I think the statement about "complete field" is rather confusing. Maybe omit it (or frame it differently). Or is it necessary to highlight the importance of comparability between campaigns?

It is indeed necessary to highlight such differences. However following the general comment of the reviewer we have put all elements referring to spatial sampling differences between the two campaign in Supp Mat sections 1 and 2 now so "complete field" does not appear in this section anymore.

L534 "the AMG model suggested that SOC decreased" . . . ?

We have rephrased to (L459 in the track changes manuscript): "The AMG model simulated a SOC stock decrease from 8.24 kg C m⁻² in 2005 to 7.25 kg C m⁻² in 2019, reflecting a cumulative loss of approximately 0.99 kg C m⁻² (-12%) over 13.25 years. "

L535 Maybe state that the AMG model predictions are higher losses than your observations (outside the CI limits of ESM, but inside the ones of FD).

In facts the AMG predictions are a bit outside the ESM CI limits which we consider is a better method to estimate the 0-30 cm layer stock change. So we have rephrased the sentence to reflect this fact (L461-463):

“This modelled SOC loss is larger than the mean SOC stock change estimated using the ESM approach in the 0-30 cm layer (-0.67 kg C m⁻²), and slightly 462 outside the associated confidence intervals (95% CI: -0.90 to -0.44 kg C m⁻²; Table 3).”

Figure 7: Cs needs to be defined in the caption.

It is now defined in Figure 6 caption: *“Cs denotes of the proportion of stable carbon pools in the model.”*

L556 I would stress more that they were only similar when going to 60cm depth but not for 0-30.

We have rephrased the sentence with the suggested emphasis (L484-487):

“Our results show that cumulative SOC stock changes between 2005 and 2019 under reduced tillage management 484 were similar between the FD and ESM approaches only when SOC stocks were integrated over the complete 485 0–60 cm profile, differing by just 3% in this layer ($p > 0.80$). In contrast, SOC stock changes differed between 486 approaches in the surface soil (≤ 30 cm).”

L599 the meteorology scenario is not well explained in the methods and in the results, so this statement is difficult to understand.

We believe that the modified material and method section has clarified this point.

L603 Not clear what you mean by “that period”.

We have clarified that it was 2005-2019 period (L549-551 of the track changed manuscript).

L607 Would be good to give more detail on the soil and climate conditions of the Mary et al. (2020) study.

We have added a short section to better explain soil and climate conditions of the Mary et al. 2020 and Dimassi et al. 2014 studies and explain better their complementarities (L534-547):

“Different patterns have been reported in long-term experiments conducted under similar pedoclimatic conditions. In a well-drained Haplic Luvisol under a temperate climate, Dimassi et al. (2014) demonstrated that changes in SOC stock under residue removal varied over time, exhibiting alternating phases of accumulation and depletion. The most substantial depletion occurred around 2002 (-0.033 kg C m⁻² yr⁻¹), possibly reflecting the lagged effects of residue removal between 1982 and 1994, as well as the impact of climate change. In contrast, the SOC stock increased in 2011 after residues were returned after 1994. Furthermore, SOC stocks increased in the upper soil layer (0-10 cm) but were offset by losses at depth (10-28 cm), resulting in near-neutral changes in SOC stock over the profile. These trends were later confirmed by Mary et al. (2020), who conducted additional sampling in 2017. Unlike the long-term experiments of Dimassi et al. (2014) and Mary et al. (2020), where surface gains largely compensated subsoil losses at the profile scale, SOC losses at FR-Gri were dominated by sustained carbon deficits in intermediate layers, resulting in a net negative balance. However, as we hypothesised here, Dimassi et al. (2014) suggested that crop management practices, such as residue removal, crop rotation (C3 vs. C4), and catch crops, mediate C sequestration under similar soil tillage conditions.”

L610 Same for the Dimassi et al. (2014) study

See previous answer.

L677 Maybe based on your discussion about the difference in sampling design, it would be good to end with some recommendations on what key points should be considered in the next resampling campaign. (since you also mention this in the conclusion).

We have added a section at the end of the discussion (L625-639) with key points recommendations:

“Based on the uncertainties identified in this study, several key points should be considered for the next resampling campaign to enhance the detectability of stock changes in SOC. First, maintaining consistency in the sampled area and sampling protocols (including material used for sampling) across campaigns is critical to avoid confounding temporal changes with spatial variability. Second, sampling depth should also extend sufficiently deep (1 m) as SOC losses and gains vary across the soil profile. Third, accurate quantification of bulk density, rock fragment content, and fine earth mass remains essential, and consistent protocols should be applied across campaigns to ensure compatibility with equivalent soil mass approaches. Finally, Consistent recording of meteorology, carbon fluxes, and C inputs and outputs, together with their uncertainties, is also key to interpreting the observations. The application of the ICOS harmonised protocols fulfils all the above-mentioned key points and ensures methodological consistency and comparability across years, particularly when using equivalent soil mass approaches. Some additional observations that are not mandatory in ICOS may be beneficial for further understanding soil carbon stock changes, particularly in terms of organic and inorganic carbon leaching. Together, these considerations will enhance the ability of future resampling campaigns to detect SOC stock changes robustly and distinguish between management and environmental-driven effects, as well as spatial and methodological sources of uncertainty.”

L687 superscript missing in “m⁻² yr⁻¹”

All superscripts have been checked.

REVIEWER 2

It is indicated in the answers to the reviewers but not in the paper why only the reduced field is shown and discussed but not the intersection field. I would add this to the results section.

We were rather prone to follow Reviewer 1 recommendations to simplify the manuscript message. We then rather propose to put all the details regarding the choice of the reduced field in the Supplementary material section. We have added the following sentence in the material and method section to suggest the readers to read this supplementary section for more details on this point (L180-185 of the track changes manuscript):

“To ensure comparability between the 2005 and 2019 sampling campaigns, all SOC stock change analyses presented in this study were restricted to a spatially comparable subset of the field, which exhibit-ed similar pedological properties in 2005 and 2019 (Figure S4). A detailed spatial comparison between the two sampling campaigns, including clustering analyses and sensitivity tests across different spatial subsets, is provided in the Supplementary Material (Figure S1-S5).”