C-PEAT's Global Peatland Carbon Database (v.2025)

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Abstract. Field-based measurements are foundational to the study of short- and long-term peatland carbon dynamics. For decades, the scientific community has amassed hundreds of valuable empirical datasets in the form of peat core records from around the world. Those records typically include peat depth, basal age, peat organic matter content, peat dry bulk density, peat organic density, and/or carbon and nitrogen content. Once combined with chronological constraints and models, peat core time series can be used to estimate changes in peat-carbon accumulation rates through time. Consolidating these peat records can help improve global peat-carbon stock estimates and quantifications of past, present, and future greenhouse gas exchanges between peatlands and the atmosphere. Large-scale synthesis can also shed light on the sensitivity of peat-carbon accumulation processes to climate change and provide context for current and future global environmental change. We can also use spatial and temporal peat data to inform, validate, and benchmark existing models that include peatland representations. This paper presents the first formal version of PAGES' C-PEAT Global Peatland Carbon Database (GD), which is available for download in the PANGAEA and International Soil Carbon Network (ISCN) data repositories. The C-PEAT GD contains 267 independently catalogued peat cores and a large number of observations from those cores, including: peat depths, organic matter content values, dry bulk density values, organic density values, as well as carbon and nitrogen content values. Raw and calibrated chronological data are included for each individual dataset when available. The metadata fields are easily searchable and interoperable, as per PANGAEA's standards. The main objective of this article is to describe the structure and content of the database, itself aimed at increasing the use, assimilation, and interoperability of peat-core data across disciplines. The C-PEAT GD can be accessed at the PANGAEA data repository (https://doi.org/10.1594/PANGAEA.986891; Loisel et al., 2025).

1 Introduction

Peatlands have stored a vast quantity of carbon (C) in their thick organic soils over the past ~10,000 years (Gorham 1991; Yu et al. 2010). The effect of this long-term carbon~~C~~ sink on the global climate system has been that of a net cooling (Smith et al. 2004; Frolking et al. 2006; Yu 2012), despite large methane (CH_4) emissions to the atmosphere (Spahni et al. 2013; Packalen et al. 2014; Treat et al. 2021). While peatlands only occupy 3% of the global land area, their current carbon~~C~~ store has been estimated at ~ 500-1000 gigatonnes (Gt) (Yu 2012; Nichols & Peteet 2019), with an apparent long-term averaged carbon~~C~~ accumulation rate (aCAR) of 23 g C ~~/~~m^{-2} ~~/~~yr^{-1} (Loisel et al. 2014). We note that peat soil carbon ~~c~~ density and aCAR are known to vary over space and time, as they depend on a number of internal factors that include local vegetation communities, hydrological setting, and topography, as well as a suite of external factors such as air temperature, moisture regime, and climate seasonality (Jones & Yu 2010; Charman et al. 2013; Cobb et al. 2017; Hoyt et al. 2019). Other key agents capable of altering a peatland's carbon~~C~~ store include wildfire, permafrost dynamics, sea-level change, atmospheric pollution and dust deposition, and anthropogenic land-use change (Dommain et al. 2011; Gibson et al. 2018; Hooijer et al. 2012; Hoyt et al. 2020; Turetksy et al. 2020).

Over the past ~ 35 years, the literature has become rich with empirical- and model-based studies aimed at quantifying peatland carbon~~C~~ storage from around the world as well as their past, present, and future CARs (Fig. 1a). While the majority of these studies have focused on northern high-latitude peatlands (> 45° N; Gorham 1991; Turunen et al. 2002; Yu 2012), there has been an increase in the number of studies based in the temperate, tropical, and southern high-latitude regions (Kurnianto et al. 2015; Kock et al. 2020; Ruwaimana et al. 2020), as well as global assessments (Gallego-Sala et al. 2018; Qiu et al. 2020; Loisel et al. 2021; Müller & Joos 2021). In particular, studies of tropical peatlands have been on the rise since 2010 (Fig. 1b).

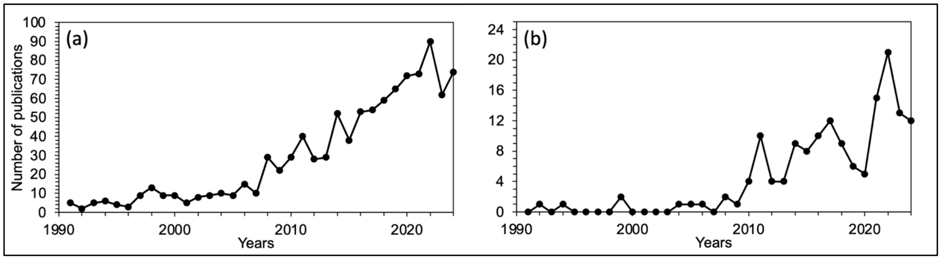

Figure 1. Number of peer-reviewed publications that relate to peat carbon, per year (1991-2024), according to Web of Science. **(a)** Global peatlands (search terms: peat* AND carbon AND (stock* OR stor*) AND rate*). **(b)** Tropical peatlands (search terms: peat* AND carbon AND (stock* OR stor*) AND rate* AND tropic*).

The 2010s have also brought along many large-scale peat-data compilations (Fig. 2), perhaps in part thanks to the broad goals of increasing scientific availability/reproducibility (Ellison 2010; Bond-Lamberty et al. 2016). The need for transparency in methods, code, and data has~~ve~~ also been fueling an increase in collaborative, open science (Adams 2012; Wolkovitch et al. 2012), which helps fulfill a growing need for integrated knowledge and actionable science, in addition to bringing an additional element of trust to the body of science (Grand et al. 2012). In particular, synthesis work has been contributing to initiating new collaborations and building working groups across the scientific community (Baron et al. 2017). In the case of ecological data, syntheses and meta-analyses increase visibility of, and accessibility to, individual case studies (Markowitz et al. 2015). These efforts may help the safeguarding, rescuing, and disseminating of ecological data that would otherwise be lost or remain inaccessible, particularly if unpublished (Dietze et al. 2014; Vines et al. 2014; Harden et al. 2017). Indeed, access to raw ecological data is generally thought to range between 1 and 10% (Reichman et al. 2011; Wolkovitch et al. 2012), making data curation, data accessibility, and data compatibility essential parts of a scientist's work today. This is particularly the case for field ecological observations and measurements that cannot be reproduced in a context of climate change (Wolkovitch et al. 2012).

It has been argued that *synthesis work* provides critical knowledge to solving environmental problems and informing policy (Carpenter 2009; Hampton & Parker 2011; Dicks et al. 2014). By integrating multiple lines of evidence, the power of synthesis work lies in its ability to develop new knowledge that broadens perspectives. The synthesis of existing research provides a means to assess individual case studies and explore generalities among datasets; it limits emphasis on specificities and instead focuses on distilling information to improve scientific understanding. In the case of peat core data, the combination of hundreds of peat records can help improve global peat-carbon stock estimates and quantifications of past, present, and future greenhouse gas exchanges between peatlands and the atmosphere (e.g., MacDonald et al. 2006; Yu 2012; Yu et al. 2013). Large-scale synthesis can also shed light on the sensitivity of peat-carbon~~C~~ accumulation processes to climate change (e.g., Charman et al. 2013; Loisel et al. 2014; Treat et al. 2019) and provide context for current and future global environmental change (e.g., Gallego-Sala et al. 2018; Hugelius et al. 2020; Qiu et al. 2020). We can also use spatial and temporal peat data to inform, validate, and benchmark existing Earth System Models that include peatland representations (Kleinen et al. 2012; Spahni et al. 2013; Qiu et al. 2018; Alexandrov et al. 2020; Chaudhary et al. 2020; Müller & Joos 2021a, 2021b; Chadburn et al. 2022).

Here we present the first formal version of PAGES' C-PEAT Global Peatland Carbon Database (GD), which is now available for download on the PANGAEA data repository. The C-PEAT GD contains 267 previously published independent peat cores and a large number of observations from those cores: 267 peat core depths, 43,467 peat dry bulk density values, 31,473 peat organic matter content values, 4,016 peat organic matter density values, 42,566 carbon content values, and 10,771 nitrogen content values. The main objective of this article is to describe the structure and content of the database, itself aimed at increasing the use, assimilation, and interoperability of peat-core data across disciplines. The database is made of four synthesis papers that were published as part of international community efforts deployed by the C-PEAT working group over the past decade. Those four synthesis papers are introduced below.~~, and in~~ Fig. 2 ~~, with the latter~~ also acknowledges~~ing~~ a number of additional synthesis papers on long-term peatland dynamics and carbon~~C~~ stock. C-PEAT is a group of over 35~~0~~0 scientists dedicated to synthesizing data and knowledge on the evolution of peatlands through Earth's recent history via collaborations between international researchers. C-PEAT operates under the umbrella of the parent organizations Past Global Changes (PAGES) and Future Earth, and has received further support from the International Union of Quaternary Research (INQUA) and UNESCO's International Geoscience Programme (IGCP) to organize community workshops and training sessions.

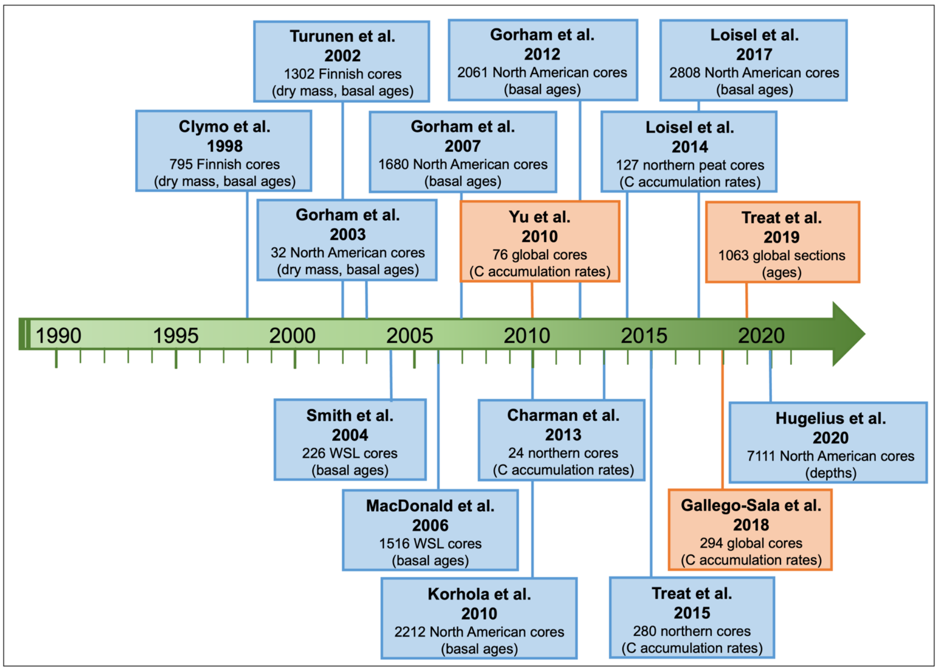

Figure 2. Timeline of some key synthesis papers on peatland carbon. Blue: northern hemisphere; Orange: global.

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Yu et al. (2010) compiled carbon~~C~~ accumulation records from 76 sites, which were used to reconstruct changes in the peat-carbon~~C~~ pool since the Last Glacial Maximum for the northern, tropical, and southern peatland regions. *Charman et al. (2013)* then focused on 24 well-dated peat profiles from the northern high-latitude regions to examine changes in C accumulation over the past millennium. *Loisel et al. (2014)* augmented the *Yu et al.*'s northern dataset by using peat core data from over 200 sites to report Holocene peat properties (i.e., bulk density, organic matter, carbon~~C~~, and nitrogen (N) content) and aCARs for 127 of those sites. *Gallego-Sala et al. (2018)* further extended the last millennium work from *Charman et al. (2013)* by combining over 250 millennium-aged peat-core records from around the globe with a modeling approach to quantify the future global peatland carbon sink function. We note that the C-PEAT group has worked on other peatland databases worth mentioning here. For instance, *Treat et al. (2015)* looked at peatland plant macrofossil records from 280 sites across the northern permafrost zone and reported differences in peat properties as well as aCARs among the different vegetation types and environmental classes. *Yu et al. (2013)* and *Loisel et al. (2017)* combined 2808 basal peat ages from previously published papers to reconstruct spatial and temporal patterns of Holocene peatland area change. Lastly, *Treat et al. (2019*) used over 1000 stratigraphic records of buried peatlands from around the world to reconstruct peatforming wetland dynamics over the past 130,000 years. The datasets from those last few papers are also available on PANGAEA, but the peat cores have not yet been cataloged individually. Recently, the compilations by Widyastuti et al. (2025) and Skye et al. (2026) have also contributed global peat depth datasets.

2. Methods

2.1. Definitions and potential uses for the C-PEAT GD

The C-PEAT GD includes high-resolution peat-core geochemical and chronological data that can be used to calculate a number of soil carbon~~C~~ indices (Fig. 3). At the peat-core level, the information can be used to quantify peatland carbon~~C~~ storage (units vary, but typically shown as g C cm^{-2}, kg C m^{-2}, or Mg C ha^{-1})~~) and *C density* (kgC/m^2). These two indices are commonly used to estimate C stocks across biomes and the terrestrial biosphere~~ (e.g., Armentano & Menges 1986; Gorham 1991; Petrokofsky et al. 2012). *Apparent ~~C~~carbon accumulation rates* (aCAR; g C ~~/~~m^{-2} ~~/~~yr^{-1}) can be obtained by dividing a core's carbon~~C~~ density by the basal age of that core (Tolonen & Turunen 1996); multiple ages and carbon~~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~~aCAR should not be misinterpreted as net carbon balance (Young et al. 2019, 2021). In previous synthesis work, aCAR was calculated for each peat layer (Fig. 3); the layer data were then combined into bins (e.g., 50, 100, 500, 1000 years) to provide time-weighted aCAR (Yu et al. 2010; Jones & Yu 2011; Loisel et al. 2014; Fig. 3). The latter makes it easier to compare apparent accumulation rates across sites and build regional assessments. It is important to note that aCAR is an imperfect measure of past accumulation rates because peatlands may be subject to secondary peat loss - from fire, erosion, a lasting drought, or management - that takes place long after initial peat deposition and early-stage diagenesis (Yu 2012; Frolking et al 2014; Young et al. 2019, 2021). Thus, a fundamental problem with aCAR is that it cannot rule out whether secondary peat loss has taken place. Aggregating a large number of core site data for which multiple age determinations and carbon~~C~~ measurements are available ~~can help~~could alleviate the issue, if one assumes that~~; indeed~~, secondary decomposition ~~can be seen as~~is site-specific "noise" that would be~~is~~ subdued in a synthesis product, though large-scale changes could affect several sites at once. *Recent aCAR* calculations (past ~150 years; Figure 3) are technically possible using our database. But here again, the use of these datasets comes with important limitations. For instance, we emphasize that near-surface records tend to represent incompletely decomposed, young peat, such that recent aCAR should not be directly compared against longer-term aCAR (Piilo et al. 2019; Young et al. 2019). In fact, the past ~150 years of peat accumulation are often omitted from synthesis work (e.g., Charman et al. 2013; Gallego-Sala et al. 2018). Lastly, it should be mentioned that the C-PEAT GD database also includes nitrogen~~N~~ content; nitrogen~~N~~ stock, soil nitrogen~~N~~ density, and aNAR can thus be calculated.

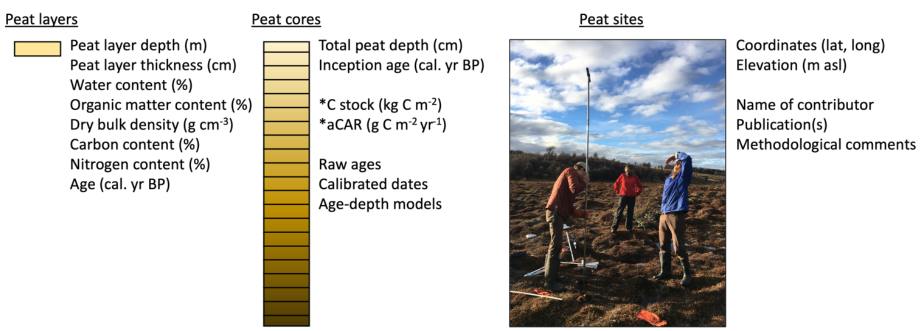

Figure 3. Datasets available from the C-PEAT Global Peatland Carbon Database. The * denotes soil carbon indices that can be derived from the database. For additional details, refer to Tables 2-3-4. Photo credit: Julie Loisel.

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2.2. Peat carbon database architecture

Here we present the first version (coined v.2025) of the C-PEAT GD. The following paragraphs provide the general database structure. We start with a brief introduction of the collaborative process that gave birth to the database. We then describe data aggregation and formatting, list the types of data/metadata that are available, and we finish by presenting data selection criteria as well as data coverage. The C-PEAT GD can be accessed via PANGAEA at: https://www.pangaea.de/?q=project:label:PAGES_C-PEAT. The latter landing page contains links to download individual records; the entire database can also be mass-downloaded using R or Python (Ransby et al. ~~2025~~2026). Metadata and data can be obtained from the PANGAEA repository with scripts using the 'pangaear' R package (Chamberlain et al. 2021) and the 'pangaeapy' Python library (Huber et al. 2025). More information on submission of new or revised datasets can be found in sect. 4.1.

This database is the product of approximately 10 years of collaborative work by the C-PEAT working group, which is endorsed by PAGES. This synthesis effort focuses on peatland-C records; it is a contribution to C-PEAT's second developmental phase and fulfills the objective of making the community's peat-C data widely available (Loisel & Gallego-Sala 2018). The C-PEAT GD is the culmination of multiple synthesis efforts that have taken place over the past decade (see section 1 and Fig. 2). For each one of these previous studies, calls for participation were widely distributed. Data inclusion criteria differed between papers to match their different scopes; in each case, decisions were made by a group of lead authors in consultation with the data contributors (Table 1). The workload for assembling the data and metadata that make up C-PEAT's GD was coordinated at Texas A&M University. All data from the four compilation papers are included in the C-PEAT GD.

Table 1. Criteria for inclusion used by the four peat-data synthesis articles that form the C-PEAT Global Peatland Carbon Database (v.2025).

References	Chronological constraints	Geochemical constraints	Geographic constraints
Yu et al. 2010	multiple calibrated ages	some bulk density measurements	none
Charman et al. 2013	at least 3 evenly spaced dates spanning the last 1000 years	contiguous bulk density measurements at <5 cm resolution	latitude: >45N
Loisel et al. 2014	at least 1 date per thousand years (on average for the entire record)	some bulk density or organic matter density measurements	latitude: >45N
Gallego-Sala et al. 2018	at least 2 radiocarbon dates from the past 1000 years	contiguous bulk density measurements at <2 cm resolution	none

2.3. Data aggregation, formatting, and availability in PANGAEA

As a data publisher for Earth & Environmental Sciences, PANGAEA (Felden et al. 2023) has an almost 40-year history as an open-access library for archiving, publishing, and disseminating georeferenced data from the Earth, environmental, and biodiversity sciences. Originally evolving from a database for sediment cores, it is operated as a joint facility of the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, and the Center for Marine Environmental Sciences at the University of Bremen. PANGAEA has been certified with the Core Trust Seal since 2019. Each published dataset can be cited with a specific data citation and an associated unique Digital Object Identifier (DOI) to cross-link to related resources such as manuscripts and data. A broad spectrum of contextual information (‘metadata’) describing the where, how, when, and why of a measurement is given. Additionally, the methods and devices used for sampling and analysis as well as references of related literature and external resources are provided. All data and metadata are compiled in close collaboration between the scientists and trained field experts acting as data editors. Both data and metadata are checked for completeness and plausibility, ensuring high quality standards according to the FAIR data principles. Semantic interoperability during data curation is ensured through strict application and dynamic evolution of terminologies according to international protocols and standards, such as Environment ontology (EnvO), the Integrated Taxonomic Information System (ITIS), and Quantities, Units, Dimensions and DataTypes Ontology (QUDT). This harmonization and standardization promote not only readability and further processability by machines, but also a high degree of reusability of the data stock. In addition to the classic access to data via the website, an integrative use of data in the form of a DataWarehouse and a set of tools for programmatic data processing are available for this purpose. The two applications, ‘pangaeapy’ (Huber et al. 2025) and ‘pangaear’ (Chamberlain et al. 2021), respectively, are written for the scripting languages Python and R, and make use of the well-developed interoperability framework of PANGAEA.

Each peat core record that is a part of our GD was either directly contributed by the original data owner or obtained from the published literature by the different synthesis author teams (Fig. 4). In most cases, records that were identified in the literature were then obtained from the corresponding author via email. In a few cases, datasets were digitized from publication tables, appendices, and supplementary materials. The synthesis team leads provided templates to the data contributors to facilitate aggregation. In the case of data acquired from publications, the synthesis teams entered the data into the templates themselves. At this stage, data quality was manually assessed by said teams (Table 1). The data were then compiled and used for analysis. During the second stage ~~–~~(i.e., in preparation for the C-PEAT GD), ~~–~~ the data and metadata were reviewed and formatted to harmonize and standardize them with the PANGAEA database. To date, PANGAEA hosts 758 C-PEAT datasets obtained from 267 distinct cores (267 geochemistry datasets, 264 age determination datasets, and 227 calibrated ages datasets). These datasets were authored by 81 individuals (or groups of individuals). The datasets refer to 84 journal articles as well as 4 thes~~e~~is, dissertations, and conference papers. Each dataset is associated with an “Event”, which is a metadata descriptor used by PANGAEA for characterizing the location ~~site / station~~ where a physical sample or measurement took place. For the C-PEAT database, “Event” is a synonym for a “peat core”. While the database contains 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). Mandatory metadata for each Event comprises a unique “Label” as well as “Latitude” and “Longitude” information (in decimal degrees). Further optional metadata include an additional / alternative core Label, Sampling method, Elevation (meters above sea level) and a Comment (free text) (Fig. 4). Duplicate cores across the 4 synthesis papers were reconciled to avoid duplications in the database. Cores from the most recent synthesis were selected over data from the same core site that were previously published (e.g., we would include a core presented by Charman et al. (2013) and leave its older duplicate from Yu et al. (2010)). This selection allowed to integrate the most updated values into the C-PEAT database, should the core data were updated over time.

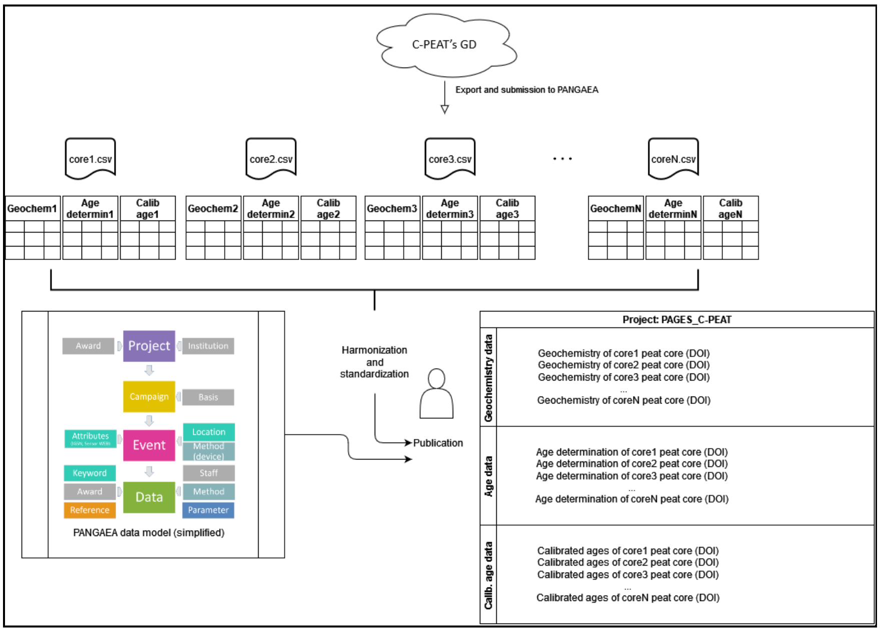

Figure 4. Workflow to integrate C-PEAT data into PANGAEA. Each peat core (called an Event in PANGAEA) is linked to Location and Methods metadata. Each peat layer includes geochemical data, raw age determinations, and calibrated ages (referred to as Data in PANGAEA). Three~~3~~ datasets per core are created, each with a distinct DOI. Those data are linked to Methods and References from the original publication (if published).

The geochemistry datasets contain the key peat geochemical properties along with the ancillary data that may complement, or help interpret, the data (Table 2). These ancillary data include entries such as the main peat type. Age determination datasets provide raw and/or calibrated age control data from different chronological sources, such as radiocarbon (^{14}C), ~~L~~lead-210 (^{210}Pb), or tephra chronostratigraphy, together with information on the type of dated material (bulk, wood, pollen etc.) (Table 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 parameters "AGE [ka BP]" and "Age model [ka]" are 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]", "AGE [a, AD/CE]", or "AGE [a, years ago]" are used. The same goes with archiving age uncertainties: some authors calculate their own uncertainty range (PANGAEA parameter: "Age, dated, uncertainty [±]") while others opt to present one standard deviation (PANGAEA parameter: "Age, dated standard deviation [±]"). Age uncertainties can also be presented in ka or in years, and different parameters are used accordingly. Table 3 presents the complete list of parameters (and associated short descriptions) that are used to archived the C-PEAT GD data entries pertaining to dates and ages. Age-depth relationships of individual peat cores~~, including their upper and lower limits,~~ are presented in the calibrated ages datasets (Table 4). Note that ~~T~~these ages were obtained from the original publications ~~published papers~~ and are thus based on different age-depth modeling techniques and calibration curves.

Geochemical metadata were obtained from the contributing authors (or extracted from the peer-reviewed articles) and they relate to study core site and author information, as well as analytical and sampling methods (Table 2). Chronological metadata relate to the different types of dating methods, laboratories where the analysis were performed, and they also include additional sampling information (when available from the original articles) (Table 3).

Table 2. Geochemical parameters included in the C-PEAT Global Peatland Carbon Database, ~~and~~ with associated descriptions and metadata.

Parameter [unit]	**Description**	**Parameter short name**
DEPTH, sediment/rock [m]	~~S~~sample midpoint depth, measured from the surface	Depth sed
AGE [ka BP]	calibrated age (in thousands of years Before Present, based on the original age-depth curve)	Age
Sample thickness [cm]	distance (cm) between top and bottom of a sample	Samp thick
Sample volume [cm^3]	amount of material	Samp vol
Water content, wet mass [%]	weight-%	Water wm
Peat type []	category	Peat type
Sedimentation rate per year [cm/a]	~~-~~amount of peat accumulated per year	SR
Peat carbon accumulation rate per year [g/m^2/a]	weight (g) of carbon accumulated per unit of surface area (m^2) per year	PCAR
Organic matter [%] *	weight-%	OM
Carbon [%]	~~converted/~~calculated from other data such as LOI	C
Carbon, inorganic, total [%]	weight-%	TIC
Carbon, organic, total [%]	weight-%	TOC
Carbon, total [%]	weight-%	TC
Comment []	free text	Comment
Cumulative mass [g/cm^2]	total accumulated peat dry mass up to the sample's depth, where CM = 0 is the deepest sample of the core and CM = max at the surface of the core	Cum mass
Density, dry bulk [g/cm^3]	ratio of dry mass to peat bulk volume	DBD

Density, organic carbon [g/cm^3]	ratio of organic carbon to peat bulk volume -	Corg dens
Density, organic matter [g/cm^3]	ratio of organic matter to peat bulk volume -	OM dens
Nitrogen, total [%]	weight-%	TN

* In some datasets, the parameter is named Loss on ignition [%] ~~-~~– both were merged for the synthesis.

Table 3. Age determination parameters included in the C-PEAT Global Peatland Carbon Database, ~~and~~ with associated descriptions and metadata. Descriptions that pertain to "original age-depth curve or publications" mean that the data that we report in our database were directly extracted from the original datasets and may have been calibrated a long time ago. The user is advised to use the uncalibrated datasets and run their own calibrations.

Parameter [unit]	**Description**	**Parameter short name**
DEPTH, sediment/rock [m]*	sample midpoint depth, measured from the surface	Depth sed
Depth, top/min [m]	sample top depth, measured from the surface	Depth top
Depth, bottom/max [m]	sample bottom depth, measured from the surface	Depth bot
Sample code/label []	sample name	Sample label
Sample thickness [cm]	distance (cm) between top and bottom of a sample	Samp thick
Laboratory code/label []	sample code (provided by a dating laboratory)	Lab label
Method comment []	comment on dating method	Method comm
Fraction modern carbon []	radiocarbon concentration as fraction modern carbon (FMC)	F14C

Fraction modern carbon, error [±]	laboratory error associated with fraction modern carbon (FMC)	F14C e
Δ14C [‰]	radiocarbon concentration	Δ14C
Δ14C, standard deviation [±]	laboratory error associated with Δ14C	Δ14C std dev
Activity of radiocarbon in percent of modern carbon [pMC]	percent of modern carbon in a sample	Activity
Activity of radiocarbon in percent of modern carbon, standard deviation [±]	laboratory error associated with percent modern carbon in a sample	Activity std dev
Age, dated [ka]	14C uncalibrated age (in thousands of years Before Present, based on the original age-depth curve)	Age dated
Age, dated, uncertainty [±]	age uncertainty (in ka) as reported in the original publication	Age dated unc
Age, dated standard deviation [±]	age uncertainty if reported as 1 standard deviation in the original publication	Age dated std dev
Age, dated material []**	type of material dated (e.g., leaf, bulk sediment, charcoal, etc.)	Dated material
Age, comment []	free text	Comm
Age model [ka]	calibrated age (in thousands of years Before Present, based on the original age-depth curve)	Age model
Age, error [±]	age error as reported in the original publication	Age e

Age [a]	calibrated age (in calendar years, based on the original age-depth curve)	Age
Age, uncertainty [±]	age uncertainty (in calendar years) as reported in the original publication	Age unc
Age, standard deviation [±]	age uncertainty if reported as 1 standard deviation in the original publication	Age std dev
Age [a AD/CE]	calibrated age (in calendar years Common Era, based on the original age-depth curve)	Age
Age, maximum/old [a AD/CE]	oldest calibrated age (in calendar years Common Era, based on the original age-depth curve)	Age max
Age, minimum/young [a AD/CE]	youngest calibrated age (in calendar years Common Era, based on the original age-depth curve)	Age min
Age, relative number of years [a]	relative age, number of years relative to the surface sample (based on the original age-depth curve)	Age
Calendar age [ka BP]	14C age or 210Pb calibrated age (in thousands of calendar years, based on the original age-depth curve)	Cal age
Calendar age, standard deviation [±]	age uncertainty (in thousands of calendar years) as reported in the original publication	Cal age std dev

Comment []	free text	Comment

~~*sample midpoint depth **type of material dated (e.g., bulk, pollen, charcoal, etc.)~~

Table 4. Calibrated age parameters included in the C-PEAT Global Peatland Carbon Database, ~~and~~ with associated descriptions and metadata.

Parameter [unit]	Parameter short name	Description
DEPTH, sediment/rock [m]	Depth sed	Sample midpoint depth
Calendar age [ka BP]	Cal age	Contains a method comment (e.g., OxCal, Bacon)
Calendar age, maximum/old [ka BP]	Cal age max	Contains a method comment (e.g., OxCal, Bacon)
Calendar age, minimum/young [ka BP]	Cal age min	Contains a method comment (e.g., OxCal, Bacon)

2.4. Data coverage, resolution, duration, and chronological constraints

Data coverage ~~and representativity~~ of the database ~~are~~ is dependent upon data availability, which is mostly out of the control of the data analysts. In the case of the C-PEAT GD, all available records that fulfilled our criteria for inclusion (Table 1) were accepted. As for the resolution and duration of the peat records included in the C-PEAT GD, they vary greatly. For example, the minimal geochemical data resolution was set at every 2 cm by Gallego-Sala et al. (2018) whereas it was set at 5 cm by Charman et al. (2013). This is because those previous synthesis activities had different research objectives (Table 1).

2.5. Analysis performed on the C-PEAT GD

To ~~determine~~ illustrate ~~our~~ overall data coverage ~~and the representativity of our database~~, we used a climate envelope and climate region analysis (Köppen) approach. For each core~~site~~, mean annual temperature (MAT) and total annual precipitation (MAP) were~~as~~ extracted from a gridded climate product (Fick & Hijmans 2017). We also investigated the peat geochemical properties of our peat samples. For each variable, central tendencies (mean, median and mode) and dispersions (minimum, maximum, variance, and standard deviation) were calculated. ~~Lastly, we compared our peat soil data against a mineral soil database (USDA-NRCS NCSS), which is currently harmonized with ISCN v.4 (Todd-Brown et al. In prep). The National Cooperative Soil Survey (NCSS) is a comprehensive soil characterization dataset that contains 15,819 pedons spanning the world (as of July 2024). In addition to comparing central tendencies between these two datasets, we also contrast changes in soil organic C density along depth for peat vs. mineral soils.~~

3. Results and Discussion

3.1. Data coverage over space and time

Spatial coverage of the dataset is global, with the majority of ~~sites~~ cores (220/267) located in the northern extratropical region (Fig. 5). With the exception of southern South America (Patagonia; 11 cores), data availability is very sparse across the southern extratropical region. As for the tropical belt (around 20° N to 20° S), the C-PEAT dataset includes 34 peat core records (Fig. 5). Future efforts should prioritize the synthesis of tropical core records.

Temporal coverage of the peat cores varies over time~~, with the number of basal ages steadily increasing throughout the Holocene~~ (Fig. 6a). To our knowledge, all peat records found in this database are continuous and their surface is assumed to be of modern age ~~(Fig. 6a)~~. We note that the oldest age available along a peat core sets the record's duration; in most cases, peat cores extend back to peatland initiation, though many cores do not. In total, 24 peat core records are younger than 1000 years (of which 11 core chronologies were solely constrained by ^{210}Pb ages), 110 records are at least 5000 years old, and 16 cores initiated prior to 10,000 years ago. The oldest records are found in southern Patagonia and Alaska, presumably because of the earlier deglacial history of those regions. The oldest tropical ~~site~~ core available in this database is approximately 11,600 years old, though we note that most of the tropical cores included in the dataset are less than 5000 years old (median = 2940 years).

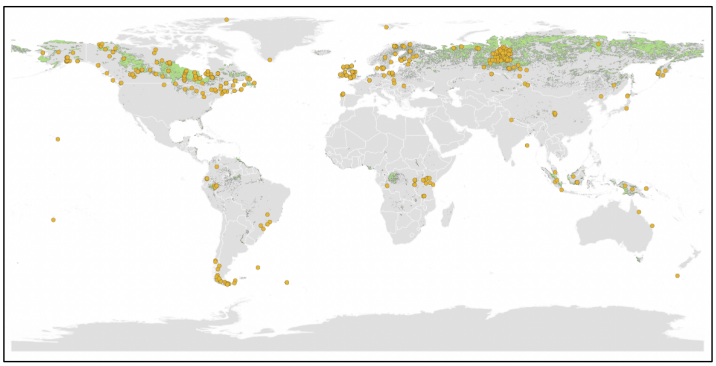

Figure 5. Spatial distribution of peat cores included in the C-PEAT Global Peatland Carbon Database. Orange circles represent individual peat cores. The global peatland area (in ~~black~~green) is from UNEP (2022). Map source: Esri, TomTom, FAO, USGS | Powered by Esri.

The temporal resolution of the peat core records varies considerably. For instance, the number of chronological constraints along a single peat core varies from 1 to 41 (median = 6; Fig. 6b). Dividing the maximum age of a record by the number of dates available for said record yields an average of 0.76 dates / 1000 years, with 64 records characterized by an averaged temporal resolution that is greater than 1 date / 1000 years. In general, there are more chronological constraints for the late Holocene than the mid- and early-Holocene time periods, in part because the data from Gallego-Sala et al. (2018) focused on the past millennium. Peat accumulation rates also vary widely between ~~sites~~cores. In general, the peatland archives therein offer a multi-decadal resolution, with an average peat accumulation rate of 0.057cm ~~/~~yr^{-1}, ranging from 0.005 to 0.5cm ~~/~~yr^{-1} (Fig. 6c).

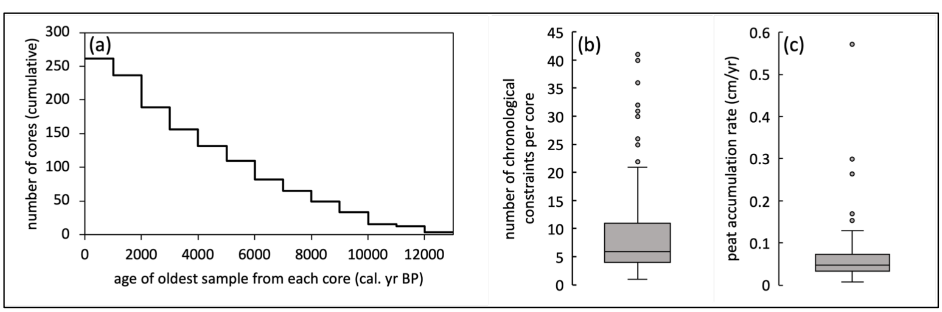

Figure 6. Temporal resolution of peat cores included in the C-PEAT Global Peatland Carbon Database. **(a)** Cumulative number of peat core records over time. **(b)** Number of chronological constraints per core. **(c)** Mean apparent rate of peat accumulation for each core (in cm ~~/~~ yr^{-1}). On panels b) and c), the 25th-75th percentile ranges (IQR – interquartile range) are displayed as the boxes, with the medians (50th percentile) marked by horizontal black lines inside. The whiskers represent 1.5 x IQR and the circles represent outliers.

3.2. Data ~~representativi~~coverage~~ty~~

The climate envelope and climate region analyses confirm that peatland ~~sites~~ cores within this database are found across a broad range of hydroclimatic conditions and climate classes, from the tropical rainforest and the tropical savannah to the polar tundra, and many other classes in between. It is clear that cold climate ~~sites~~ cores dominate the dataset (222/267 sites) and that more cores from the warmer bioclimatic regions would help balance representation in the database (Fig. 7).

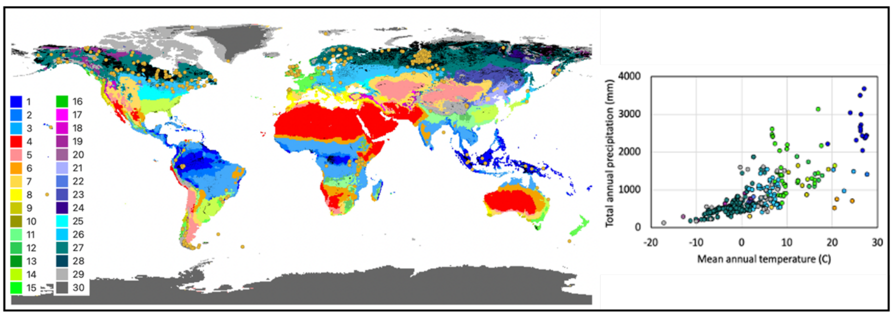

Figure 7. Distribution of core sites included in the C-PEAT Global Peatland Carbon Database in the context of the Kö~~o~~ppen-Geiger climate classification. Peatland ~~sites~~ cores (orange circles on the map) are the same as on Fig. 6. The climate map is from Beck et al. (2023) and the global peatland area (in black) is from UNEP (2022). The biplot presents those same peatland ~~sites~~ cores (color-coded using the Kö~~o~~ppen climate classes) in a climate space. The legend reads as follows (from Beck et al. 2023): 1 Af (Tropical, rainforest), 2 Am (Tropical, monsoon), 3 Aw (Tropical, savannah), 4 BWh (Arid, desert, hot), 5 BWk (Arid, desert, cold), 6 BSh (Arid, steppe, hot), 7 BSk (Arid, steppe, cold), 8 Csa (Temperate, dry summer, hot summer), 9 Csb (Temperate, dry summer, warm summer), 10 Csc (Temperate, dry summer, cold summer), 11 Cwa (Temperate, dry winter, hot summer), 12 Cwb (Temperate, dry winter, warm summer), 13 Cwc (Temperate, dry winter, cold summer), 14 Cfa (Temperate, no dry season, hot summer), 15 Cfb (Temperate, no dry season, warm summer), 16 Cfc (Temperate, no dry season, cold summer), 17 Dsa (Cold, dry summer, hot summer), 18 Dsb (Cold, dry summer, warm summer), 19 Dsc (Cold, dry summer, cold summer), 20 Dsd (Cold, dry summer, very cold winter), 21 Dwa (Cold, dry winter, hot summer), 22 Dwb (Cold, dry winter, warm summer), 23 Dwc (Cold, dry winter, cold summer), 24 Dwd Cold, dry winter, very cold winter), 25 Dfa (Cold, no dry season, hot summer), 26 Dfb (Cold, no dry season, warm summer), 27 Dfc (Cold, no dry season, cold summer), 28 Dfd (Cold, no dry season, very cold winter), 29 ET (Polar, tundra), 30 EF (Polar, frost). Map source: Esri, TomTom, FAO, USGS | Powered by Esri.

3.3. Key peat properties and characteristics

When combined, the peat records yield a total of 267 peat core depths, 43,467 dry bulk density values, 31,473 organic matter content values, 4,016 peat organic matter density values, 42,566 carbon content values (~~total carbon and carbon~~

~~combined~~%C, %TC, %TOC combined), and 10,771 nitrogen content values. Descriptive statistics of the dataset are presented in the paragraphs below as well as in Fig. 8 and Table 5.

Peat core depth is provided for all 267 cores and ranges from 0.30 to 10.95 m, with a mean value of 2.24 ±1.9 m (1 standard deviation (SD); Table 5). We note that 'peat core depth' refers to the deepest sample provided ~~for~~ along a ~~site~~core; while most peat cores in the dataset extend back to peatland initiation, many cores may not. When in doubt, it is recommended to refer to the original publication to confirm whether the record starts at peat inception.

Peat dry bulk density values (n = 43,467) are available for 263 ~~sites~~ cores and range from 0.01 to 3.380 g ~~/~~cm^{-3}, with a mean value of 0.140 ± 0.178 g ~~/~~cm^{-3} (1 SD; Fig. 8a; Table 5). Organic matter content data (n = 31,473) are available for 174 ~~sites~~ cores and range from 0 to 100% (though there are some data points > 100%), with a mean value of 88.5 ± 20.1% (1 SD; Fig. 8b; Table 5). Organic matter density values (OMD; n = 4016) are available for 20 ~~sites~~ cores and range from 0.008 to 0.399 g OM ~~/~~cm^{-3}, with a mean value of 0.117 ± 0.046 g OM~~/~~cm^{-3} (1 SD; Table 5).

In the database, carbon content is presented as three distinct variables: C%, TC%, and TOC%. While C% refers to estimated carbon~~C~~ content based on organic matter~~OM~~ measurements (authors often multiply their OM% by 50% to estimate C% and 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. Here we report C% data from 151 ~~sites~~ cores (n = 26,842), TC% from 114 ~~sites~~ cores (n = 14,430), and TOC% data from 11 ~~sites~~ cores (n = 1532), for a total of 42,804 measurements. We note that 16 ~~sites~~ cores report both C% and TC% values, that 7 ~~sites~~ cores report C% and TOC% values, that 1 ~~site~~ core reports TC% and TOC% values, and that 1 ~~site~~ core reports C%, TC%, and TOC% values. Carbon content (C%) estimates range from 0.0 to 71.7%, with a mean value of 46.7 ± 10.5% (1 SD; Fig. 8c; Table 5). Total carbon content (TC%) values range from 0.0 to 100%, with a mean value of 45.4± 16.4% (1 SD; Fig. 8c; Table 5). Total organic carbon content (TOC%) values range from 0.0 to 77.0%, with a mean value of 37.7 ± 19.6% (1 SD; Fig. 8c; Table 5). Lastly, organic carbon density values (OCD; n = 3952) are available for 28 ~~sites~~ cores and range from 0.005 to 0.195 g C/cm3, with a mean value of 0.058 ± 0.024 g C ~~/~~cm^{-3} (1 SD; Table 5). 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.

Total nitrogen content (TN) data are reported for 87 ~~sites~~ cores (n = 10,770) and range from 0 to 6.3% (there is an outlier at 56.6% that was omitted from Fig. 8d), with a mean value of 1.2 ± 0.7 % (1 SD; Fig. 8d; Table 5).

~~Overall, the central tendencies and data ranges presented therein are in line with previously published datasets (e.g., Loisel et al. 2014).~~ While the averaged data (Table 5) may be used as reference values, we advise data users to further dig into the dataset, as the database structure allows for much finer analysis. For instance, it is possible (and simple) to query the dataset for a particular region of the world and/or time period, with the goal to obtain more specific peat characteristics.

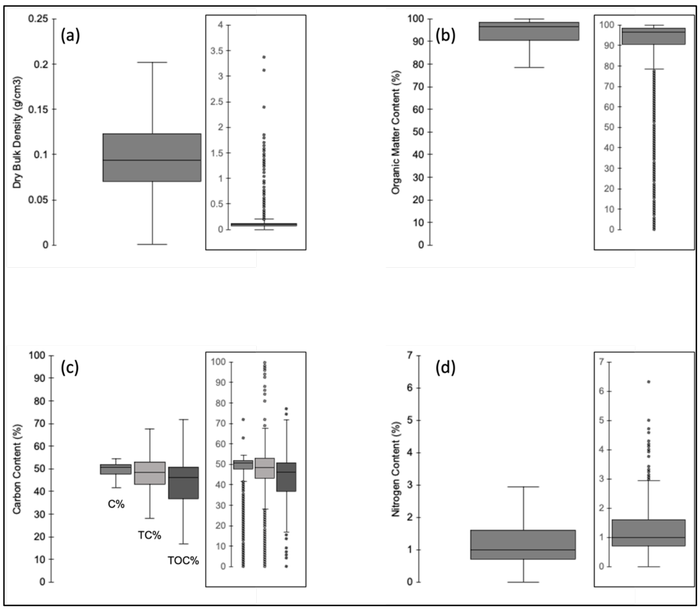

Figure 8. Descriptive statistics for the C-PEAT Global Peatland Carbon Database. **(a)** Dry bulk density; **(b)** Organic matter content; **(c)** Carbon content, where the 3 datasets are displayed (see sect. 3.3 for details), and **(d)** Nitrogen content. For each variable, the left inner panel displays the interquartile range (IQR~~T~~) (represented as the box, with the median shown as a horizontal black line) while the right inner panel presents the entire data range (including the outliers, denoted as circles). Whiskers present 1.5 x IQR~~T~~.

Table 5. Central tendencies and dispersions for the C-PEAT Global Peatland Carbon Database (267 cores).

Variable name and sample count		**Central tendencies**		**Dispersions**		
	n	**mean**	**median**	**minimum**	**maximum**	**SD**
total peat depth (m)	267	2.24	1.61	0.30	10.95	1.90
DBD (g/cm^3)	43,467	0.140	0.098	0.001	3.380	0.178
OM (%)	31,473	88.5	96.5	0.0	100.0	20.1
OMD (g OM/cm^3)	4016	0.117	0.109	0.008	0.399	0.046

C (%)	26,842	46.7	50.8	0.0	71.7	10.5
TC (%)	14,430	45.4	48.4	0.0	100.0	16.4
TOC (%)	1532	37.7	46.0	0.0	77.0	19.6
OCD (g C/cm^3)	3952	0.058	0.055	0.005	0.195	0.024
TN (%)	10,771	1.2	1.0	0.0	56.6	0.7

3.4. Comparing peat vs. mineral soil data

The peat vs. mineral soil data comparisons provided a way to quantify key carbon stock differences between these two soil types. On average, soil organic carbon content for the top 100cm was 16 times greater in peat soils (17.53 g/cm^2 area mass) than in mineral soils (1.08 g/cm^2). Most mineral soils in the NCSS database exhibit very low SOC stocks (0 - 1.33 g/cm^2), with a skewed distribution for higher stocks (max = 55 g/cm2) (Table 6). The distribution of soil organic carbon over depth (top 100 cm) also highlighted key differences, with mineral soil data exhibiting a clear decreasing trend in organic carbon with depth that is absent from the peat soil data (Fig. 9a). Deeper records, which we limit to 600 cm because that is the deepest mineral soil data, show a similar trend (Fig. 9b). Overall, peat soils are rich in organic matter (Table 5) and therefore have higher concentrations of organic carbon compared to mineral soils (Table 6). This result is supported by the order-of-magnitude lower bulk density values for peat soils (mean: 0.14 g/cm^3) compared to those of mineral soils (mean: 1.54 g/cm^3).

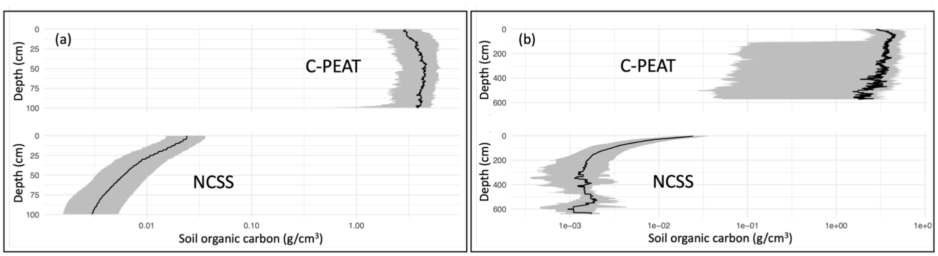

Figure 9. Comparison of soil organic carbon data between the C-PEAT Global Peatland Carbon Database (267 cores) and the NCSS soil pedons (15,819 pedons). **(a)** Depth distribution of soil organic carbon stocks for the top 100 cm soil profile for C-PEAT samples (top) vs. NCSS soils (bottom). **(c)** Depth distribution of soil organic carbon stocks down to 600 cm for C-PEAT samples (top) vs. NCSS soils (bottom).

Table 6. Central tendencies and dispersions for the NCSS soil pedons (15,819 pedons).

Variable name and sample count	**Central tendencies**	**Dispersions**

	n	mean	median	minimum	maximum	SD
Bulk density (oven dry)	78,551	1.5452	1.58	0.03	4.47	0.263
Soil Organic Carbon (g/cm^3)	78,551	0.0123	0.0063	0.3746	0.6142	0.019
estimated_organic_carbon	30,634	1.3655	0.5	-3.9	62.4	3.419
Organic C walkley-black (%)	48,018	0.9304	0.4	0.15	54	1.895
Total coarse fraction (wt_pct_gt_2_mm_ws)	78,551	8.96	1	0	4229	28.767

4. Usage notes

4.1. Database availability, updates, and submission of new datasets

The C-PEAT GD v.2025 presented therein can be accessed via PANGAEA, under the project label C-PEAT. There also exist R and Python scripts that allow for mass-downloads of the entire dataset (Ransby et al. 20265). The database is expected to keep evolving over time, as new datasets are integrated, existing datasets are extended (or corrected), and new sharing standards are developed. Formal database updates will be tentatively initiated every two to three years; said updates will be described online, directly within the data repository. Future updates will be reflected in the database identifier, which will include the update year (e.g., v.2027, v.2030, etc.). Between updates, database users are asked to flag any existing issues by contacting the PANGAEA editors through the contact form https://www.pangaea.de/contact/; a new version of the erroneous data can then be published. The inclusion of new datasets or the expansion of existing ones are performed manually. 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.

Whether they used the database in its entirety or only a subset, users are asked to cite the C-PEAT GD v.2025. When possible, and particularly when a subsequent product makes use of a few specific records, we request that the original publication(s) from which the primary data were extracted be cited as well.

4.2. Outstanding usage notes

Lastly, it is important to recognize the limitations of this database. Most importantly, the dataset is incomplete, in that there remain many numerous peat core sites that have not yet been integrated into this dataset. As a reminder, the C-PEAT GD v.2025 only includes sites cores that were already integrated to previously published data synthesis products. Second, and as mentioned in the text, not all peat core records are complete, meaning that some of themcores may not have reached the bottom of the peatland. Along those linesSimilarly, we remind the users that peat cores are not necessarily representative of an entire peat basin; rather, their record should be interpreted as a snapshot of an ecosystem's history. Additionally, individual research teams might have had different research goals than the data users when they selected coring sites locations and collected their samples, such that some cores therein could represent the deepest portion of a peatland basin, but others might have been purposefully collected near basin marginsthe edge. It is always advised to read the primary data source to gain further knowledge about the study sites and core locations.

Appendices

n/a

Code and data availability

The database is publicly available via the PANGAEA data repository (https://doi.org/10.1594/PANGAEA.986891; Loisel et al. 2025). The datasets can be explored and queried at https://www.pangaea.de/?q=project:label:PAGES_C-PEAT. Code for accessing the data using Python and R is available on Zenodo (https://doi.org/10.5281/zenodo.20734314~~https://doi.org/10.5281/zenodo.17465602~~; Ransby et al. 2026~~5~~).

Supplement link

n/a

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Author contributions

JL & AGS built and managed the C-PEAT GD, and coordinated the broader C-PEAT network; JL, AGS, SU & ER assembled or entered datasets and/or metadata into the database; DR, CB & SS performed quality control, term standardization, database cleaning, and/or QC certification; JL, KTB & VM analyzed data and generated figures for this paper; JL wrote and revised the manuscript; AGS, DR, SU, ER, CB, SS, KTB & VM reviewed and improved ~~a~~ preliminary versions of this manuscript.

Competing interests

n/a

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Review statement

n/a

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