

Comment on soil-2021-109

Anonymous Referee #2

Referee comment on "Microbial soil characteristics of grassland and arable soils linked to thermogravimetry data: correlations, use and limits" by Helena Doležalová-Weissmannová et al., SOIL Discuss., <https://doi.org/10.5194/soil-2021-109-RC2>, 2021

General comments

The authors present a manuscript where they attempt to connect incremental thermal mass loss (TML) to various metrics associated with soil quality indicators (SQI), soil health, and soil microbial activity. Standard protocols for assessing SQI typically require multiple subsamples that are prepared for different measurements at different moisture contents and narrow temperature ranges. Authors suggest that TML may be a feasible technique to acquire data for multiple SQI metrics with a single measurement by correlating TML to select SQI. The TML temperature ranges are compared to measurements of SQI and linear regression is used to create models that are predictive of SQI values based on TML measurements. Although the authors present an interesting case for investigating connections between TML and SQI, their analytical approach does not clearly answer their objective due to obscure correlations that are not clear in interpretation. The predictive equations generated from their modeled data do not seem to provide a more reliable method of interpreting SQI and the authors fail to make a case for why they believe the generated equations have merit for SQI assessment. A different approach to analysis is suggested, and if authors do not find an analysis that is more fitting to the objective, perhaps a different experimental design is also needed.

18 – SQI are not officially standardized into groups or arranged in any official capacity. Authors should mention that the SQI listed here are the ones that they have considered and that the listed parameters do not cover all SQI that could be measured

22 – physical, chemical, and biological soil properties can change because of slight or major soil modification. I suggest avoiding categorizing them in this way because it limits which SQI are chosen to represent different soil processes.

28 – What do the authors imply here by 'number of methods'. Do you refer to different

methods that measure the same property or different methods to measure different SQI?

45 – the authors state that mass losses using TG do not have a clear meaning unless connected to accessory information. This is partially accurate, but there are many experiments connecting TG measurements to accessory measurements in ways that greatly increase the ability for TG to be predictive of certain soil properties. Thinking specifically of how gravimetric water content is measured and how the C:N ratio to soil organic matter is measured. The authors suggest that fractionated TML may also be useful for assessing SQI but fail to reasonably address that existing methods are conducted at narrow temperature ranges because those narrow ranges are typically most associated with the property being measured. How does a single measurement of TML over all those ranges collect valuable information

85 – this step to reach the same relative humidity across all samples seems unnecessary. Many researchers would instead focus on reaching a constant dry mass before analysis

88 – what is the rationale for this heating rate? A heating rate of 5°C per minute from 20-950°C minutes is approximately 186 minutes of heating on a 0.2 g sample. Do the authors have a reason for this protocol and why they expected this to produce reasonable results? There is no reference mentioned in this section

102 – what is meant by water holding capacity compared to water content? I interpret this to mean the water holding capacity of an intact soil sample based on porosity, texture, and related factors. Was WHC measured on these soils based on their natural state before being disturbed?

141 – at this point in the manuscript, the term LTML has not been described. I think it should not be abbreviated here.

144 – how are the TML being correlated to soil parameters here. Is the same TML range for each soil sample being correlated to the soil parameter measurement for each soil sample? It seems like this is what is being done, but please elaborate more clearly for readers.

160 – Although people highly versed in the field may know this information, it is important to include citations about the 30-600°C temperature range you are referring to for SOM degradation.

169 – What is the meaning of the equations when two or more TML ranges are used. How are we to interpret the meaning of each variable attached to this equation?

171 – Does your selection of large thermal mass loss areas have a significant quantitative meaning? It seems that you have selected wide ranges but do not explain a meaning for each lower and upper limit. This is also important because LTML values from table 2 are used to determine which linear equations are appropriate for further discussion in table 3 and beyond.

179 – for table 4, are there fewer applicable results for grassland because grassland had a smaller sample size? This outcome should have more explanation.

190 – you state that the closeness between TML and LTML correlation is close with a few exceptions. Is there interpretation about why some correlations were not close and others were (other than TN, for which you do provide speculation)? Does it have something to do with the LTML ranges selected for correlation? Other factors?

193 – Although there is speculation about why TN was among the biggest differences between the two soil types, the authors neglect to mention the relevant temperature ranges for soil N and why correlations with TML outside of those ranges would have meaning in this measurement. Are the authors confident that N is a significant part of mass loss across the entire range specified?

200 - It is well known that microbial biomass C and N are correlated with SOM, but your interpretation does not explain why TML in different temperature ranges are useful for this interpretation. For example, many researchers measure SOM by combustion between 300-400°C. Why are measurements outside of this range also valuable? Please elaborate.

205 – Belaboring the point here, but this is important for discussion. Microbial respiration in soil and microbial activity above 100°C is unlikely to have much meaning in practical situations. A measurement above 200°C is unlikely to be predictive of any microbial activity unless the prediction is that there is little to no microbial activity. The vast majority of microbes and microbial exudates are not part of the active C fraction at this point and greater. What do these correlations mean?

211-221 – Similar criticisms toward interpretation of N compounds. The authors present speculation with little connection to the objective based on TML and its use to interpret and assess results for different SQI

234 – I would like to see more exploration about how these factors like MB, TN, SOC, etc. overlap in terms of TML within a certain range. Considering most of the temperatures in the incremental TML are outside of microbial activity range of soil, I am curious to know if the correlations are confounded by other factors that are not currently discussed in the

manuscript. The authors should discuss this in order to make their argument for using this method more convincing.

239 – I think your data do not currently support the idea that rhizosphere inputs for grassland are what negatively affected the validation. As stated on line 247, the sample set is limited and unbalanced. Authors are far too speculative in this regard.

262 – Microbial activity can still be correlated with stable C fractions. This data has been observed. I am not confident that authors have shown that the thermal intervals measured in this way are associated with microbial activity. It would be interesting to see how the measured microbial and SOM parameters correlated to each other rather than the TML.

268 – TML may be a useful proxy for some soil analyses, but the way that authors have analyzed data in this manuscript does not show this. Interpretations in this manuscript drifted away from the proposed objective of showing how TML is connected to various SQI. Authors present very little data and interpretations that answer this question in a coherent way.

267 – authors make claims in this concluding paragraph that are not supported by their data and interpretations. TML does not appear to be a useful proxy for the soil analyses mentioned because authors did not present a strong case for a reliable or more convenient predictive model. The validation step failed in most cases for grassland soil and interpretations of the model for arable soil are not well supported in the manuscript. Authors may benefit from adjusting the overall objective and analysis methods so that the value of TML data is more apparent to readers, specifically for matters of SOM and its various fractions. The TML connection to microbial activity is likely confounded by chemical fractions of SOM that authors did not do a satisfactory job of parsing through in their results and interpretations.

Technical error

59 – the word 'vary' may be a typo with the intended word as 'various'.

252 – I think the intention is to write 'intermediate pools (...)' rather than 'intermediate (pools...)' Parenthesis after the word 'pools'.

Figures 1 and 2 should include the full text of abbreviated terms in the description (e.g. SOC = soil organic carbon).