Dear Authors,

both reviewers have agreed that the manuscript improved considerably and can be published if a few corrections are implemented:

First, figure 7 needs to be overhauled, a 1:1 line added, and the x and y axes need to have the same range. Both reviewers state that the way that it is presented, deviations from the 1:1 line are not clearly visible.

Secondly, reviewer 1 recommends to state the limitations of the MIR/FTIR method even more clearly. These are mainly the missing libraries in some regions of the globe and that it is questionable if MIR has the precision to detect changes in SOC at the field scale (much harder than predicting SOC across a range of soils). Consequently, reviewer 1 recommends to temper the claims about the general applicability in the abstract, main text and conclusion.

RESPONSE: Thank you for sharing the referee comments and for giving us the opportunity to make the suggested minor revisions for resubmission. Figure 7 has been updated to address all the referees' comments and each specific comment has been addressed as detailed below.

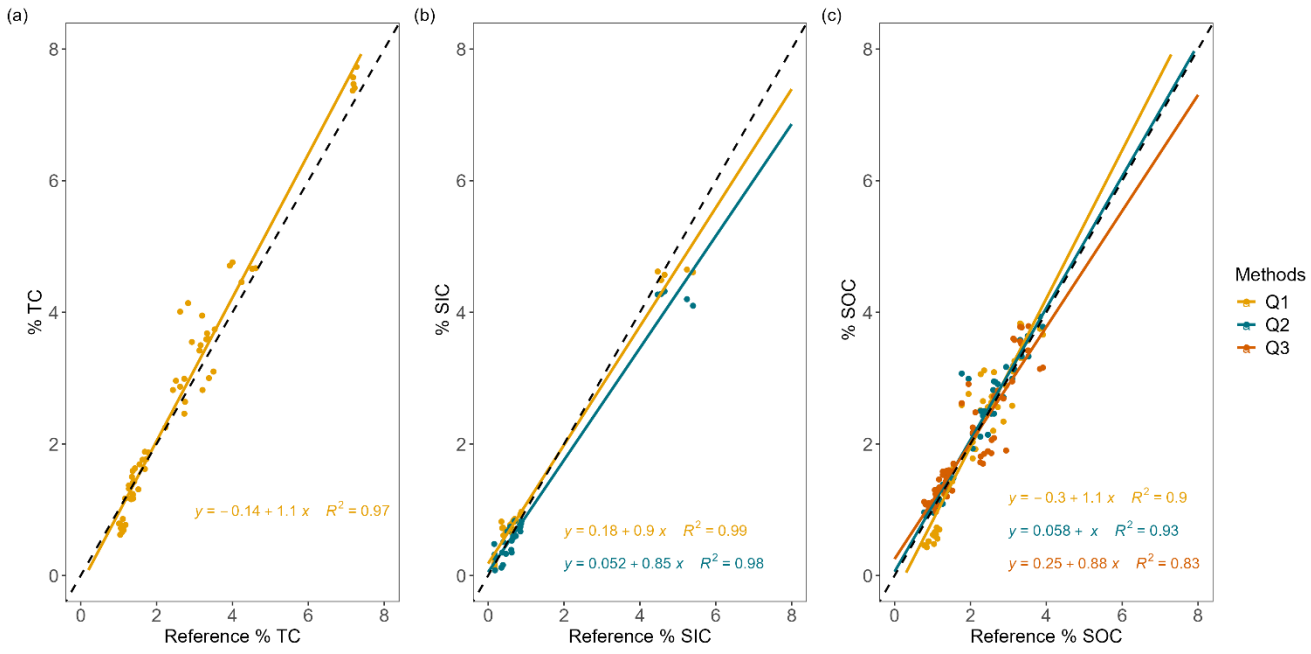

Figure 7: All quantification methods for % soil total carbon (TC), % soil inorganic carbon (SIC), and % soil organic carbon (SOC) plotted against the reference method where Q1 is predictions using Fourier transformed infrared spectroscopy, Q2 is acid fumigation, and Q3 is loss on ignition as described in detail in Fig. 1. The dashed line represents a 1:1 relationship.

To expand on the limitations of FTIR spectroscopy, we have revised L34-35 in the abstract to read "Moreover, we show promising results using FTIR spectroscopy coupled with predictive modeling for estimating % TC, % SIC, and % SOC in regions where spectral libraries exist." We have also added text as detailed below.

Proposed text (L577): Additionally, the KSSL library used in our study was representative of the geographical region for our sample set. The effectiveness of FTIR coupled with predictive modeling depends on the accessibility of spectral distribution within the geographical area of interest. Projects may be limited by the spectral libraries available.

Proposed text (L596): Moreover, as the use of FTIR gains traction, laboratories need to be aware that model transfer from a large spectral library (like the KSSL) may be problematic if the instrumentation used to analyze the soils does not match the instrument used to build the spectral library (Safanelli et al., 2023).

Proposed text (L641): We also encourage future research to better understand if the precision of FTIR predicted SOC measurements is sufficient to detect changes in SOC at the field scale.

Specific comments:
Line 67-68: It might be worth to mention here that international recommendations exist. For example, the ISO 23400:2021 that aims to standardize the sampling, measurement (e.g. dry combustion) and calculations. This is also partly discussed in Meurer et al. (2024) for European countries.

ISO. (2021). ISO 23400:2021(E), Soil quality-Guidelines for the determination of organic carbon and nitrogen stocks and their variations in mineral soils at field scale.

Meurer et al. (2024): 8

> **RESPONSE:** Thank you for this suggestion. We have added the following text as detailed below.
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> **Proposed text (L67):** And while several standards exist that guide methodologies for soil analysis of SOC (e.g., the International Organization for Standardization (ISO) 23400:2021(en)), divergence of methods occurs as the guidelines are not followed by every lab, especially for soil preparation procedures prior to elemental analysis.

Line 110: It is rather that the MIR spectroscopy is coupled with predictive modelling, which needs to be well trained. Please rephrase.

> **RESPONSE:** Thank you. We have reworded the sentence to read "…Fourier-transformed infrared spectroscopy (FTIR; Reeves, 2010; Goydaragh et al., 2021) where samples are scanned in the mid-infrared region. The produced spectra are then coupled with predictive models that must be well trained to produce accurate soil C estimates."

Line 165: To be complete, it would be good to have this information site specific. Can it be added for each soil in Table 1? At least the land use during sampling.

> **RESPONSE:** We have added a column with the land use and added text to the caption accordingly.

Line 173: If I am not missing it, CSU is introduced as an abbreviation in Line 187.

> **RESPONSE:** Good catch. We will introduce the abbreviation at the first use of it.

Line 256: The NRCS-KSSL is the basis for the model used here in OPUS.

> **RESPONSE:** Correct. We have added "and models" to L259.

Figure 7: To make it easier to read, a 1:1 line would be helpful here.

> **RESPONSE:** We agree and have added a 1:1 line as illustrated above.

Line 453-453: Yes, selecting roots after sieving can be important here. I wonder how you would standardize this. To my experience it is very hard. One can spend hours for one sample. What is your opinion here to get hands on this in a mor systematic way?

> **RESPONSE:** Yes, the authors agree that it is difficult. The best approach may be to standardize a time for picking roots that is site (soil) dependent. However, the defined time needs to be within reason. This is why we usually only 2 mm sieve a representative subsample of the whole soil based on analytical needs so we can scale the proportion of fine earth after 2 mm sieving up to the whole sample (for bulk density) without spending hours picking roots. We will add these suggestions to the revised manuscript.
>
> **Proposed text (L455):** In soils with a high density of fine root material, extra time may be necessary to adequately remove roots using tweezers. The time could be standardized by site (soil) so that all samples receive the same treatment. It is also worth noting that a representative subsample of the whole soil could be 2 mm sieved to eliminate the time needed to remove coarse materials.

Line 498-499: The automatic machines were less efficient with clayey soils? This is not clear and how you can make this statement here, did you test? In general, I am not sure what this adds to the discussion.

> **RESPONSE:** Yes, we did perform an internal test at the Soil Innovation Lab and concluded that the automated sieving machine did not save time sieving heavy clay soils because the aggregates did not break well. We included this in the discussion based on another referee's suggestion and will retain the text because it is important that readers know automated sieving machines are on the market and could be a potential option but have not been tested in a formal study (to our

knowledge). However, we have added "…after testing one machine internally at CSU" to be clearer.

Line 542-548: That is very interesting and good that you are able to emphasize the issue to SOC volatilization.

RESPONSE: Thank you. We agree. It is difficult to find publications related to this issue.