Reply on RC2
Juri Palmtag et al.

Author comment on "A high-spatial resolution soil carbon and nitrogen dataset for the northern permafrost region, based on circumpolar land cover upscaling" by Juri Palmtag et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2022-8-AC2, 2022

Response to Kristen Manies

Major comments

This manuscript describes the data collection methods for over 6500 soil samples and uses these data to provide C and N stock estimates for the circumpolar permafrost region. These data are very useful and important. The Introduction and Results are presented well. However, I do think that the Discussion section is missing a paragraph discussing the caveats of the data. This information is only briefly mentioned in the Conclusions (line 415) and needs to be discussed more in depth in the Discussion portion of the paper. As stated in line 415, their data are concentrated in non-North American locations, such that a more complete picture could be obtained by combining their data with other datasets. In addition, the dataset only contains one high alpine site, so this ecosystem type is underrepresented. I don't expect this manuscript to do analysis beyond what is presented here, but I do think it's important to be clear about the limitations of their data and what next steps (i.e., combining with other datasets) could be taken to expand our understanding on this important information.

Dear Kristen Manies. Thank you very much for all your valuable comments to help to improve our manuscript. We fully agree, that the database has several really underrepresented areas and classes which are problematic. And it would benefit from combining this data with other available sources. As suggested, a section was added in the discussion pointing out again the issue with underrepresented sites and the benefits of combing this dataset.

In addition, there were many times when I was reading the methods that I had unanswered questions regarding specific methodology and/or how their methods might impact data quality. I would like to see many, if not all, of the following questions answered, such that others who want to use the data truly understand how it was collected. Areas where I had questions include (line #: question):

119: Do you mean that the following field descriptions were classified as wetlands? Also, why is “mineral” a wetland?
We used the Canadian system to classify the different wetland classes in the field, including the one for mineral wetlands. All the following classes were then grouped in the Tier I class wetland (organic, mineral, seasonal, permanent, ombrotrophic and minerotrophic wetlands). To make it more clear, we made some changes in the text including a new reference.

124: I don’t understand what your reason is (as no reason was stated in the previous sentence).

Thank you for the comment. I changed the sentence to “The Tibetan permafrost region was also excluded from our estimates as none of the sampling sites originated from that area”.

127: How did you define the Yedoma region? I don’t think that this classification is something you can determine with site photos.

The Yedoma extent was defined by Strauss et al. (2017), where the area was overlaid on the ESA’s land cover product and constrained to the Northern Hemisphere permafrost region by Obu (2021). To clarify, text changed to “The land cover class Yedoma is defined as areas in Siberia, Alaska, and Yukon underlain by late Pleistocene ice-rich syngenetic permafrost deposits. We used the spatial extent for the Yedoma domain from Strauss et al. (2017) which occupied an area of 570,000 km² from here ESA CCI land cover product” as additionally described in the section 2.4.

135: How many soil descriptions per site usually?

Added following text to the sentence: “with on average 37 sampling sites per study area”

145: Does the top organic layer mean all organic soil? Or does it mean organic soil to a certain depth? Or organic soil to a certain (estimated) bulk density?

Rephrased to “Organic layer (OL)” as we mean the all organic soil.

146: If a steel pipe was not used, how was permafrost soil sampled?

Permafrost was always sampled using a steel pipe except in Greenland where an Earth Auger was used.

[It would probably be helpful for the reader if the paragraphs from line 145 and 152 were combined. There would be less duplication and some of my questions raised reading the 1st paragraph were answered when reading the 2nd paragraph.]

Thank you for this comment and fully agree that a combined paragraph makes more sense. Paragraph combined and rewritten, partly shortened but also added additional information which you asked for below and above.

156: Was the active layer never deeper than 50 cm? If so, how was the deeper active layer sampled? There must have been areas where the organics were deeper than 50 cm, especially in the wetlands. How were these soils sampled?

Additional explanatory text added “Deeper unfrozen soil layers were sampled using a steel pipe” as of course, most sites had a much deeper active layer thickness than 50 cm.

156: The way this sentence is currently written it sounds like only in the “few cases from natural exposures” were the horizontal sampling rings used. But, according to Figure 2, this is the method used for the entire active layer. This sentence needs to be rewritten to
clarify this point as well as include the information requested below.

Thank you for again for this observant point. The horizontal sampling referred to permafrost sampling in exposures where the steel pipe was hammered in horizontally. Sentence moved to the right place of permafrost sampling.

157: I’m also worried about the sampling that happened at fixed depth intervals. How frequent were these intervals (every 5, 10, 20 cm)? Could you have missed changes in soil horizons (and thus bulk density and C concentration, affecting your C stock values) by sampling this way?

Thank you for that comment. Usually, the frequent sampling interval of the active layer was each 10 cm with a 60 mm in diameter sample ring. So only 40 mm of pedon wall was left to stabilize the pedon. In some cases, where the soil texture was very sandy and the sampled pedon wall not stable, sapling interval had to be increased. However, minor changes in soil horizons could have been missed but the sampling intervals were dense enough and should not affect the C concentration overall. We added additional text to the manuscript.

158: I don’t understand what “emphasis” means here. Or what was done when there was a lot of spatial variability within a soil pit. I think additional descriptions (i.e., depths were measured every 10 cm on the photograph and then averaged) or an example is needed here.

As also commented by reviewer 1, this sentence is not adding any relevant information as all the sampled samples were treated similar for calculating the depth, and therefore this part is now removed.

For clarity to the reader, maybe describe the normal way you measured the active layer. Then give the details about the special cases (natural exposures, spatial distribution).

Following information added “Active layer thickness was measured at each location using a graduated steel probe or measuring tape in excavated soil pits.”

170: Please clarify that the length of this pipe was measured each time it was used, so that the bulk density measurements are accurate.

As pointed out by reviewer 1, this part is not of relevance and is now removed from the manuscript. But to clarify, every time the pipe had to be cut, it was of course remeasured and new marked.

185: How were you able to do hand manipulations on the frozen sections? Did you let part of the sample thaw and then test for soil texture? Also, if you are taking these subsamples out for texture analysis, did you return that subsample to the bag so that the weights remained accurate?

Really good point. Yes, subsamples were thawed which happens usually within a minute and hand analyzed. And of course, returned back to the sample bag. This information is now also added in the text.

213: It’d be nice to have a few more details about how the determination of the presence of inorganic C was done. For example, were they chosen by eye? Or if the sample fell a certain percentage off the 1:1 line between LOI550 – LOI950?

Additional information added. Inorganic carbon was only high at 2 sites, where the samples were treated with HCl prior the EA analysis. Following information in the text: “If
LOI950 following Heiri et al. (2001) indicated presence of inorganic carbon with > 1%, samples were acid treated (Ny Ålesund, Norway; Aktru, Altai mountains, Russia) with hydrochloric acid prior to determination of TOC.

217: Since you are using LOI data to predict C for some samples, I’d like to know a) the percentage of samples for which this predication was used (i.e., no C data available) and b) how good the fit of this relationship for these data are.

Added additional information about the % of samples where %C was only known from LOI and added the fit between LOI and EA which is $R^2$ of 95%. Following text now in the manuscript: “To estimate the organic carbon % (OC %) for samples where only LOI was available (44 % of samples), a polynomial regression model ($R^2=95\%$) was performed between LOI550 and OC % from EA on samples for which both analyses were available at study area level”.

237: I am confused why you took three organic samples when only one was used for C stock measurements. I’m assuming that you only used OL1 because it matched with the rest of the soil profile. Maybe clarify that the other two samples were taken to quantify the variability of this layer (if this is the correct reason) and are available as data for others but aren’t considered in these results.

Similar question was raised by the other reviewer. In most cases we did collect additional organic layer as the differences can be significant. However, to avoid misunderstanding and as you correctly pointed out, we used only OL1 for the calculation as it matches the soil profile. Therefore, other OL samples were now removed from the text as they were not used anyway.

**Additional, but minor suggestions, are as follows (preceded by the line number):**

37: Are you missing a verb here? “to be 380 Pg”?

Thank you, indeed the verb was missing. Added as suggested.

38: I found this sentence a very confusing.

I removed this sentence as it is not relevant for the abstract.

41: What is the difference between the 2 datasets? It would be nice to have this detail, so readers know which link to use.

Added information about the content in the “Data access” section.

66: misspelling “volumetric water content for organic soil”

Changed

68: The word “cover” before “stones and boulders” initially made me think you were looking at those data as a percent cover. Consider removing this word (maybe need to say percentage of stones and boulders?).

Agree about the good comment and exchanged the “cover” with “percentage of” as suggested

105: I found these two sentences confusing and think would be more understandable if they were a) a part of section 2.1 and rewritten a bit. For example, “All sites were classified with Tier 1 descriptions using field descriptions and, where possible, assigned a
more detailed (Tier 2) description.”

Agree with your comment. I moved these two sentences to the next section and rewrote following your suggestion.

120: It might be clearer if you say something like “Where the permafrost status within the top 2 m of a site was known, a Tier 2 status was assigned.”

Rewrote this part

165: Please revise – you say earlier in this sentence that these soils weren’t always frozen.

Revised

191: I was confused why this information was presented, especially since I didn’t see this information discussed in the results or presented in the datasets.

Same issue was pointed out by reviewer 1. Fully agree and this part is removed from the manuscript as not further discussed.

Figure 2 is very nice.

Thank you, I will forward this to the responsible person!

214: If you place the information that these regressions were done for each study area in this sentence readers won’t be left wondering (as I was) until they read on.

Done

218: Aren’t C:N ratios usually based on percentages of these elements, not weights?

Thank you for the comment, you are absolutely right. I removed the “weight” from this sentence.

220: Simpler to say “more decomposition”?

Revised to your suggestion.

222: This ratio? I’m confused what “this” is referring to.

Text revised to make it more understandable.

270: I’m confused by the words “indicated by permafrost area”. I don’t understand what this phrase is clarifying for the previous statement “but not the actual area underlain by permafrost”?

Thank you for the comment. The words “indicated by permafrost area” are now removed, as they were referring to a previous version.

271: Simplify to “This dataset”?

Revised as suggested

273: I suggest you move this paragraph to right after the paragraph on line 260 that introduces the ESA database.
Moved this paragraph up as suggested

283: I think the first Tier mentioned should really be “Tier I”.
True, done as suggested.

286: Better to put the equation here?
Moved the equation up.

346: I don’t see Yedoma tundra (yellow line) on the Figure 5 panels for the silt+ clay nor sand panels. I also see a lot of variability in the Non-permafrost wetlands for many data types, so you may want to also mention this class.
Figures adjusted as also additional text explaining the non-permafrost behavior.

355: The scientific communities don’t have high spatial resolution, the dataset does.
Sentence structure changed and moved the “scientific communities” to the end.

358: I think this sentence is a better topic sentence, with the sentences following this sentence explaining how it’s better than what previously existed.
Fully agree that the location of this sentence was not optimal. Moved up to be the introductory sentence for the discussion section.

374: Despite? Or because of different upscaling approaches? I find this and the following sentences to be confusing/too wordy. I think you need to focus on the points: although your values are a bit lower than their estimates, they’re within each other errors. You used different upscaling approaches, which could be the cause of some of these differences. Your upscaling approach was chosen because...
Thank you for the comment and the suggestions. This section is now rewritten following your suggestion.

382: I found this wording confusing. Maybe “estimate of 66 Pg (+/- 35 Pg) by Harden et al.”?
Changed to as suggested.

384: If you’re going to have this paragraph on C:N ratios in here I think you need to discuss your results more (i.e. how they vary with land type, etc.). Right now it’s just saying what you already said at line 218. There are other data you don’t discuss. Maybe the focus of this paragraph should be about the other data available in this dataset and what their uses could be? Otherwise, I’d delete this paragraph.
Thank you for that comment. I decided to remove this paragraph as the main focus is on SOC and TN storage and the used land cover product. Also as you mentioned, several other variables are not discussed as well which is not the scope of this manuscript.

390: I think “although” fits better at the beginning of the sentence as it’s currently written.
Changed to “although”.

393 & 395: This what? Make sure to follow the word “this” with a noun so readers don’t
get confused about the subject you are discussing.

Parts rewritten according to suggestion.

395: I don’t think you need to say “in this study” here.

Deleted

396: I’m not sure “throughout” is the appropriate word here since you’re only discussing wetland classes. I suggest deleting it.

Deleted

397: It might be clearer to say “exchange the ESA wetland areal coverage for the values in Hugelius”. Also, you give us your updated estimates, but please remind us how those relate to the other estimates and what those values are. (Otherwise I have to reread the paper to find them.)

Changes made as suggested.

401: I think your argument needs to be that you present a more complete dataset in regard to variables used to parametrize models. Because other data sets have similar data, maybe just not to the completeness you do.

Changed as suggested.

We thank reviewer Kristen Manies for the constructive comments, which helped to improve our manuscript and hope we addressed all the questions raised by the reviewer.