

Dear Reviewer 1 and Reviewer 2.

Thank you again very much for your comments and suggestions to improve our manuscript. Here is the respond to all your comments point by point:

Response to the anonymous Referee #1:

Major comments

I have looked over your replies and the revised manuscript. I have a few questions about comments that I feel were not fully incorporated, and some more minor comments.

Especially, in my previous review, I advised you to describe and discuss the “other soil parameters” (C/N ratio, $\delta^{13}\text{C}$, BD, volumetric fractions and grain size fractions). You stated that the description and discussion of these parameters are beyond the focus of this paper and therefore only the data are included. But it does not add anything to report data that are not described and discussed and if not done so, you will have to take them out completely. You could publish them in a data repository, but they don't belong in the manuscript in this way. You should then also take out the description of the parameters in the methods section. However, I think it would be valuable to describe at least the C/N ratios and possibly the $\delta^{13}\text{C}$.

Dear Reviewer 1, thank you for the comment. I do agree the C/N ratios and the isotopes are an important contribution of this paper. Therefore, we added an additional section in “Results” which was further discussed in the “Discussion” section. Also, added more information in the “Result” “Soil stratigraphies” part about the dependence of DBD with the mineral fraction and the Yedoma classes.

You do use the coarse fraction for the correction in Equation 1, so you could have those data in the supplements.

Agree that this is important data, but this is exactly the dataset which accompanies the paper in the data repository. This data (n=6500) is available on sample level, same as for C%, TN%, and so on.

In the discussion, you compared the total SOC and TN store to previous estimates and explained why the numbers might be different. However, it would be very valuable to compare the SOC and TN densities to previous studies, because they are independent from the mapping. When these are different from other studies, the density values might be part of the answer to why the SOC and TN store are different in your estimates and not just the mapping.

Thank you for that interesting point. Agree that SOC and TN densities are very important. This is also, why the accompanied dataset has this information for each available sample. Looking at our data, there is a good correlation between SOC and TN density of $R^2=0.8$. However, looking into other recent studies, which we used with circumpolar SOC estimates, no such data is available. For example, Mishra's et al. estimate is modeled based on 2700 soil profiles. But even in the supplementary material only the mean and total SOC concentrations are given with very different classes. While TN data is hardly available at all.

Minor comments:

L24: please add “land surface area” or something similar to “Northern Hemisphere” (as you say in L55)

Thank you, indeed good to clarify this in the beginning. Changed as suggested.

L30-31: what do you mean with “turnover times”? Please remove “soil texture” here when not describing and discussing these parameters

Removed as not discussed. while

L45: remove “in turn” (because you use it in the next sentence as well)

Removed as suggested

L61-64: remove parameters that you don’t describe and discuss

We added additional information to several parameters in the text. Also, the data is used in the used soil stratigraphies in Figure 5.

L64-65: not relevant here

Removed as suggested.

L69: you followed my suggestion to change the word objective to aim, but in the next sentence you are still using objectives. Be consistent

Thank you and fully agree. Now “aim” is used throughout the text.

L72: replace soil organic carbon by SOC

Changed to SOC

L107: add space between 50 and cm

Space in between added.

L118: do you really mean “where soil is absent”, cause what did you then sample?

I added “almost” prior completely absent. But is true that in some cases, soil sampling was not possible as with predefined equidistant intervals we ended up on e.g. exposed bedrock. If possible, we could sometimes collect a few mm thin OL layer.

L127-137: Thanks for specifying what you meant with “most sites” and “for some locations”. I would suggest to rephrase it a bit such as: “A stratified sampling scheme consisting of linear ... elements was used to retrieve 582 soil pedons.” or rather add (n=582) at the end of the sentence. Do I understand it correctly that in the other 69 cases, the last 2 sentence of the paragraph (When sufficient time... each sampling point) apply? Please add this too: “... additional sampling (69 soil pedons) using a random...”

Thank you for additional suggestions. Made changes as suggested.

L140: use abbreviation OL or leave out introduction of abbreviation in L138

Decided to remove the abbreviation in L138, as not used anymore anyway.

L145, 156, 163: you mention the core was described but nothing else so it does not add any info to mention it. I suggest to remove this and only mention it where you explain it (L164)

Thank you for that comment. Indeed repetitive information which is now removed as suggested and only kept the one in L164.

L149 and 152: add (n=X) to “at several locations”

N added to both “several locations”

L173-174: move sentence up to before you mention the thawing and analyzing

Sentence moved one up.

L265: in other cases, you capitalized the word Tier

All “Tier” words are now capitalized

L271: Thanks for clarifying about the replicates. However, I still don’t understand what you imply with the sentence “Replicates were only considered for pedons reaching the full depth,”

Changed slightly the sentence to. “. Replicates were only considered for pedons reaching the full sampling depth, resulting in fewer replicates available with increasing sampling depth”. What we mean is that pedons to a depth of e.g. 180cm are accounted in the CI calculation only to 0-100cm and not to 0-200, since we don’t know the remaining 20cm. This is why the amount of pedons for CI calculation is decreasing with depth.

L285: the same pattern as what? And L287: do you mean in the highlighted areas?

Sentence changed to: “*Spatially, the SOC distribution in Figure 3 is following the same pattern and highlights the largest SOC content predominantly in permafrost peatlands in Western Siberia, Russia and the Nunavut territory in Canada.*”

L331, 333, 335: don’t capitalize “non-permafrost” and “permafrost”, “barren”

Changed as suggested.

L362: Maybe a better way to say that your estimates are in each other’s errors is to say they are not significantly different?

I see your point but since I can not test Harden’s estimate statistically due to different statistical approaches, I prefer to keep the comparison as it is but have exchanged the word “error” to “ranges”.

Response to Kristen Manies

Thank you to the authors for their work revising the manuscript. The changes made have made it easier to read and understand. I have some more minor comments that I think would continue to help them communicate their work (see below). I have no major comments or revision suggestions.

Dear Kristen Manies. Thank you once again for your time and your valuable comments to help to improve our manuscript. We gladly incorporate all your additional comments and suggestions.

MINOR COMMENTS:

Lines 69-71: Consider rewording these objectives. Since the word core can also be a soil core, consider using “primary” or some other synonym. I also feel like the “Secondly,” sentence is missing some words. Consider something like “In addition, we used this soils dataset and ...”

I see your point and agree, that core is not optimal wording. Changed to “primary” as suggested. Also made changes to the “Secondly”.

Line 73: I think this sentence, which is about the dataset, needs to be put right after the sentence about the dataset to make sense.

Thank you for that comment, moved this sentence up as suggested.

Line 110: I think the detail now included here on the numerous types of wetlands is confusing. At first I read this sentence thinking these were going to be your Tier II categories. I suggest that instead you say something simpler like “Areas that met the National Wetlands Working Group (1997) definition of a wetland were classified as such.”

Agree that it might sounded confusing. Changed to your suggested version.

Line 121: What do you mean by “from here ESA CCI land cover product”?

Thank you for finding that, it’s a typo. It should have been “the”. I changed it now to “which occupied an area of 570,000 km² from the used ESA CCI land cover product.”

Line 139: Consider “or, when this was not possible, to a depth of at least 50 cm.”

Changed to as suggested.

Line 158: This sentence doesn’t make sense to me. Are you trying to say “An accurate determination of soil bulk density (BD) is crucial when calculating SOC stocks”?

Thank you for that comment. Agree, that it doesn’t make sense. Sentence changed to: “Since the accurate determination of soil bulk density (BD) is crucial when calculating SOC, special attention was paid to accurate soil volume estimation during field sampling.”

Figure 2: This figure still shows three organic surface blocks – this figure needs to be modified now that you only discuss sampling 1 block.

Thank you again for that observant comment. Figure now modified with only one sampling block.

Line 186+: I find these sentences confusing as written. Consider just saying “To ensure that there was no remaining water in the organic rich and/or fine grained samples (n=3684), subsamples of ~10 g were dried again at 105 C to verify the oven dried weights. There were no noteworthy differences between samples dried at the two temperatures.” I also am not sure you need the rationale for this process (lines 188 – 191). If you keep it, maybe include the reasoning in the first sentence, when you first mention the lower OD weights.

Agree and changed the sentence to the suggested version. Also, removed unnecessary parts as not needed.

Lines 197 & 198: Instead of “burned” consider “heated to”

Changed to “heated to”

Line 201: Do not need the word “with”

Agree and removed

Line 206: This paragraph does not seem to fit within the methods but should instead be in the Results or Discussion sections. Or deleted.

This paragraph is now moved to the Result section.

Line 257: Do you actually use and/or present wet bulk density? I’ve only ever seen bulk density calculate using oven dried soil.

Not sure if the line number “257” is correct. However, we do use the wet bulk density to calculate for example the air fraction in the soil stratigraphy’s. Also, the wet bulk density is calculated for each sample and part of data available to download.

Tables 4 & 6: What does the word “landscape” signify here? You only discuss land cover and these values appear to be for all data. I think you should delete this word (so it reads “Mean SOC storage”).

Agree that the landscape in this content does not make sense, work deleted.

Line 331: I think these sentences should be combined.

Merged as suggested.

Line 333: I don’t think you need the word “instead” here. Also, would the descriptor “consistent” be better than “rather stable”?

Thank you, exchanged the wording to the suggestions.

Line 334: I think a more simplified statement, such as “which is due to the high organic fraction of these soils” is better.

Changed as suggested.

Line 334: I don’t think its correct to start a sentence with the word “which”. It also helps the reader when you set up the next idea, so they know what’s coming (more evidence, a difference, etc.). Consider something more like “In comparison, the barren has the lowest SOC and TN, as these soils

are dominated by the coarse mineral fraction.” Also, these classes were not capitalized earlier. Please be consistent throughout the manuscript.

Indeed and thank you for that comment. Changes made as suggested.

Line 336: I’m confused, because I would think that “these important trends” would be related to the previous sentences, but you haven’t discussed water content yet. In fact, to me the trend is the relationships you’ve been discussing have been related to the amount of organic / mineral fractions and TOC, not the silt/clay you mention here. I think this sentence needs to be rewritten some.

Thank you for pointing out the confusion. Sentence is now completely rewritten to *“While the stratigraphy for the Yedoma classes proves the Yedoma typical ice-rich silt sediments visible in the high silt + clay and high water/ice fraction.”*

Line 372: Clearer if you say “...aquatic vegetation, which corresponds to our wetland class, is unfortunately...”

Changed to the suggestion

Line 376: Sentence starting with the word “Which” appears to be incomplete.

Sentence rewritten and additional explanation added.

Once again, we would like to thank both reviewers for the constructive and valuable comments and suggestions, which helped us to improve the manuscript and hope we were able to address all the comments.