Peat-DBase v.1: A Compiled Database of Global Peat Depth Measurements

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Abstract. Peatlands are globally important carbon stores that face increasing threats from human activities and climate change impacts. Comprehensive peatland data are essential for understanding ecosystem responses to these stressors and mapping their past and current characteristics. Current peatland datasets remain limited due to poor representation in global soil mapping

initiates and the absence of a recognized, coordinated central repository for peat depth data. Existing compilations often contain errors, duplicates, and outdated observations, requiring researchers to repeatedly gather and harmonize data on a study-by-study basis. To address these challenges, we present Peat-DBase version 1.0—a harmonized, quality-controlled global compilation of basal peat depth measurements.

Version 1.0 of Peat-DBase comprises 204 902 peat depth measurements from 29 sources spanning 54.933°S to 82.217°N, with a significant proportion of measurements in Atlantic Canada and Scotland due to the inclusion of two particularly large datasets focused on those regions. We supplement the peat study measurements with 94 615 non-peat soil measurements to ensure comprehensive coverage consistent with the relatively low spatial coverage of peatlands globally. Despite the uneven distribution of peat depth measurements, Peat-DBase contains reasonable coverage of the major global peatland complexes in temperate and boreal North America and Europe, portions of Russia, the Amazon and Congo basins, and the Malay Archipelago, though gaps remain in the lower Amazon Basin, Eastern Indonesia, and Eastern Russia. From the current data, peat depths have a median value of 130 cm (IQR: 60 - 240), although this is influenced by a predominance of measurements in the North Atlantic regions. Peat-DBase's deepest measurement is 2 223 cm.

While sampling biases and measurement uncertainties exist, Peat-DBase provides an essential foundation for global peatland research. Peat-DBase is under active development and future versions will incorporate additional datasets, information on current peatland status, and improved positional uncertainty quantification. Peat-DBase eliminates the need for overlapping data compilation efforts while identifying critical observational gaps for future research. Peat-DBase is available at https://doi.org/10.5281/zenodo.15530645

1 Introduction

Peatlands are important carbon (C) stores, comprising roughly one-third of global soil C despite only covering about 3% of Earth's land surface (Joosten and Clarke, 2002; Jackson et al., 2017; Xu et al., 2018; Melton et al., 2022). They also contain about 10% of the world's fresh surface water and support unique biodiversity (Joosten and Clarke, 2002; Page and Baird, 2016). Their persistently saturated conditions inhibit decomposition, enabling peat accumulation over centuries to millennia (Koster and Favier, 2005; Page and Baird, 2016; Joosten and Clarke, 2002). However, these ecosystems are sensitive to anthropogenic activity and climate change impacts (Loisel et al., 2021). Drainage for agriculture, forestry, and other land uses can alter peatland soil structure and function, lower water tables, promote aerobic decomposition, and dramatically increase carbon emissions (Fluet-Chouinard et al., 2023; Page and Baird, 2016; Warren et al., 2017; Koster and Favier, 2005; Li et al., 2018).

35 Climate change intensifies these threats through rising temperatures and altered hydrologic regimes, with extreme weather events often leading to increased wildfire risk (Canadell et al., 2021; Helbig et al., 2020).

Comprehensive peatland data – including extent (Xu et al., 2018; Melton et al., 2022; Gumbricht et al., 2017), carbon content (Gorham, 1991; Page et al., 2011), protection status (Austin et al., 2025), land-use, land cover, and degree of degradation (Fluet-Chouinard et al., 2023) – are urgently needed to understand ecosystem responses to current environmental and anthro-

40 pogenic stressors and project future ecosystem dynamics. As peatlands are increasingly incorporated into land surface models (Chadburn et al., 2022; Bechtold et al., 2019b; Wu et al., 2016) for eventual integration into Earth system models, as well as data-driven mapping applications (e.g., Minasny et al., 2019; Melton et al., 2022), robust peatland datasets are essential for model initialization and evaluation. However, peatland data remain scarce due to under-representation in global soil mapping initiatives (Krankina et al., 2008; Minasny et al., 2019) and the characteristically wet, and often remote, locations of peatlands,

45 which create challenging conditions for field data collection (Minasny et al., 2019; Rudiyanto et al., 2016). Peat depth mapping is particularly difficult as it requires labour-intensive field surveys or proximal remote sensing techniques (Minasny et al., 2019; Jowsey, 1966).

To address these needs, we present Peat-DBase version 1.0—a harmonized, quality-controlled global compilation of basal peat depth measurements. The database also includes mineral soil core data (Batjes et al., 2020b) to provide comprehensive

50 coverage of peat-free areas. The rest of our paper is structured as follows. First, in Sect. 2, we explain the intentions of Peat-DBase and why it is needed now to advance global peatland science. Next, in Sect. 3, we describe the present state of Peat-DBase, the protocols for the acquisition, formatting, and processing for the peat study data; mineral soil data is covered in Appendix Sect. A. Then, in Sect. 4, we provide an analysis and discussion of the resulting database, including its limitations and our future plans for Peat-DBase. Finally, in Sect. 5 and 6, we discuss the conclusions and data availability, respectively.

55 ## 2   Motivation: Why Peat-DBase and why now?

While Peat-DBase v1.0 focuses on peat depth, our vision is to establish it as a comprehensive global repository for peatland carbon information. Our intention is to complement similar community-led initiatives like the Soil Respiration Database (SRDB; Jian et al., 2020), World Soil Information Service (WoSIS; Batjes et al., 2020a), and the International Soil Radiocarbon Database (ISRaD Lawrence et al., 2020), but with a focus on peatlands and their carbon stocks. Current peatland compilations

60 assembled for individual studies (e.g. Gorham et al., 2012; Treat et al., 2019; Hugelius et al., 2020) can contain errors, duplicates, outdated observations (whereby a peatland has experienced natural or anthropogenic disturbance since measurement), among other issues. By creating a curated, open-source database, we eliminate the need for researchers to repeatedly gather, clean and harmonize data independently. Peat-DBase also does not duplicate the work of other peatland databases, such as "The Global Peatland Database" (https://greifswaldmoor.de/global-peatland-database-en.html), which focuses on peatland ex-

65 tent and drainage status rather than depth measurements and does not permit access to the datasets behind the released map products; or "PeatData Hub" (https://peatdatahub.net/data-packages/; Xu et al., 2018), which is also focused on peatland extent and water table depths.
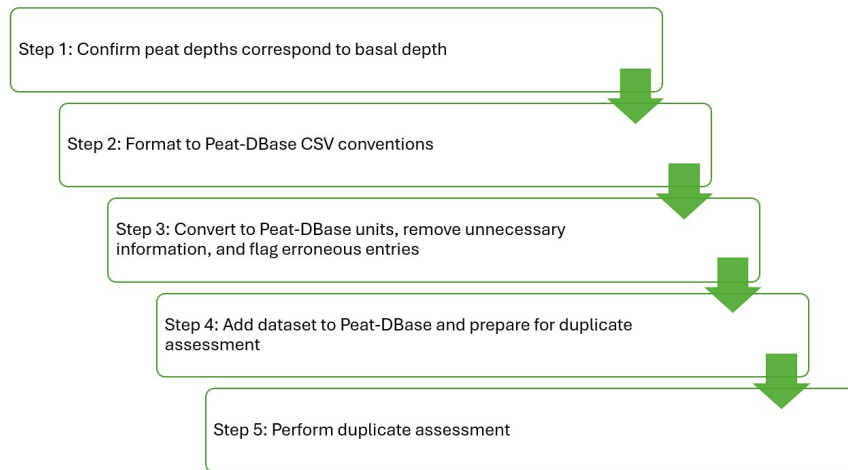
Figure 1. Workflow to ingest peat-focused datasets into Peat-DBase. Future versions of Peat-DBase will allow peat data that does not reach the basal depth through the use of appropriate flags indicating that fact

Peat-DBase is particularly timely for several reasons. First, advancing peatland representation in land surface models (Wu et al., 2016; Bechtold et al., 2019a; Apers et al., 2022) requires accurate, extensive data for initialization and evaluation, especially as these models are integrated into Earth system models. Second, the proliferation of artificial intelligence (AI) techniques in geosciences (Wadoux et al., 2020) has enabled data-driven mapping of peatland extent (e.g., Minasny et al., 2019; Melton et al., 2022), carbon stocks (Hugelius et al., 2020; Widyastuti et al., 2025), and depth (Skye, 2025; Widyastuti et al., 2025). However, AI model outputs depend critically on training data quality and quantity (Aroyo et al., 2022; Roscher et al., 2024). Since these approaches cannot reliably extrapolate beyond their training domains (Xu et al., 2020; Hateffard et al., 2024), providing spatially extensive, high-quality datasets is essential. Third, despite facing intense pressures from human activities and climate change, peatlands remain poorly mapped, hindering conservation and restoration efforts (Austin et al., 2025). Fourth, as part of the Paris Agreement, 20 countries have already listed peatland or wetland soil organic carbon mitigation targets in their Nationally Determined Contributions (NDCs) (Wiese et al., 2021). However, many other countries did not include peatland or wetland soils in their NDCs, citing, among other reasons, the difficulty in accurately quantifying and monitoring change in these stocks (Wiese et al., 2021). Finally, global databases like Peat-DBase can identify critical observational gaps, motivating targeted research and data collection efforts.

3 Methods: Peat Data Compilation and Processing

The workflow to compile and process new peat depth datasets is shown in Figure 1. The individual steps will be described in the following sections.

3.1 Data Acquisition

Peat study data were accepted into Peat-DBase provided the measurements were taken down to the basal depth indicated by mineral soil or bedrock[1]. Any coring or sampling method was allowed that could accurately determine this basal depth. To select studies we relied on the authors' identification of what constitutes peatlands or peat soils and their determination of the basal peat depth. In permafrost regions In permafrost regions, Cold Regions Research and Engineering Laboratory corers (Brockett and Lawson, 1985) were often used. In non-permafrost sites, Russian-type corers (Jowsey, 1966), Box corers (Shotyk and Noernberg, 2020; Fenton, 1980), and Jeglum corers (Jeglum et al., 1991) were the primary tools. In cases where pole probing was conducted as part of a coring transect, the probing measurements were also included. Probing, involves the use of metal poles which are inserted into the peat until they meet a non-peat layer and cannot go any further (e.g. Oakfield probes; Magnan et al., 2024; Householder et al., 2012; Crezee et al., 2022). We note probing has higher uncertainty for estimating peat depths as there is no visual confirmation of the interface between the peat and the underlying substrate.

The sampling protocol varied depending on the goals of the researchers. In some cases, transects of varying lengths were chosen with measurements taken at consistent intervals across the transect (e.g. Crezee et al., 2022; Kelly et al., 2020; Winton et al., 2025). In other instances, unique core sites were chosen across single or multiple peatlands (e.g. Cole et al., 2015; Davies et al., 2023b, a; Silvestri et al., 2019a). Some peat study datasets also included some cores taken in peat-free soils as a result of their sampling procedures (e.g. Crezee et al., 2022; Keys and Henderson, 1987; Thibault, 1992). Other data sources were extensive compilations of numerous field campaigns with different goals and objectives yielding comparably dense measurement coverage (e.g. Keys and Henderson, 1987; Thibault, 1992; Scottish Government, 2025).

Peat depth data available from government or non-governmental agencies were the largest sources of data in terms of number of measurements. The two principal datasets were made available for download online (e.g. NatureScot, n=174 159; accessed on May 26, 2025) or associated with publications where the data was available upon request (e.g. the Government of New Brunswick, n = 20 505; Keys and Henderson, 1987; Thibault, 1992).

Generally, the largest peat depth datasets derived from the scientific literature were compilations of other datasets. Such compiled datasets were typically developed for modelling purposes (e.g. Hugelius et al., 2020; Treat et al., 2017, 2019). As these compiled datasets can often have convoluted histories – frequently incorporating other compilations – they were added to Peat-DBase under the single citation of the compiling authors. Additional fields were used to track any information the compiling authors provided regarding their data sources (see Sect. 3.2 and Table 2).

A total of 204 902 peat depth measurements came from 29 sources (all totals are after error/duplicate assessment and listed in Table 1). Of these, four sources are previously unpublished representing 2 352 measurements. Some publications were excluded from Peat-DBase because their underlying data were not readily accessible, lacked usable data files, or we could not confirm from the publication that the measurements represented basal peat depth. All sources of peat depth measurements used in Peat-DBase are listed in Table 1.

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[1]Future versions of Peat-DBase will allow peat data that does not reach the basal depth through the use of appropriate flags indicating that fact.

Table 1. The sources of peat study measurements in Peat-DBase v. 1. The final number indicates the number of measurements (n) retained after error/duplicate assessment (`sample_duplication_flag` values of 1 – 5; see Sect. 3.3 and Table 2). The percent column indicates what percent of the original number of cores was retained after error/duplicate assessment.

Sources	Region	n	final n	%
Bauer et al. (2024)[a]	Canada	769	739	96.1
Beilman et al. (2009)[a]	West Siberian Lowlands	23	23	100
Benfield et al. (2021)[a]	Sierra Nevada del Cocuy (Eastern Colombian Andes)	22	20	90.9
Cole et al. (2015)	Sarawak, Malaysian Borneo	3	3	100
Comas et al. (2015)	West Kalimantan, Indonesia	8	8	100
Crezee et al. (2022)	Central Congo Basin	1558	1558	100
Davies et al. (2021)	Southern Hudson Bay Lowlands	1	1	100
Davies et al. (2023a)	Western Hudson Bay Lowlands	2	2	100
Davies et al. (2023b)	Western Hudson Bay Lowlands	3	3	100
Gorham et al. (2012)[a]	North America	1685	1478	87.7
Hribljan et al. (2023)	Colombian, Ecuadorian, Peruvian, and Bolivian Andes	25	24	96.0
Hugelius et al. (2020)[a]	N of 23°N	7738	6899	89.2
Kelly et al. (2020)	Quistococha, Pastaza-Marañón Foreland Basin, Peru	29	29	100
Keys and Henderson (1987); Thibault (1992)[a]	New Brunswick, Canada	20 505	20 505	100
Group of A. Gallego-Sala (unpublished)	>60°N, 5°S – 5°N	230	230	100
Lawson et al. (2023)	Pastaza-Marañón Basin, Peru	280	280	100
Manitoba Dept. of Natural Resources and Northern Development[a] (unpublished)	Manitoba, Canada	1709	1598	93.5
Lamentowicz (2005)	Poland	14	14	100
Group of M. Lamentowicz (unpublished)	Poland	249	249	100
Scottish Government (2025)	Scotland, U.K.	174 159	170 052	97.6
Silvestri et al. (2019a, b)	Kubu Raya District, West Kalimantan, Indonesia	63	63	100
Treat et al. (2017, 2019)[a],[b]	Global	614	486	79.2
Sun et al. (2023)[a]	Tibetan Plateau	146	145	99.3
Warren et al. (2012)[a]	Indonesia	33	32	97
M. Warren (unpublished)	Indonesia	276	275	99.6
Winton et al. (2025)	Colombia	186	186	100

[a] indicates sources that are confirmed to be a compilation of other datasets. [b] Five of the cores in Treat et al. (2019) were excluded due to being located in the present-day ocean. These sites were not in error, but were collected to characterize peatlands across the last glacial cycle when the sites were subaerial.

3.2 Data Formatting

All collected data were processed into a consistent format. Source datasets were first converted to a CSV file format, if not already. Any measurements that were missing a latitude, longitude, or depth value were removed. All peat depth values were converted to centimetres and the coordinates of each measurement location were converted to the World Geodetic System 1984 (WGS84 or EPSG:4326) coordinate system, where required. When the depth measurement was presented as a range (this occurred in less than five measurements), the median of the values was determined and used within Peat-DBase. All datasets were then added to the Peat-DBase, which is structured as a single CSV file. The columns of this synthesized database are explained in Table 2.

3.3 Data Processing

Data entry errors require careful handling. As described in Sect. 3.2, incomplete measurements (e.g., missing latitude or longitude values) were excluded during initial data processing. However, some complete records contained obvious errors, such as peat measurements with coordinates placing them in the ocean. These clearly erroneous entries were flagged by setting the `error_found` column to `True` and documenting relevant details in the `investigation_notes` field (see Table 2). Since Peat-DBase incorporates compiled datasets that are themselves compilations (see Table 1, e.g. Treat et al., 2017; Hugelius et al., 2020), additional quality control steps are necessary to handle duplicate entries. As Sarracino and Mikucka (2017) demonstrated, duplicates in modelling datasets can bias regression estimates, particularly when their distribution is non-random – a common occurrence when the same peat depth measurements appear across multiple compilations. To address this issue, we reassessed the database for duplicates each time a new source dataset was added. Rather than removing duplicates automatically, we flagged them to allow users to retain one measurement while filtering out redundant entries as needed (see Table 2 for columns used in duplicate assessment). This approach – retaining one instance while flagging others – was among the most effective strategies for reducing bias tested by Sarracino and Mikucka (2017), outperforming alternatives such as ignoring duplicates, removing all instances, or applying weighting schemes.

Duplicate flagging occurred in two phases. First, we identified exact duplicates – measurements with identical depth values and coordinates – and flagged all but the first instance with `sample_duplication_flag` values of 6 or 8 (depending on whether the duplication is occurring within the same source dataset or not, see Table 2) with the first instance given a value of 3. In the second phase, we deliberately reduced measurement precision to detect potential rounding by previous data sources. This process identified measurements with matching depth values when rounded to 0.5 cm and coordinates rounded to 0.01°, then flagged them for manual assessment. These precision thresholds were determined iteratively by testing progressively coarser rounding until the number of confirmed duplicates became minimal. We note that the rounded duplicates identification step was not applied within the Scottish Government (2025) dataset because of the high precision available for its sample coordinates.

For each potential duplicate, we examined the measurements and their citation information to determine whether they originated from a common study when possible. Measurements were flagged if they came from compiled datasets containing processed or rounded versions of data already present in Peat-DBase from their original sources. For example, both Sun et al.

Table 2. The column headers within Peat-DBase and their meaning.

Peat-DBase v.1 columns	Meaning
original_dataset	A citation of the publication or owner of the source dataset.
original_entry_num	Location of the measurement in the ordering of its original dataset.
lat	Latitude in decimal degrees with original number of significant figures retained.
lon	Longitude in decimal degrees with original number of significant figures retained.
depth_cm	Basal peat depth measurement in centimetres with precision as recorded in the original source.
sample_date	Date the sample was collected[a].
site_condition	Condition of the site where the sample was collected[a].
original_dataset_source_notes	Any citation information provided by the original_dataset publication or owner.
peat_measurement	True if the original_dataset is a primary field study[b]. False if the data comes from WoSIS (see Sect. A).
error_found	True if possible errors (such as incorrect coordinates). Otherwise False.
investigation_notes	Notes on the nature of the error in error_found.
location_is_duplicate	True if there are more than one measurement in the database for the given latitude and longitude (these measurements may or may not be duplicates of one another; see sample_duplication_flag.). Otherwise False.
location_id	An identifier unique to each location, i.e. each unique combination of latitude and longitude in the database.
sample_duplication_flag	Numerical flag: 1 - Sample obtained from a primary field study[b] confirmed in/by the original publication/owner. No further duplicate assessment performed. 2 - Sample not obtained from a confirmed primary field study[b] and not detected as a possible duplicate. 3 - Sample found to be the first instance of an exact[c] duplicate. 4 - Sample found to be the first instance of a rounded[d] duplicate. 5 - Sample found to be a redundant instance of a rounded[d] duplicate, but we have low confidence that this is a true duplicate. 6 - Sample found to be a redundant instance of an exact[c] duplicate. 7 - Sample found to be a redundant instance of a rounded[d] duplicate and we have high confidence that this is a true duplicate. 8 - Sample not obtained from a confirmed primary field study[b] and found to potentially be the duplicate of another measurement within the same source dataset.
sample_id	A group identifier unique to each group of duplicates in the database. Samples identified as duplicates are assigned the same sample_id.

[a] Presently only available for the Scottish Government (2025) data. [b] Primary field study means the authors of the publication or dataset owners collected the data themselves. [c] Exact duplicate means that the lat, lon, and depth_cm values are identical. [d] Rounded duplicate means the lat and lon values are identical when rounded to 2 decimal places and the depth_cm values are within 0.5 cm.

150 (2023) and Treat et al. (2017) incorporate data from Zhao et al. (2014), converting the original arc-minute coordinates to decimal degrees. Since Treat et al. (2017) retained fewer significant figures, their duplicate entries were flagged with values of `7` for the `sample_duplication_flag`. However, incomplete citation practices in some datasets prevented definitive conclusions. Measurements confirmed to originate directly from field studies were always retained, and we applied conservative criteria throughout—keeping measurements unless clear evidence of duplication existed (e.g. exact same coordinates with high precision and exact same depth). If we had low confidence in our assessment of a rounded duplicate, we applied a

155 `sample_duplication_flag` value of `5` indicating the potential for the measurement to be a duplicate but also conveying the uncertainty in that assessment. Detected duplicates were sorted by precision and source. For rounded duplicates, the point with the greatest decimal precision was designated as the first instance. For exact duplicates, points were sorted alphabetically by dataset name (e.g., Gorham et al. (2012) before Hugelius et al. (2020)). When datasets were added incrementally,

160 previous duplicate assessments were retained, and newly added data were compared only against existing first instances and unduplicated records. Consequently, first instance designation reflects both the sorting criteria and the temporal sequence of data acquisition, which followed the order datasets were obtained (except datasets with publication restrictions, which were added last in their acquisition order).

As mentioned above, we retain all measurements in Peat-DBase, regardless of their `sample_duplication_flag` and

165 `error_found` values. We do this to allow future refinement of these assessments, enhance traceability back to their original data sources, and to ensure our assessments can be audited as needed. When using Peat-DBase we suggest the following filtering then be applied: 1) select only `error_found` values of `False`, and 2) select `sample_duplication_flag` values of `1`, `2`, `3`, `4`, and `5`. We note that some applications of Peat-DBase may require stringent removal of duplicates, in that case, `sample_duplication_flag` values of `5` should be removed as well.

170 4 Results and Discussion: Overview and Characteristics of Peat-DBase

4.1 General overview

Following harmonization and quality control procedures, Peat-DBase version 1.0 comprises 204 902 measurements from 29 peat-focused sources (Table 1). When combined with non-peat study data from WoSIS, the database contains 299 517 measurements (Figure 2). The peat study data spans 54.933°S to 82.217°N, a latitudinal range that remains unchanged when

175 incorporating non-peat study data.

Figure 3 reveals that peat study data is heavily concentrated in the northern extratropics, with particularly high sample densities in New Brunswick, Canada and Scotland. This concentration reflects the inclusion of two large source datasets (Keys and Henderson, 1987; Thibault, 1992; Scottish Government, 2025). Users of Peat-DBase should be aware of this uneven spatial distribution, as it may introduce regional bias depending on the intended application. For global-scale analyses, sub-sampling

180 these data-rich regions may be necessary to prevent New Brunswick and Scotland from exerting disproportionate influence on results.
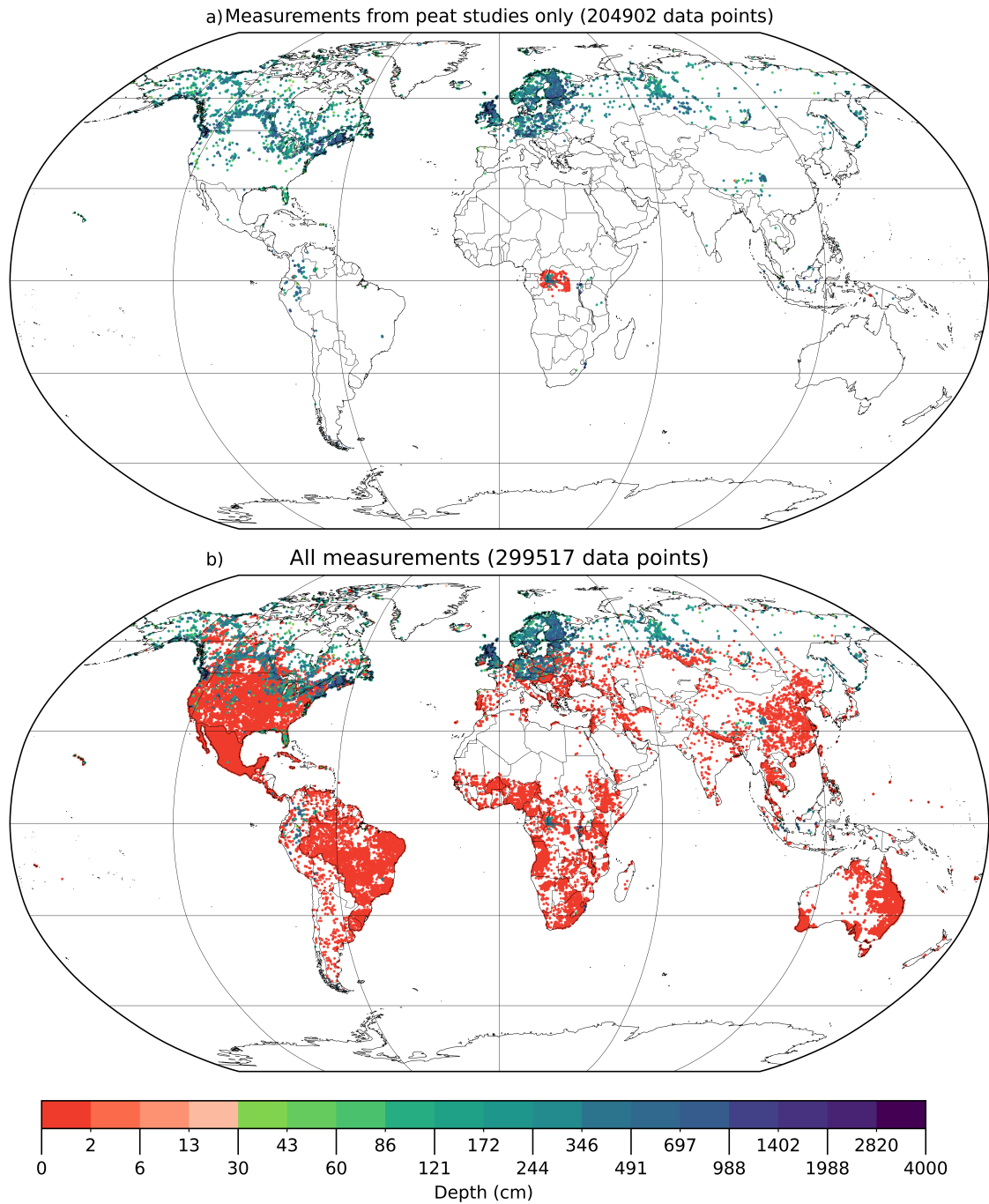
Figure 2. Distribution of data points in Peat-DBase version 1.0. (a) Only the data points originating from peat-focused sources (primary field studies or compilations) without errors or duplicates, i.e. `sample_duplication_flag` values of 1 – 5; see Sect. 3.3 and Table 2, are shown. (b) As in subplot a, but including those filtered from WoSIS. Note, the colour bar has a log scale with a colour break at 30 cm to visually delineate a common peat depth threshold for classification as a peatland (Loisel et al., 2017).

Figure 2a shows that most peat depth measurements exceed 30 cm – a common threshold for peatland classification (Loisel et al., 2017). Among the peat-focused studies, 5 831 measurements (2.8%) report a zero cm peat depth, primarily from sampling schemes that measured across transects to assess peatland presence, such as those by Crezee et al. (2022) and Keys and Henderson (1987).

When incorporating filtered WoSIS data, zero-depth measurements increase to 100 446 (Figure 2b). Figure 2b also highlights notable data gaps in desert regions like the Sahara and in certain countries such as Paraguay. These gaps exist in the original WoSIS database before any filtering described in Sect. A3 and are further discussed by Batjes et al. (2020b).

4.2 Spatial and Depth Distribution of Data

Peat-DBase represents most major global peatland areas. The distribution of peat depth measurements (Figure 2a and Figure 3) broadly aligns with peatland fractional coverage shown in published global products: PEATMAP (Xu et al., 2018) and Peat-ML (Melton et al., 2022) and in the tropics-only CIFOR (Gumbricht et al., 2017). PEATMAP synthesizes the most detailed regional peatland maps available prior to 2018, while Peat-ML uses machine learning to predict global peatland coverage by training on regional peatland maps and environmental variables (Melton et al., 2022). Conversely, CIFOR is an expert-informed system predicting peatland area by integrating moisture supply, soil saturation, and geomorphological characteristics (Gumbricht et al., 2017).

Peat-DBase includes measurements from most major peatland complexes identified in both PEATMAP and Peat-ML, including those in North America, Eurasia, South America, the Congo Basin, and the Malay Archipelago (comparison against Peat-ML shown in Figure 2). However, coverage gaps exist in the Amazon Basin, Indonesia, and Papua New Guinea, where PEATMAP and CIFOR indicate extensive peatland presence (Xu et al., 2018; Gumbricht et al., 2017). Peat-ML similarly shows greater peatland coverage in these regions and additionally in Eastern Russia. While paleoecological evidence supports substantial peatland presence in Eastern Russia (Yu et al., 2010, Figure 1), we have not identified additional readily available peat depth datasets for this region. African peatlands are particularly poorly documented across the scientific literature (Gallego-Sala et al. in review 2025) and Peat-DBase also appears to also poorly represent the full extent of peatlands on the continent.

While Peat-DBase captures a significant proportion of our current knowledge on peat depth, it also reflects inherent biases arising from field research constraints. The database shows notably sparse coverage in low-latitude regions (Figures 2, 3, 4), consistent with the historically less extensive mapping of tropical peatlands (Zinck, 2011; Ruwaimana et al., 2020). Although this tropical data gap shapes the current distribution within Peat-DBase, ongoing research efforts (e.g., Peat-ML2 - discussed in Sect. 4.3 and Winton et al. (2025)) are attempting to address these knowledge gaps, and future studies will be incorporated into subsequent database versions as they become available.

The distribution of measurements in Peat-DBase reflect the prominence of peatlands in boreal, temperate, and tropical regions (Xu et al., 2018; Melton et al., 2022; Joosten and Clarke, 2002; Koster and Favier, 2005). Looking beyond the high sample densities in New Brunswick and Scotland, Figure 4 and Figure 3 shows peat measurements concentrated in high latitudes (particularly 40°N–50°N) and near the equator. Additional clusters appear at intermediate latitudes, such as around
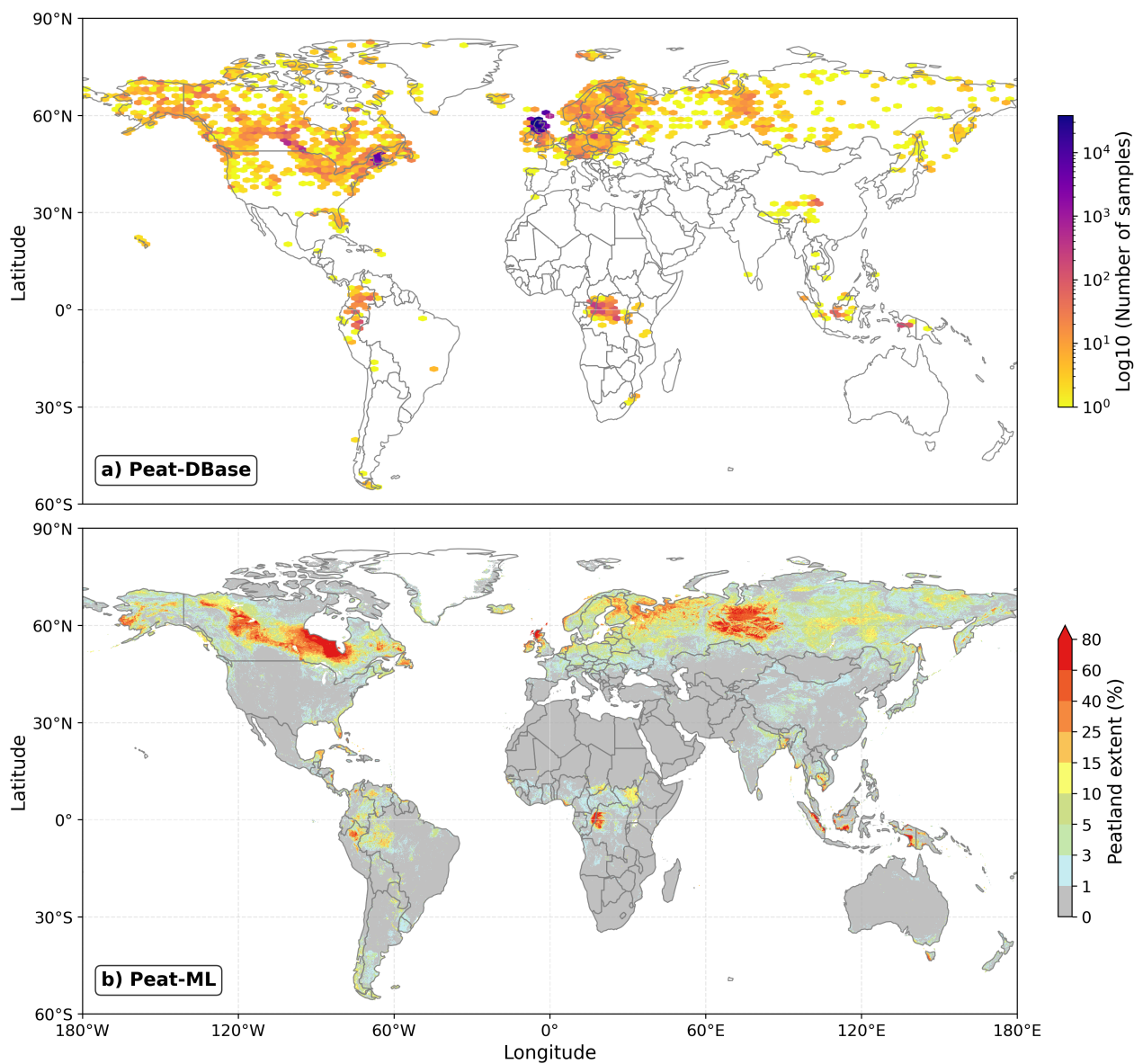
Figure 3. a) Map of Peat-DBase sample density for peat measurements as in Figure 2a. Bin sizes are approximately 2.88° in longitude and 2.5° in latitude. Note the log scale. b) Predicted peatland extent from Peat-ML Melton et al. (2022).
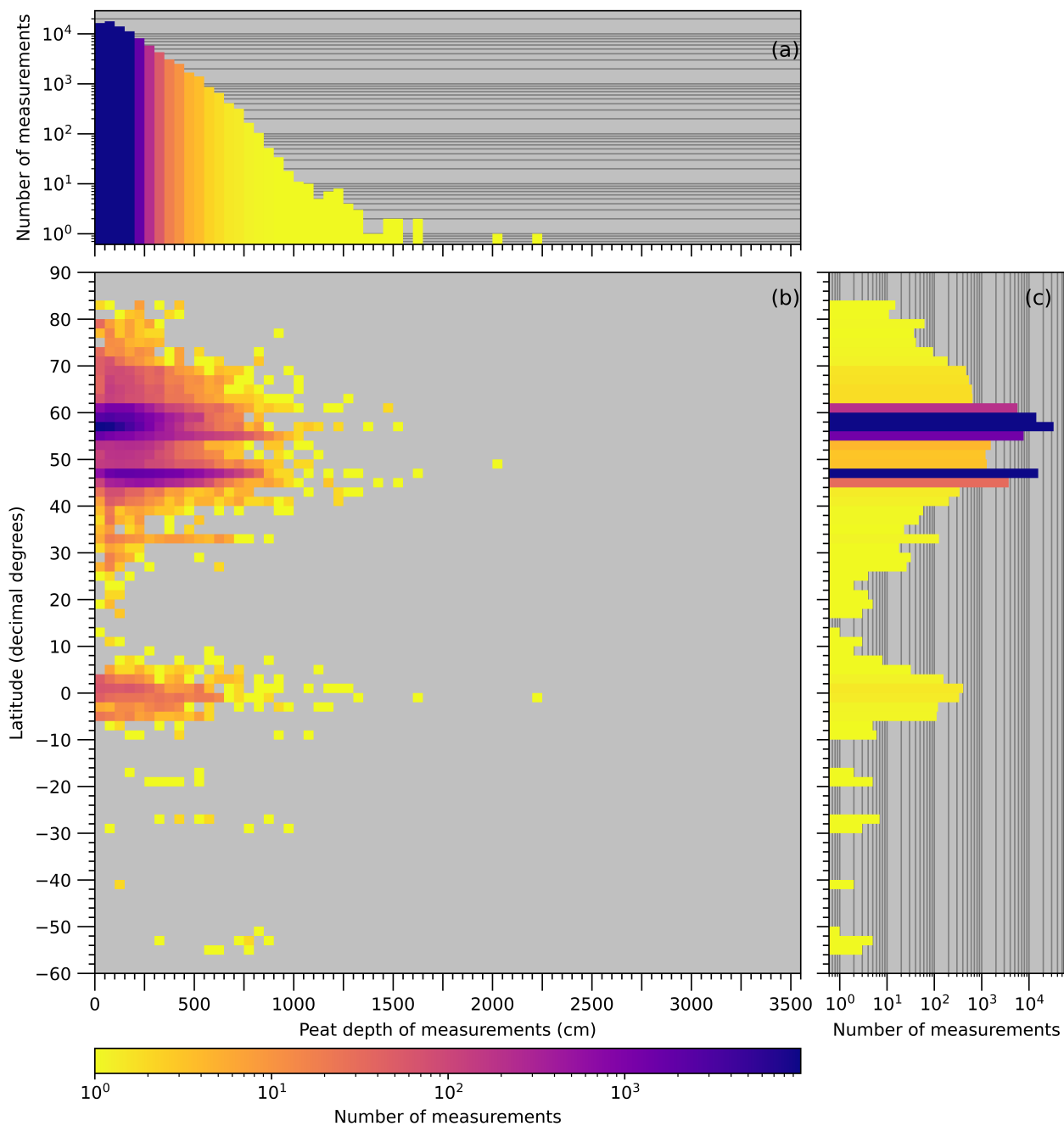
Figure 4. Distribution of measurements by depth (a), by depth and latitude (b), and by latitude (c). WoSIS data are excluded from all panels. Additionally, for this plot, we removed data points noted as drained or modified. At present, this information is only available for the observations derived from the NatureScot dataset (Scottish Government, 2025). Data has been binned by 2° in latitude and 50 cm of depth.

35°N, corresponding to peatland complexes in Florida and the Tibetan Plateau (Figure 2a). The deepest recorded measurement within Peat-DBase (2 223 cm) occurs in Uganda in the East African Highlands (Treat et al., 2017).

The deepest peat deposits typically occur in regions that either escaped glaciation during the Last Glacial Maximum or were among the first to become ice-free during deglaciation, allowing extended accumulation periods (Treat et al., 2019; Ruwaimana et al., 2020; Gowan et al., 2021). Favourable topographic settings, such as flat floodplains and narrow river basins, also facilitate deep peat formation (Figure 2, 4, and see Figure 1 in Treat et al. (2019)). However, peat depth does not correlate linearly with age, as peatlands undergo variable accumulation rates influenced by changing climatic and hydrologic conditions, including periods of enhanced growth, loss, stagnation, or erosion (Ruwaimana et al., 2020; Blaauw and Christen, 2005; van Bellen et al., 2011).

The depth distribution of non-zero measurements in Peat-DBase, which comprise 66.5% of the database, can be fit with a Weibull Minimum distribution (red line in Figure 5). When WoSIS data are excluded, the database composition shifts to non-zero peat depths constituting 97.2% of measurements, with a median depth of 130 cm (interquartile range of 60 - 240 cm).

Most peatland field studies lack spatial scaling considerations, resulting in non-random, clustered distributions around research sites of interest (Hugelius et al., 2020; Meyer and Pebesma, 2022). This spatial clustering prevents direct comparisons between peat-to-non-peat ratios in Peat-DBase and actual peatland coverage.

Figure 5 reveals decreasing data availability with increasing peat depth. While this pattern may reflect natural peat development, sampling bias likely contributes. Deeper coring presents logistical challenges: standard equipment typically handles depths up to several hundred centimetres, while depths exceeding 1000 cm require specialized strategies and equipment (Bansal et al., 2023; Shotyk and Noernberg, 2020).

Our prioritization of large datasets for Peat-DBase version 1.0 may have excluded smaller studies or single-core investigations that reached substantial depths. Counterbalancing that bias, researchers often target presumed peatland centres – typically the deepest areas – for paleo-reconstructions, accumulation rate estimates, or carbon stock assessments. These studies frequently collect limited cores (Hugelius et al., 2013; Hribljan et al., 2016; Loisel et al., 2017), potentially skewing the database's depth distribution toward deeper measurements.

Limited core sampling can affect the representativeness of peat depth distributions in Peat-DBase. In peatlands developed over flat mineral basins with uniform surfaces, relatively few measurements may adequately capture depth variability. However, peatlands formed in complex topography or with variable surface gradients require more extensive sampling to accurately represent depth distributions (Hugelius et al., 2020; Loisel et al., 2017). van Bellen et al. (2011) illustrate this variability using probing, coring, and ground-penetrating radar to reveal surface altitude variations of two to eight metres within individual peatlands. Their findings show that maximum depths do not necessarily occur at geographic centres due to underlying basin topography. To address these sampling challenges, national or regional inventories, such as those from NatureScot (Scottish Government, 2025) and the Government of New Brunswick (Keys and Henderson, 1987; Thibault, 1992), and peatland mapping initiatives employ systematic transects and comprehensive sampling strategies designed to capture diverse peat formations (Hugelius et al., 2020; Crezee et al., 2022; Silvestri et al., 2019a; Parry et al., 2012). These broader sampling approaches can help mitigate depth representation bias within Peat-DBase.
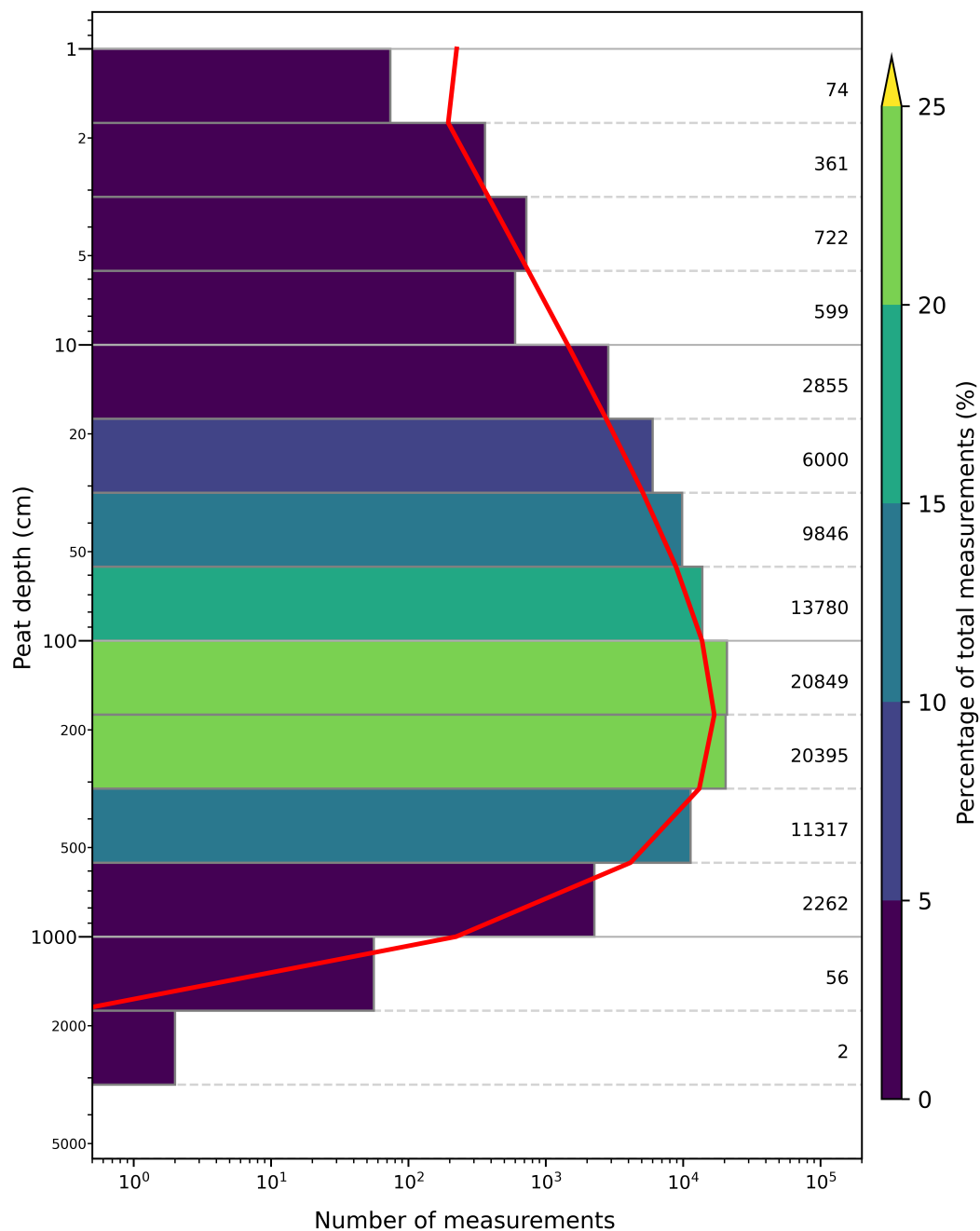
Figure 5. Peat depth distribution within Peat-DBase version 1.0 on a log scale for all peat-present data points. The red line indicates the Weibull Minimum distribution (calculated via SciPy; Virtanen et al., 2020). Note the log scale is applied to both the x and y axes. As this plot focuses on depth distributions, we removed data points noted as drained or modified (n=110 924). At present, this information is only available for the observations derived from the NatureScot dataset (Scottish Government, 2025). Figure A1 is a version of this plot with those measurements included.

4.3 Database Limitations and Future Work

Several uncertainties and limitations should be considered when using Peat-DBase. The database does not reflect current peatland status, as we included historical measurements regardless of present-day conditions. Consequently, some measurements may originate from peatlands that have since been degraded or destroyed by land-use change or climate impacts (Joosten and Clarke, 2002; Koster and Favier, 2005; Ratnayake, 2020; Silvestri et al., 2019a). Future versions will incorporate data on current peatland status to address this limitation. This enhancement is particularly important for applications utilizing Earth observation (EO) data, such as high-resolution land cover datasets, where temporal mismatches can create inconsistencies. Land surface changes occurring after peat core extraction –such as conversion to urban or industrial uses – can create conflicting information between recorded peat depths and current land use, potentially compromising data utility for contemporary analyses. Peat-DBase will also be expanded to include organic carbon content and bulk density data for the soil cores, as well as characteristic information about the sampling site such as hydrological status, soil water pH, vegetation present, etc.

The literature lacks consensus on peat definition, introducing classification uncertainties into Peat-DBase (Lourenco et al., 2022; Gumbricht et al., 2017; Page et al., 2011; Zinck, 2011; Magnan et al., 2024). Organic matter thresholds vary widely: Silvestri et al. (2019a) define peat as containing at least 30% organic matter, while Cole et al. (2015) and Crezee et al. (2022) require at least 65%. Currently, Peat-DBase does not track these varying definitional criteria; however, future versions will incorporate this information to ensure the influence of classification decisions on data interpretation remains traceable.

Measurement accuracy in Peat-DBase reflects the technological constraints of each study period. Many measurements from the 1950s through 1990s predate GPS technology or used early, less accurate receivers (Treat et al., 2017; Hugelius et al., 2020; Sun et al., 2023; Keys and Henderson, 1987). Historical data storage methods also pose challenges for the incorporation of known, existing data, with some datasets existing only in formats difficult to access or process (Thibault, 1992).

Field measurement techniques introduce additional uncertainties. Metal probes may encounter false resistance from buried wood fragments or interbedded mineral layers from ash (Hribljan et al., 2016), fluvium (Lähteenoja et al., 2012), or colluvium before reaching the true peat base (Parry et al., 2014). Coring can compress peat layers, leading to underestimated depths (Shotyk and Noernberg, 2020).

WoSIS shares similar sampling uncertainties with the peat study components of Peat-DBase. Batjes et al. (2020b) document variability in geographic coordinate precision and laboratory measurements within WoSIS, along with corresponding uncertainty metrics. However, since Peat-DBase focuses on peat presence rather than precise mineral soil characterization, we did not incorporate these WoSIS uncertainty measures when identifying non-peat locations. Nevertheless, variability in geographic coordinate precision affects Peat-DBase data from peat-focused sources and will be investigated in future versions to provide positional uncertainty estimates. These estimates are particularly important when using peat measurement data with high-resolution Earth observation (EO) data, as positional uncertainty can result in measurements being erroneously placed in oceans, on mountain tops, or other environments unsuitable for peat formation.

Our duplicate assessment (Sect. 3.3) may introduce subjective bias, as it relies on our interpretation of reasonable evidence of coordinate rounding. Furthermore, we did not test all possible decimal placements due to rounding, potentially missing both subtle and extreme rounding instances.

While some regions lack available peat depth data (Sect. 4.2), other areas have data not yet incorporated into Peat-DBase. Known examples include peat depth measurements from the Amazon Basin near the Madre de Dios River (Householder et al., 2012) and various Indonesian sites (Anda et al., 2021). These datasets were excluded because they lacked readily accessible point-based formats. Additionally, our prioritization of large datasets may have overlooked publications with single or few measurements. Future database versions will aim to incorporate these missing sources and additional datasets as they become available. For example, the Can-Peat project (https://uwaterloo.ca/can-peat/) is currently developing a database of >100 000 Canadian peat depth measurements by digitizing and collating data from both published literature and mandated environmental impact assessments (pers. comm. A. Dalton, June 2025). We are aware of another large dataset (>18 000 measurements) focused on Alberta, Canada (pers. comm. K. Bona, July 2025) that will also be incorporated as it becomes available.

5 Conclusions

Peat-DBase version 1.0 represents the most comprehensive global-scale compilation of peat depth data currently available. With over 200 000 measurements from peat-focused studies alone, it substantially expands when incorporating non-peat soil data. The database's spatial distribution largely aligns with established peatland coverage maps, though notable gaps remain in under-sampled regions. While sampling bias influences the depth distribution, the database serves dual purposes: providing essential data for global-scale analyses and highlighting geographic and depth-range gaps that warrant future research attention. Peat-DBase is presently under active development to both expand the number of measurements and improve its relevance and accuracy.

6 Data availability

Peat-DBase version 1.0 is stored in a CSV file located here https://doi.org/10.5281/zenodo.15530645 (Skye et al., 2025).

Peat-DBase is under active development under a Google grant, *Peat-ML2: A new global benchmark for global peatland carbon inventories*, awarded to JRM and RSW. We encourage interested data contributors to fill out a short survey found at https://forms.gle/WzbUpPQFZMK3Yyme6 to join the project or contact JRM, RSW, or LS.

Appendix A: Non-Peat Study Data

Non-peat study data were added to Peat-DBase to provide representation of non-peat regions. Given that non-peat areas were not the primary focus of Peat-DBase, detailed soil profiling was not prioritized. Rather, the goals in acquiring non-peat data were broad land coverage and confirmation of mineral soil presence. Measurements from these areas were assigned a peat depth of zero cm.

A1 WoSIS

WoSIS maintains a harmonized and quality-controlled database of global soil profiles for digital soil mapping purposes. Exist-
ing soil data are submitted by owners for consideration in WoSIS, where they are stored, assessed, and standardized through
the WoSIS workflow. Iterations of the fully quality-assessed and standardized database are released periodically as snapshots.
The September 2019 snapshot was acquired for use in Peat-DBase. This snapshot is documented in Batjes et al. (2020b) and
the data are available through Batjes et al. (2019).

A2 WoSIS Data Formatting

The non-peat study data were processed to the same format as the peat-focused study data. The WoSIS database is stored
across several TSV files. Only the `wosis_201909_profiles.tsv` and `wosis_201909_layers_chemical.tsv`
files were required for subsequent processing steps; these were converted to CSV file format. These files contain soil profile
coordinates in WGS84 format and the chemical properties of soil profiles, respectively (Batjes et al., 2020b). This information
was used to determine which cores represented mineral soil profiles and therefore non-peat cores.

A3 WoSIS Data Processing

The acquired soil profile data were filtered to include only mineral soil profiles. Our study broadly follows the peatland defini-
tion suggested by Lourenco et al. (2022), which specifies an area with a minimum of 5% organic carbon content to a minimum
depth of 10 cm. Here we treat soils with less than 5% organic carbon content as mineral soils for the purpose of establishing
peat-free locations. The WoSIS dataset often contains organic carbon content measurements in g/kg for multiple layers within
a soil profile, although not all soil profiles have associated organic carbon content data (Batjes and Van Oostrum, 2023; Batjes
et al., 2020b). Therefore, the first processing step was to exclude all soil profiles with no organic carbon content measurements,
since their qualification as mineral soil based on our 5% organic carbon threshold could not be readily determined otherwise.
Next, all organic carbon content measurements were converted from gC/kg of soil mass to percent mass. Any profiles contain-
ing a layer with organic carbon content greater than or equal to 5% were then excluded from the dataset. The coordinates of all
remaining soil profiles were collected as a new dataset, and these locations were assigned a peat depth of zero cm.

The data derived from WoSIS were not subject to duplicate assessment within this study. Duplicate assessment was deemed
not necessary within the dataset itself, as assessment and exclusion processes were applied prior to the WoSIS snapshot release
by the dataset authors (Batjes et al., 2020b). Regardless, we note there remains some entries from the WoSIS database within
Peat-DBase that have the same `location_id` and with a `depth_cm` of 0. Users may need to filter those entries depending
on their need as they may also be considered duplicates (e.g. when training machine-learning models). Duplicate assessment
was additionally not conducted between the derived mineral soil cores and the peat study database, as we assumed significant
duplication between mineral soil profiles and peat study data would be unlikely.
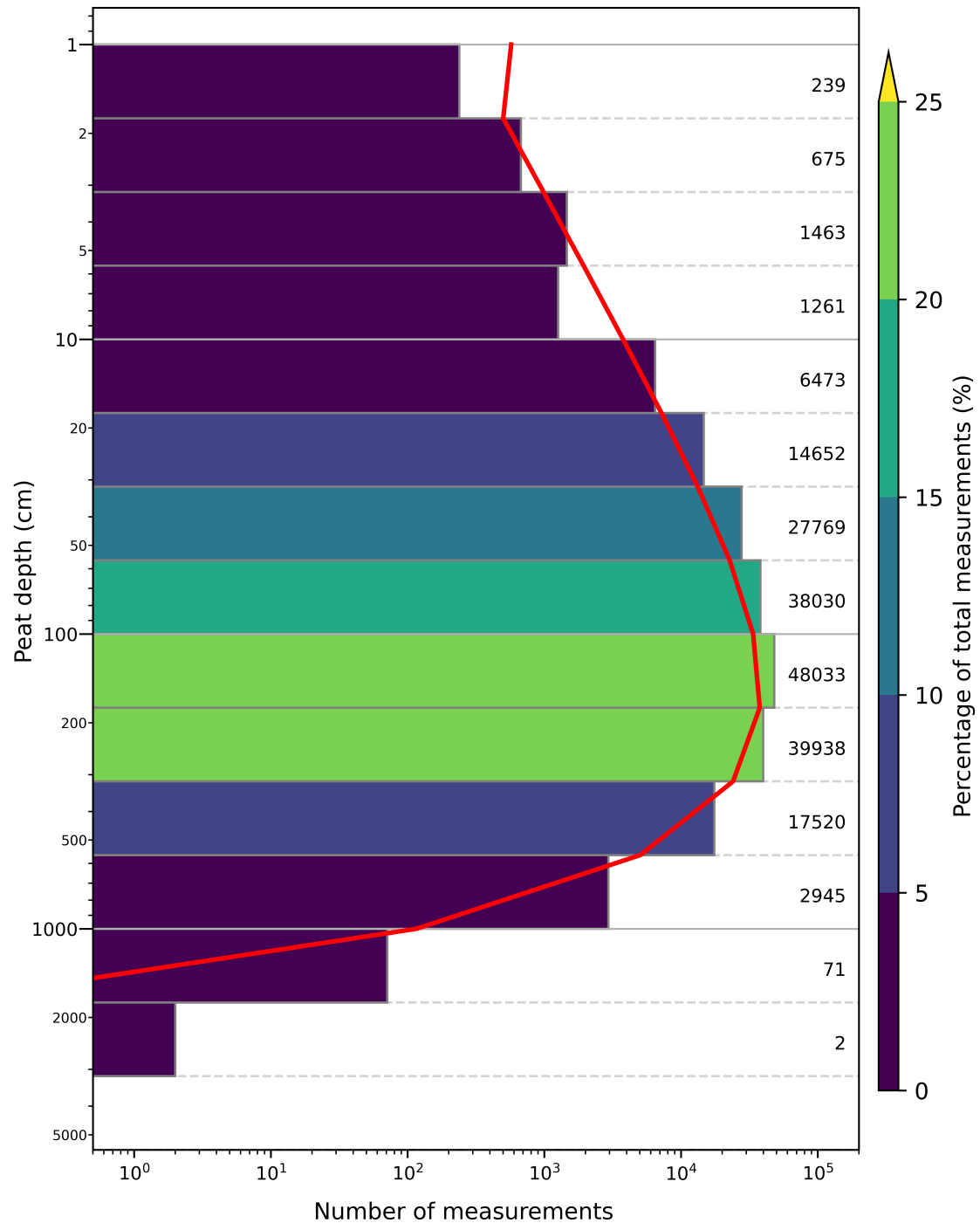
Figure A1. Peat depth distribution within Peat-DBase version 1.0 on a log scale for samples with peat present. The red line indicates the Weibull Minimum distribution (calculated via SciPy; Virtanen et al., 2020). Note the log scale is applied to both the x and y axes. This plot includes data points noted as drained or modified in the NatureScot dataset (Scottish Government, 2025), which were excluded from 5.

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Competing interests. The authors declare no competing interests

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