Response to Reviewers' Comments

Loisel et al: C-PEAT's Global Peatland Carbon Database (v.2025)
(https://doi.org/10.5194/essd-2026-222)
Earth System Science Data

The reviewers' comments are presented in grey, bolded text.

The responses to those comments are presented in black, indented text.

Reviewer #1

General comments
In this manuscript, the authors present a peatland chronology (depths, calibrated und uncalibrated ages) and biogeochemical (bulk density, C and N contents) database (Global Peatland Carbon Database, GD) created by the PAGES' C-PEAT working group. The database contains data from 267 cores across the globe with a majority of data from high latitudes and can be downloaded free of charge from the PANGAEA repository and used free of charge by interested parties.

This is a to date unique contribution to the datasets available on peatlands; I am not aware of a similar datasets with uncalibrated ages with age errors and biogeochemical data for such a number of cores that covers peatlands from all latitudes. Such data are useful to calibrate and test both local long-term process models and peatland modules in earth system and dynamic vegetation models. The ability to use other calibration models to estimate peat ages is an important and necessary feature. For this reason, I think that the GD is an important and new contribution to peatland research.

Thank you!

I have tested downloading the data using the R script from Ransby, Riemann-Campe, and Sanderson (2025) mentioned in the manuscript. Except for one error in the scripts that I could correct myself (see comment below), this all worked fine, the dataset is complete and mostly in a usable format. I have comments on some limitations in the script and the metadata documentation that could prevent usage of the GD or lead to erroneous usage of the GD that I list below. I did not test the Python script since I do not use Python.

Great; we appreciate that you took the time to test the code and we look forward to reading your comments (and making improvements that will improve the code!).

The description of methods and metadata in the manuscript is generally of good quality. Besides some technical comments, my main point is that I do not fully understand the analysis of the representativity of the GD because of the lack of a — in my point of view — sensible reference population for which the GD should be representative. I would expect that an analysis of the representativity of the GD would compare the dataset to a population is expected to be representative for. For exampe, while I think that the climate envelope and climate region analyses are sensible to give the reader an overview on climate conditions at the sampling locations, an analysis of the representativity of the GD would mean to compare the distribution of climate conditions to that of a reference population. For instance, one could perform the climate analysis using all grid points covered by peatlands according to some current peatland distribution map like PEATMAP (Xu et al. 2017, 2018) and test whether the sampling distribution is similar to the population distribution (globally or within specific strata). Similar analyses would be expected for the geochemical data. I also do not understand why we would be interested to compare the USDA-NRCS NCSS to the GD because the differences of peat to mineral soil are widely known. Finally, I think that (if I correctly understood the data compilation) the analysis displays circular reasoning when the authors argue that "the central tendencies and data ranges presented therein are in line with previously published datasets (e.g., Loisel et al. 2014)." because Loisel et al. (2014) is part of the GD.

Representativity: we see the reviewer's point. The idea of presenting the C-PEAT GD within the context of the regional climate analysis was to illustrate that the GD includes sites from most climatic regions. We do not intend to compare or statistically assess representativeness through a comparison with other products (such as predictive or inventory-based peatland maps) because they are limited in their scope and accuracy, and these maps are known to under- or over-estimate some (climatic) regions, depending on the methods employed by the authors. To alleviate the issue, we have removed the word "representativeness" throughout and replaced it with "data coverage".

Comparison with NCSS: agreed; we have removed this comparison.

Circular reasoning: agreed; this sentence was removed from the text (see detailed comments below, where it is mentioned).

I want to emphasize that I fully understand that these analyses of the reprsentativity of the GD would demand lots of work (and may have their own limitations, for example because we lack a systematic inventory of peat geochemistry independent of the data in the GD) and I do not think they must be included in the manuscript, even though they are of couse an important feature for potential users of the dataset. If this was my work, I would expand the representativity analysis of climate conditions, as described above, but drop the comparison to the USDA-NRCS NCSS.

See our previous reply. We did drop the comparison with NCSS and changed the wording around “representativeness”.

Other than that, I would like to thank the authors for providing such a useful dataset to all those interested to analyze peatland accumulation and C and N dynamics.

We are glad to be (finally) providing this resource to the community!

Specific comments

1. In the R scripts provided by Ransby, Riemann-Campe, and Sanderson (2025), one gets an error when loading "Data/dataset_IDs_by_events_2025-10-28.txt". This happens at l. 8 in 02_geochemistry_data.R and 03_cal_age_data.R. The reason is that the code that writes this file in 01_download_all.R always pastes the current date into the file name which obviously won’t be 2025-10-28.

Thank you for pointing this out! We have corrected the error in the R code and updated the reference: Ransby, D., Riemann-Campe, K., & Sanderson, N. K. (2026). C-PEAT data retrieval from PANGAEA (R & Python) (2.1). Zenodo. https://doi.org/10.5281/zenodo.20734314.

2. Just as suggestion: The R script provided by Ransby, Riemann-Campe, and Sanderson (2025) would be more useful if it would also include code to prepare the uncalibrated age data. I think this is important because usage of the data will in many cases require applying new calibration models with updated calibration curves and with the possibility to obtain the Markov Chain Monte Carlo draws for proper error propagation, for example for the computation of aCAR or tests of peatland models.

While we agree with this comment, its implementation goes beyond the scope of our paper as it pertains to the PANGAEA database / R code workflow as a whole. Such an overhaul of the code is a challenging task and in fact, the PANGAEA team is currently working on code updates that are similar to those proposed by the reviewer.

3. For what is shown in the figures in the manuscript, many of them have a poor resolution. For example, Figure 7 does not allow to clearly distinguish sampling points from each other and from regions with yellow filling.

We have re-saved all the figures to make sure they have a resolution of at least 600 dpi.

4. l. 39: “soil-c”: Typo.

Updated.

5. Figure 2: Possible language errors by the software used to create the figure are still highlighted.

Thank you! Updated.

6. l. 129: "C density (kgC/m2)." This definition seems to contrast with the definition used elsewhere in the manuscript, for example Table 2 (Density, organic carbon), Table 5.

Updated to: "At the peat-core level, the information can be used to quantify peatland carbon storage (units vary, but typically shown as g C cm^{-2}, kg C m^{-2}, or Mg C ha^{-1}).

7. l. 132: "multiple ages and C measurements along a peat profile can also be used to estimate temporal changes in aCAR (e.g., Yu et al. 2010), though this technique has methodological limits; see below (Young et al. 2019, 2021)." Actually, it is perfectly fine to compute temporal changes in aCAR in this way. The problem is not that the approach has methodological limits, but if aCAR is misinterpreted as net C balance (NCB) of the peatland — as rightly described a few sentences below in the manuscript — which is the point of Young et al. (2019) and Young et al. (2021).

Glad that we agree ☺ Since this approach has been (and is still) used in publications, we took the opportunity to spell out the issue. We updated the original text slightly to: "… multiple ages and carbon measurements along a peat profile can also be used to estimate temporal changes in aCAR (e.g., Yu et al. 2010), though aCAR should not be misinterpreted as net carbon balance (Young et al. 2019, 2021)."

8. l. 140: "Aggregating a large number of core site data for which multiple age determinations and C measurements are available can help alleviate the issue; indeed, secondary decomposition can be seen as site-specific "noise" that is subdued in a synthesis product." I think that this statement is only true if the secondary decomposition is a process random in space in time, but do we know that this is the case? If there are large-scale changes in land use, this may lead to population-level changes in NCB. But perhaps I misunderstood what the authors wanted to say.

You are correct: we did mean that secondary decomposition would be site-specific, though we do acknowledge your point re: large-scale changes in land use or hydrology could affect several sites (and it would then not be 'site-specific noise'). We softened the language as follows: "Aggregating a large number of core site data for which multiple age determinations and carbon measurements are available could alleviate the issue, if one assumes that secondary decomposition is site-specific "noise" that would be subdued in a synthesis product, though large-scale changes could affect several sites at once." We opted to keep this comment in, though it could also be completely deleted, as those discussions should be taking place in the peatland community.

9. l. 194: "international protocols and standards". Can the authors please name and cite the protocols and standards relevant for the GD and to what part of the meta(data) they apply to?

This part of the text is aimed at describing the general process that is followed by PANGAEA for their data curation. We added some examples that are useful for the C-PEAT GD: "Semantic interoperability during data curation is ensured through strict application and dynamic evolution of terminologies according to international protocols and standards, such as the Environment ontology (EnvO), the Integrated Taxonomic Information System (ITIS), and Quantities, Units, Dimensions and DataTypes Ontology (QUDT)."

10. Figure 5: The caption says that the global peatland area is shown in black, but it seems to be shown in green.

Good catch; we updated the figure caption to "green".

11. Units are not always displayed correctly in the text. For example, l. 39 has "gC/m2/yr", but this should be "gC/m /yr" or "g m yr ".

Units have been updated throughout the text.

12. Table 2, table 3, table 4: It would be good if there was a textual description that explains what each parameter means. Table 2 has a column that provides descriptions for each parameter, but these are missing for many parameters and could be more detailed for others. For example, was DEPTH, sediment/rock [m] measured from the peat surface (beneath the moss layer) or from the moss surface (or were both methods used depending on the dataset)? Table 3 does not have such a column and I do not understand, for example, what the parameter Age model represents, or how Age, error differs from Age, uncertainty. Such explanations are necessary because the individual datasets in the GD vary with respect to how values are encoded as parameters and therefore one can only combine different datasets if the parameters are unambiguously defined.

Table 2: good point about the DEPTH parameter. We added a description: "measured from the surface". We also added descriptive text for all parameters.

Table 3: we added a description column and descriptive text for all parameters.

13. Table 3: It seems that the units shown in brackets are sometimes omitted or wrong. For example, is no measurement unit, but is displayed as measurement unit of Fraction modern carbon, error. Such information are necessary because the individual datasets in the GD vary with respect to how values are encoded as parameters and therefore one can only combine different datasets if the parameters

units are unambiguously defined.

We have revised Table 3 and added any missing units. We also appreciate how the large number of 'age parameters' could be complicated to navigate. We therefore added some text to explain PANGAEA's approach to age archiving (section 2.3): "Since different authors opt for different nomenclatures and notation systems when presenting their raw dates and calibrated ages, PANGAEA uses a relatively long list of parameters aimed at maintaining the original meaning of the original data entries. For example, the parameter "AGE [ka BP]" is used to store the calibrated age for each sample along a peat core, and the data are presented in thousands of calibrated years Before Present (BP). In publications where age is instead presented in calendar years, the PANGAEA parameters "AGE [a]" and/or "AGE [a AD/CE]" are used. The same goes with archiving age uncertainties: some authors calculate their own uncertainty (PANGAEA parameter: "Age, dated, uncertainty [±]") while others opt to present one standard deviation (PANGAEA parameter: "Age, dated standard deviation [±]"). Table 3 presents the complete list of parameters (and associated short descriptions) that are used to archived the C-PEAT GD data entries." We also added a description of each parameter in Table 3 (per the previous comment from this reviewer).

14. Table 3: There seem to be some parameters in the downloaded data not listed in the table. For example, some datasets have parameters Age [a] (years ago), Age [a AD/CE] (#0 = below detection, Age, 210Pb), or Age dated [ka] (converted age).

Thanks for pointing out the omissions. We have added the missing parameters to Table 3.

15. l. 226: "These ancillary data include entries such as the main peat type. Age determination datasets provide raw age control data such as radiocarbon (14C), Lead-210 or tephra chronostratigraphy". Does the GD contain taw data on Pb or tephra chronostratigraphy data? I could not find any such raw data (e.g., for Pb total Pb activities, Ra activities or Cs activities)?

The C-PEAT GD does not contain raw Pb data. Updated to: "Age determination datasets provide raw and/or calibrated age control data from different chronological sources, such as radiocarbon (^{14}C), lead-210 (^{210}Pb), or tephra chronostratigraphy".

16. l. 229: "… including their upper and lower limits …": How are these limits defined? Are these the max/min age values of Markoc Chain Monte Carlo draws from the posterior distributions representing the age-depth models (which would be rather unstable depending on Monte Carlo errors) or some quantiles (e.g. 5% and 95%) or does the definition differ between datasets?

This segment was confusing and it was removed.

17. l. 279: "Temporal coverage of the peat cores varies over time, with the number of basal ages steadily increasing throughout the Holocene (Fig. 6a).". This sentence may be misleading. Since Fig. 6 (a) shows the cumulative number of basal ages (counted from older to younger times), it does not show that the number of basal ages steadily increases throughout the same time period. In fact, more basal records seem to be added from 12000 to 11000 yr BP than from 11000 to 10000 yr BP.

Good point. Updated as follows: "Temporal coverage of the peat cores varies over time (Fig. 6a)."

18. l. 334: "a total of 267 peat depths …". This may be a typo? There are 267 cores, but with more than one peat sample per core.

Rephrased to: "… a total of 267 peat core depths…".

19. l. 347: "Organic matter density values (OMD; n = 4016) are available for 20 sites …". Is there a distinction between "core" and "site"?

In the C-PEAT GD, each "core" is referred to an "Event" per the PANGAEA ontology. While we do have individual peatlands that harbor several cores, each "core" is represented individually. There is no direct way to differentiate by "peatland site", besides by looking at the "event" names (cores collected from a single site typically have the same first letters in their name (e.g., event: Mariana_coreMF03-1 vs. event: Mariana_coreMF03-2)) and through the use of site coordinates. We have updated the text to avoid any confusion about the terminology; we replaced the word "site" with either "core" or "event" (depending on which is most relevant to the context of each section of the document). We have also some text to clarify this detail (see section 2.3).

20. l. 351: "… C content based on OM measurements, …" Could the authors please explain how C% was estimated based on OM content?

We added the following text: "While C% refers to estimated carbon content based on organic matter measurements (authors often multiply their OM% by 50% to estimate C%; GD data users are prompted to refer to the original publications to know more about the conversion factors that were used), reports of TC (total carbon) and TOC (total organic carbon) data refer to values that were measured directly, typically through elemental analysis."

21. l. 356: "Total carbon content (TC%) values range from 0.0 to 100%, …" How is a TC% of 100% possible for peat?

A TC% of 100% is not possible for peat. As explained in the text (a few lines later): "We acknowledge that a few individual data points are above the expected data ranges (e.g.,

%C > 60%); we did not exclude said data points from the database. Data users can easily filter outliers as they see fit." As data curators, we made the decision to leave the data as provided by the original data contributors or as collected in the literature.

22. l. 366: "Overall, the central tendencies and data ranges presented therein are in line with previously published datasets (e.g., Loisel et al. 2014)." Is this worth mentioning? If I understand correctly, Loisel et al. (2014) is part of the GD?

This sentence was removed.

23. Figure 8: The caption mentions "IQT". Could you please provide the unabbreviated term and define what it means?

Updated. First off, the abbreviation should have been IQR (we fixed the typo, twice). And we added its meaning (interquartile range).

24. Figure 9: What do the shaded regions represent?

As both reviewers suggested to remove the comparison between the C-PEAT GD and the NCSS mineral soil database, we have done so. This comment is no longer relevant.

25. Figure 9: The x axis title, axis labels or unit seems to be wrong because they suggest a mean soil organic carbon density of ca. 1.05 g cm for peat while Table 5 suggests that the mean organic carbon density is ca. 0.06 g cm .

This comment is no longer relevant.

26. Table 6: Some of the parameters are listed without units (e.g., Bulk density (oven dry)). If you decide to keep this table, could you please add units for all parameters?

This comment is no longer relevant.

References

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Young, Dylan M., Andy J. Baird, Angela V. Gallego-Sala, and Julie Loisel. 2021. "A Cautionary Tale about Using the Apparent Carbon Accumulation Rate (aCAR) Obtained from Peat Cores." Scientific Reports 11 (1): 9547. https://doi.org/10.1038/s41598-021-88766-8.

Reviewer #2

The paper presents the C-PEAT Global Peatland Carbon Database v.2025, with 267 peat cores and large numbers of depth measurements, including dry bulk density, organic matter, carbon, nitrogen, raw chronological data, and calibrated ages.

Few comments

-The title says "Global Peatland Carbon Database", which is fine but the dataset is heavily dominated by northern extratropical sites. This is a major limitation because tropical peatlands differ strongly in peat formation, hydrology,etc. The paper does clearly discuss this

> Thank you. As you said, we do discuss the low representation of tropical datasets in the database and look forward to adding tropical sites to C-PEAT! For now, the compilation only includes 4 previously published databases, and only one of those 4 includes tropical sites (Gallego-Sala et al. 2018); that 2018 dataset only included cores with at least 2 radiocarbon dates from the past 1000 years and contiguous bulk density measurements at <2 cm resolution (see Table 1 in the main text), which limited the number of cores that were integrated.

Whether there is a possibility for future improvements for e.g. many data are now collected in the ttropics eg, Anshari, Gusti Z., et al. "Peatland inception and development across Kalimantan, Indonesia." Scientific Reports (2026).

Absolutely! We envision improving the database by adding numerous cores from the tropical biome (and beyond), including the excellent work presented in Anshari et al. 2026 and many others. But as mentioned above, this current database simply aimed at making available the raw data from 4 existing compilations (Yu et al., 2010; Charman et al., 2013; Loisel et al., 2014; Gallego-Sala et al., 2018).

At the end of the manuscript (section 4.1), we specified that: "Data contributors interested in sharing one or a handful of datasets are asked to follow the instructions and use the templates provided by PANGAEA (https://wiki.pangaea.de/wiki/Best_practice_manuals_and_templates). Contributors who wish to share a larger quantity of datasets (> 10) should contact a PANGAEA editor through the contact form linked above."

-The manuscript says PANGAEA performed quality control, but it does not fully explain what was checked, what was corrected, and what remains uncertain.

We added the following text to address this comment: "Quality control of data and metadata is part of PANGAEA's harmonization workflow, which ensures FAIRness (findability, accessibility, interoperability and reusability) of all data by checking for completeness, correctness, and machine readability. As the curator, PANGAEA does not check the completeness, accuracy, and legality of the research contents."

For example, Table 5 reports unrealistic values of max : dry bulk density values up to 3.380 g cm^{-3}, total carbon up to 100%, and nitrogen at 56.6%.

Thank you for pointing this out. We are aware that some unrealistic values are present in the dataset, but those data were entered as such by the data contributors or in the original papers, and we have decided to refrain from manipulating, deleting, or correcting said data. The rationale is that we act as curators of the original data; we do not apply filters or pick which data to keep vs. reject. It is ultimately the responsibility of the data user to select the data they wish to work with. There is already a statement addressing this issue in the main text.

- Table 6. The peat versus mineral soil comparison is interesting, but it is distracting. The comparison needs more caution because NCSS is not a globally representative mineral-soil dataset in the same way that C-PEAT is not globally representative of peatlands. Also, the NCSS table includes impossible or problematic values such as negative SOC and coarse fraction up to 4229%.

Thank you for pointing this out. We originally presented the comparison between mineral and peat soils as a means to expand the discussion on the need for a peat (i.e., organic-rich soil) database, as most of the soil-data available come from mineral soils. Since both reviewers find this analysis distracting, we have decided to retract it from the final publication.

- The manuscript compares C-PEAT with the NCSS pedon database and reports that "On average, soil organic carbon content for the top 100 cm was 16 times greater in peat soils 17.53 g cm^{-2} than in mineral soils 1.08 g cm^{-2}." This seems to be erroneous SOC stock=bulk density×C fraction×depth. For the top 100 cm: 0.140×0.467×100=6.54 g C /cm2. Alternatively, using their reported mean organic C density: 0.058×100=5.8 g C /cm2. So the cited value does not make sense.

Thanks for pointing this out. This section has been retracted (see comment above).

-"C-PEAT GD contains 267 cores", explain whether duplicate cores across previous syntheses were reconciled and how.

Duplicate cores across the 4 synthesis papers were reconciled to avoid duplicate cores in the database. When the datasets were exact replicates, cores from the most recent synthesis were selected (e.g., we would opt for Charman et al. 2013 rather than Yu et al. 2010). This selection allowed to integrate the most updated values into the C-PEAT database, should the core data were updated by a data contributor over time. We have added this text to the revised document.

"carbon content values (total carbon and carbon combined)" Better "C%, TC%, and TOC% records combined."

Updated as suggested.

-The paper includes age determination and calibrated age parameters, but the treatment of chronological uncertainty is still descriptive. The number of chronological constraints varies from 1 to 41 per core, with a median of 6, and the average is only 0.76 dates per 1000 years. That means carbon accumulation rates can be highly uncertain

The treatment of chronological uncertainty is beyond the scope of the work presented in this study. Age determinations are completely dependent upon the data contributions from the original papers and datasets. In the C-PEAT database, raw chronological constraints (i.e, uncalibrated data) are provided, so data users can calibrate them following their own methodological preferences. We also provide the calibrated ages that were presented in the original datasets. This information is already presented in the main text (section 2.3).

-For a data paper, the question is: How should users use this database correctly? The paper has usage notes, but they are too general.

In the 'usage notes' section, we explain how to access, download, and cite the database. We also provide words of caution that pertain to the datasets themselves (e.g., some peat core profiles are incomplete or may unrepresentative, etc.), such that each data user should be thoughtful when they select and download datasets. We also recommend that data users refer to the original articles (where the data were originally presented) to better understand data collection context.

The database is useful for summarising peat properties, analysing Holocene apparent carbon accumulation rates, and benchmarking Earth system models, and global mapping of peat properties. See also recent peat data and mapping effort that the C-peat can contribute to Skye et al. "Peat-DBase v. 1: a compiled database of global peat depth measurements." Earth System Science Data Discussions 2025 (2025): 1-26. Widyastuti et al. "Digital mapping of peat thickness and carbon stock of global peatlands." Catena 258 (2025): 109243.

Thank you for pointing out those other studies. While they cannot be integrated into our database because they do not provide high-resolution data on peat properties or chronologies, we did add those references to the main text (see the last sentence of section 1).

The writing is generally clear but somewhat sloppy in presentation, mainly because of inconsistent terminology, awkward phrasing, formatting errors.

Thanks for pointing out those irregularities. We have updated them all and re-read the manuscript several times to improve terminology and formatting.

Some examples:

L.39 "peat soil-c density" -> "peat soil C density" or "peat-soil C density"

Updated to "peat soil carbon density".

L.63–64 "The need for transparency in methods, code, and data have also been fueling..." -> "The need for transparency in methods, code, and data has.."

Done.

L.79 "provides means to assess" -> "a means to assess"

Done.

L.97 "with the latter also acknowledging..." -> "Fig. 2 also acknowledges..."

Done.

L.128 "peatland C storage (kgC)" -> "peatland C storage (kg C)"

Done.

L.129 "C density (kgC/m2)" -> "C density (kg C m^{-2})"

Done (here and elsewhere in the text).

L.131 "gC/m2/yr" -> "g C m^{-2} yr^{-1}"

Done (here and elsewhere in the text).

L.143 "the use of these datasets come with important limitations" -> "the use of these datasets comes with important limitations"

Done.

L.212 "4 thesis, dissertations, and conference papers" -> "4 theses "

Done.

L.233 "labs where the analysis were performed" -> "laboratories where the analyses were performed"

Done.

L.252,259, 310 "representativity" -> "representativeness"

Replaced by “data coverage” (per reviewer 1’s comment on the meaning of representativeness).

L.260 "MAT and MAP was extracted" -> "MAT and MAP were extracted"

Done.

L.268 "we also contrast changes" -> "we also contrasted changes"

Done.

L.315–320 "KoppenGeiger" / "Koppen climate classes" -> "Köppen–Geiger" / "Köppen climate classes"

Done.

L.344 "g/cm3" -> "g cm^{-3}"

Done (here and elsewhere in the text).

L.367 "may be used as references" -> "may be used as reference values"

Done.

L.403–405 "IQT" -> "IQR"

Done.

L.405 "1.5 x IQT" -> "1.5 × IQR"

Done.

L.431 "Soil Organic Carbon" -> "soil organic carbon"

Done.

L.455 "some of them may not have reached" -> "some cores may not have reached"

Done.

L.456 "Along those lines" -> "Similarly" or "In addition"

Updated to “Similarly”.

L.459 "collected near the edge" -> "collected near basin margins"

Done.