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MOdern River archivEs of Particulate Organic Carbon: MOREPOC

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Abstract. The supply of particulate organic carbon (POC) associated with terrigenous solids transported to the ocean by rivers plays a significant role in the global carbon cycle. To advance our understanding of the source, transport, and fate of fluvial POC from regional to global scales, databases of riverine POC are needed, including elemental and isotope composition data from contrasted river basins in terms of geomorphology, lithology, climate, and anthropogenic pressure. Here, we present a new, open-access, georeferenced, global database called Modern River Archives of Particulate Organic Carbon (MOREPOC) version 1.0, featuring data on POC in suspended particulate matter (SPM) collected at 231 locations across 118 major river systems. This database includes 3,424 SPM data entries, among which 2,943 with POC content, 3,260 with stable carbon isotope ($\delta^{13}C$) values, 2,018 with radiocarbon activity ($\Delta^{14}C$) values, 1,838 with total nitrogen content, and 309 with aluminum-to-silicon mass ratios (Al/Si). The MOREPOC database aims at being used by the Earth System community to build comprehensive and quantitative models for the mobilization, alteration, and fate of terrestrial POC. The database is made available on the Zenodo repository in machine-readable formats as data table and GIS shapefile at https://doi.org/10.5281/zenodo.6541925 (Ke et al., 2022).

1. Introduction

Rivers are the main conveyor of terrestrial material to the ocean in the form of suspended particulate matter (SPM), which carries particulate organic carbon (POC) (Leithold et al., 2016; Blair and Aller, 2012). The input of terrestrial POC to coastal and ocean environments is a key feature of the global carbon cycle, which needs to be better quantified in particular in the context of current global environmental changes.

Riverine POC is a mixture of organic carbon (OC or C_{org}) from various sources, which can be split into two major origins: biospheric POC (POC_{bio}) and petrogenic POC (POC_{petro}) (Blair et al., 2003; 2004; Galy et al., 2007; Hilton et al., 2008). Plants, microbes, soils, and aquatic organisms all contribute radiocarbon-enriched POC_{bio} to riverine POC, with ages ranging from modern to multi-millennial (Galy et al 2007; Blair et al., 2010; Hilton et al., 2011). Radiocarbon-dead POC_{petro} is derived from the erosion of sedimentary rocks and consists of terrestrial or marine organic carbon photosynthesized millions of years ago and have survived to at least one full erosion/sedimentation/exhumation cycle (Galy et al., 2008a; Hilton et al., 2011). The balance between the release of CO_2 by oxidation of POC_{petro} and the drawdown of CO_2 by burial of POC_{bio} in marine sediments controls the impact of the OC cycle on atmospheric CO_2 level at geological time scale (> 100,000 years). The resulting long-term global carbon fluxes are similar in magnitude to those from silicate weathering and volcanism (Berner, 2003; Hilton et al., 2014; Petsch, 2014; Galy et al., 2007; Galy and Eglinton, 2011; Hilton and West, 2020). Consequently, it is fundamental to quantify POC sources and fluxes as well as to understand the fate of the different POC pools, in order to better constrain the role played by POC in the global carbon cycle. To that aim, radiocarbon activity provides unique information on POC age, residence time, and source. Thanks to improved carbon-dating technology and more easily accessible accelerator mass spectrometry (AMS, Wacker et al., 2010), routine and high-precision radiocarbon dating has been extensively applied for the analysis of radiocarbon abundance in riverine POC during the last two decades. Together with the stable isotope composition of carbon ($^{13}C/^{12}C$ ratio, expressed as $\delta^{13}C$), POC content, or other organic-inorganic proxies (*e.g.*, organic carbon-to-nitrogen C_{org}/N ratio, aluminum-to-organic carbon Al/OC ratio), radiocarbon activity helps to constrain the source, transport, and fate of riverine POC (Raymond and Bauer, 2001).

Globally, rivers drain areas of contrasted lithology, climate, tectonics, vegetation, and anthropogenic pressure. At the global scale, temperature and precipitation exert strong controls on turnover time, and thus radiocarbon activity, of soil organic carbon (SOC; Shi et al., 2020; Carvalhais et al., 2014), which is a dominant component of riverine POC (*e.g.*, Tao et al., 2015; Wu et al., 2018; Wild et al., 2019). In permafrost regions, SOC has longer turnover time and is depleted in ^{14}C, whereas SOC with the shortest turnover time and the most enriched ^{14}C signature is found in tropical forests and savannahs (Shi et al., 2020; Carvalhais et al., 2014). Consequently, riverine POC is significantly older in Arctic rivers (*e.g.*, Kolyma, Lena) than in tropical rivers such as the Congo or Amazon (Holmes et al., 2021; Marwick et al., 2015; Mayorga et al., 2005). The geodynamic setting of a river system also exerts a strong control on POC dynamics. In passive margins, terrigenous sediment typically experiences a series of erosion-deposition episodes because of the long distances between the upland source region and the ocean (Blair and Aller, 2012). Consequently, it is on active margins that the original POC source signature is transmitted with the best fidelity (Blair and Aller, 2012). Finally, humans greatly modify the delivery of POC to the ocean, in particular through massive storage of POC at reservoirs (Best et al., 2019; Battin et al., 2009) or increase in soil erosion in response to agricultural practices (Montgomery, 2007; Quinton et al, 2010).

Even though recent research has advanced our understanding of the governing environmental controls from catchment- to global scales (Galy et al., 2015; Hilton, 2008; Coppola et al., 2018; Hemingway et al., 2019; Eglinton et al., 2021), there is still a lack of quantitative constraints on the effect of environmental drivers on the carbon isotopic composition of riverine POC. The recent release of the International Soil Radiocarbon Database (ISRaD) (Lawrence et al., 2020) enables the improvement of those Earth system models aiming to predict global SOC radiocarbon distribution and turnover time (Shi et al., 2020; Carvalhais et al., 2014). However, such prediction is still hampered for fluvial POC, despite existing capabilities for modeling water discharge, SPM concentration, and POC content based on global water quality datasets (Ittekkot, 1988; Ludwig et al., 1996, Meybeck, 1993), such as the WBMsed global hydrology model (Cohen et al., 2014) or the Global NEWS2 (Mayorga et al., 2010).

Here we provide a new database for riverine POC, called MOREPOC (for MOdern River archivEs of Particulate Organic Carbon) v1.0, compiling 2,018 $\Delta^{14}C$ data, thereby representing a significant update of the previously reported global dataset by Marwick et al. (2015) with 531 $\Delta^{14}C$ data. MOREPOC v1.0, featuring data published in international, peer-reviewed articles, provides the basis to 1) uncover the fundamental mechanisms of preservation and alteration of river POC (in terms of "bulk" POC as well as for the individual POC_{bio} and POC_{petro} pools); and 2) help with the construction of numerical models able to simulate the isotopic compositions of POC in the context of global change. MOREPOC database is publicly available on the Zenodo repository at https://doi.org/10.5281/zenodo.6541925 (Ke et al., 2022).

2. MOREPOC v1.0: a compilation of data on global riverine POC

2.1 Data source

In MOREPOC v1.0, through a comprehensive literature investigation of 117 peer-reviewed articles, we compiled 3,424 POC-related data entries, including 2,100 with SPM concentration, 2,943 with POC content, 3,260 with stable carbon isotope $\delta^{13}C$ values, 2,018 with radiocarbon activity $\Delta^{14}C$ values, 1,835 with total nitrogen content (see details in Table.1), and 309 with aluminum to silicon mass ratios (Al/Si). Note that river bed or bank sediments are not included in this database. We selected studies reporting at least one carbon isotopic data, and those with paired elemental and dual carbon isotopic values. Studies reporting only POC contents were not compiled into the MOREPOC v1.0. Error generated during the compilation of data entries was carefully checked through manual and statistical examination, and duplicate data were removed. A supplementary table “MOREPOC_RM” is provided to give additional information on references, sampling method of SPM, filtration strategy, decarbonization methods, and detailed information for acid adopted, etc.

Table 1: Riverine SPM data availability for each continent.

Continent	Samples no.	SPM no.	POC no.	TN no.	$\delta^{13}C$ no.	$\Delta^{14}C$ no.
Asia	1,889	1,131	1,793	1,106	1,811	1,186
Africa	278	277	277	103	278	115
Europe	130	81	99	23	125	113
Oceania	91	59	91	89	91	26
North America	756	336	424	379	676	475
South America	280	216	259	135	279	103
Total	3,424	2,100	2,943	1,835	3,260	2,018

2.2 Georeferencing

When available, sampling location was projected in a Geographic Coordinate System using the World Geodetic System 1984 (WGS1984). For references only providing a sampling map without any numerical information on sampling, sampling coordinates were manually extracted using ArcGIS 10.3 after georeferenced adjustment. In the end, 3,211 SPM samples have coordinate information among the 3,424 compiled SPM entries (Figure 1).

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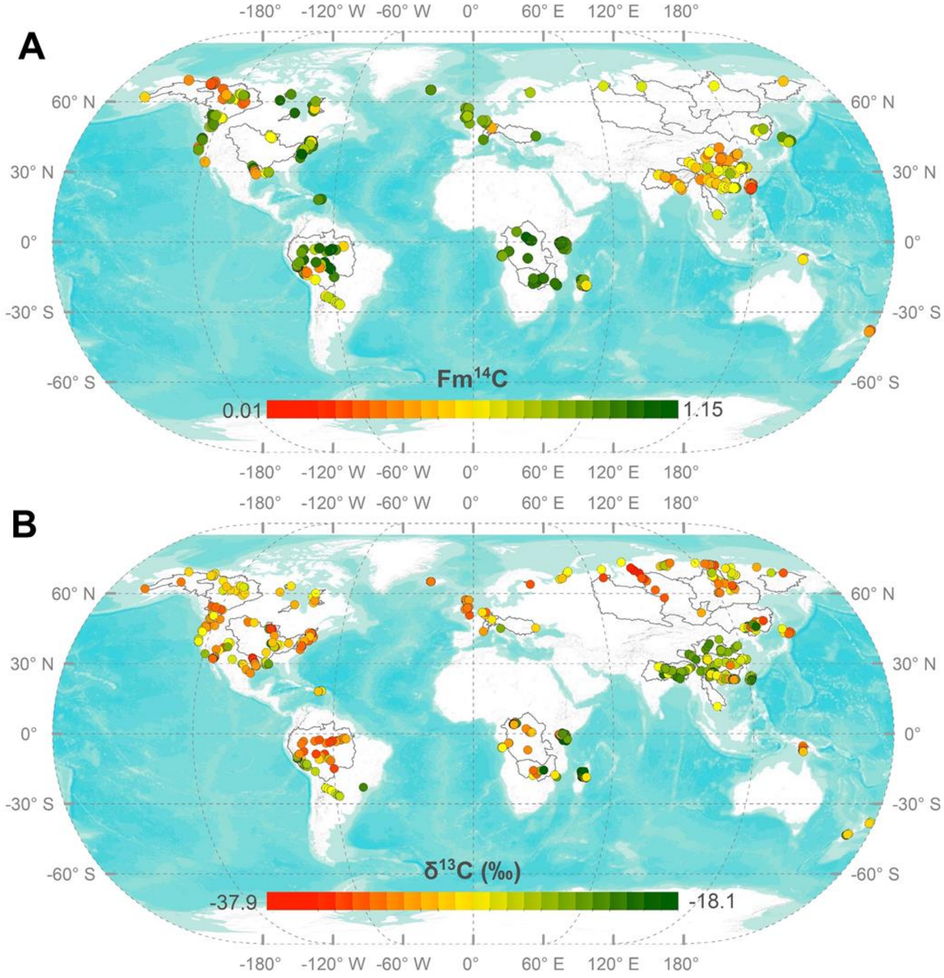


90 **Figure 1: Overview of the dual carbon isotope data of MOREPOC v1.0. A; Fm^{14}C values; B :δ^{13}C values. If several samples are from the same location, only the average is presented here.**

2.3 Database structure

To make MOREPOC v1.0 machine-readable, the compiled parameters were labeled with a short name as shown in Table. 2.

95 **Table. 2 Description of the parameters of the MOREPOC v1.0 database.**

Parameter	Description	MOREPOC column name
River name	Name of the major river system	riv_na
Sub river name	Name of the sampled river/stream	bas_na
Continent	Name of the continent	cont
Sampling site/code	Expedition sampling ID	code
Sampling date	Time (month/day/year) when the SPM sample was collected	time_m/d/y
Latitude	Decimal latitude using WGS 1984	lat
Longitude	Decimal longitude using WGS 1984	lon
Sampling technique	Method of SPM sampling	type_spm
Size fraction of SPM	Reported size fractions analyzed	fra_spm
SPM concentration (mg/L)	The total dry weight of SPM in mg per liter water column	conc_spm
POC concentration (mg/L)	The total dry weight of POC in mg per liter water column	conc_poc
POC content (%)	The total POC content of SPM in wt %	per_poc
δ^{13}C (‰)	δ^{13}C values of POC (decarbonated) in ‰	d13c_poc
Δ^{14}C (‰)	Δ^{14}C values of POC (decarbonated) in ‰	D14c_poc
Fraction modern (Fm)	Fraction modern of POC	f14c
Radiocarbon ages (year)	Radiocarbon ages before present (1950)	rca
TN content (%)	The total nitrogen content of SPM in wt %	per_tn
C_{org}/N mass ratio	Mass ratio of POC to TN in SPM	cn_mar
Al/Si mass ratio	Mass ratio of Al to Si in SPM	as_mar
Reference	Full list of citations of the data source	ref
Complete reference	Complete information for cited references	ref_c
Measured carbon isotopes	Summarization of ^{13}C or/and ^{14}C measured	iso_m
Filter	Filter used to obtain SPM	filter
Acid	The acid type used to remove carbonate in SPM	acid
Decarbonization method	The method used to remove carbonate in SPM	m_acid
Acid concentration	The concentration of adopted acid to remove carbonate in SPM	conc_acid
Decarbonization temperature	The environmental temperature for acid to remove carbonate in SPM	temp_acid
Decarbonization duration	The reaction time used for acid to remove carbonate in SPM	time_acid
Note	Additional information for the decarbonization process	note

2.4 Information on sampling technique

In the compiled studies, five different sampling techniques (parameter "type_spm" of MOREPOC v1.0) have been adopted to retrieve river sediments with the aim of measuring POC content and composition:

- *Surface SPM sampling ("type_spm = SS")* consists in collecting SPM within the first meter below the channel surface. This sampling scheme is the most frequently used and widely adopted in riverine POC studies.
- *Mid-depth SPM sampling ("MS")* consists in collecting SPM at an intermediate depth between the river surface and bottom. This sampling strategy has been used in studies on the Mekong (Martin et al., 2013) and the Mackenzie (Campeau et al., 2020).
- *Integrated sampling over depth profiles ("ISD")* aims at obtaining a representative SPM sample accounting for grain size sorting along the water column, typically by making a flux-weighted composite of several samples collected at different depths along the water column. This sampling strategy has been adopted only for the Huanghe and the Changjiang (Wang et al., 2012), and for the Zengjiang, a tributary of the Zhujiang (Gao et al., 2007).
- *Point sampling along depth profiles ("PSD")* is the collection of SPM along individual depth profiles at different depths in the water columns. In this method and in contrast to the previous one, each SPM sample is treated and analyzed separately. This method allows accessing the full range of particle sizes of SPM, explaining its wide use in the literature (*e.g.*, Ganges-Brahmaputra [Galy et al., 2008], Mackenzie [Hilton et al., 2015], Bermejo [Repasch et al., 2021]).
- *Point sampling over transects ("PST")* corresponds to *PSD* collection of SPM along several depth profiles across a given river channel section. This sophisticated sampling scheme allows for the exploration of the potential lateral heterogeneity in a river channel. It has been recently used in the Amazon (Bouchez et al., 2014), the Salween and the Irrawaddy (Baronas et al., 2020), and the Danube (Freymond et al., 2018).

2.5 Information on SPM extraction from river water samples and on analyzed size fractions

Broadly speaking, two methods are commonly adopted to extract SPM from a water sample, 1) continuous flow centrifugation, whereby large volumes of water can be centrifuged at high centrifugal forces; 2) filtration under pressure or vacuum using membranes in glass fiber (GF/F), PolyEtherSulfone (PES), Polycarbonate (PTCE), Nylon, quartz, or Mixed Cellulose Esters (MCE), at a porosity of 0.22 μm, 0.45 μm, or 0.7 μm. This information is recorded in MOREPOC_RM in detail if described in the corresponding source reference (parameter “Filters”).

In general, most studies used bulk SPM retrieved after filtration for the analysis of POC. However, in some studies, only certain size fractions of SPM were analyzed, after separation into *e.g.*, a fine (<63 μm) and a coarse (>63 μm) fraction. This information is reported in MOREPOC v1.0 as the “fra_spm” parameter (see Table 2).

2.6 Information on decarbonization method

Particulate inorganic carbon (PIC) and POC have distinct carbon isotopic signatures, such that the accuracy of POC δ^{13}C and Δ^{14}C values could be compromised if the PIC is not efficiently removed by acidification prior to POC analysis (Komada et al., 2008). Two methods have been mostly adopted in the studies referenced in MOREPOC v1.0:

- The "*acid rinse method*", in which sediment samples are acidified at a given temperature for a given time, and then rinsed with distilled water.
- The "*acid vapor method*", in which sediment samples are exposed to vaporous concentrated hydrochloric acid in a closed system maintained at a given temperature for a given time, and then evacuated under vacuum.

A separate file of MOREPOC v1.0 ("MOREPOC_RM") provides detail on decarbonization method (*m_acid*), acid type (*acid*), molarity and quality (*conc_acid*), reaction time (*time_acid*), and temperature (*temp_acid*), allowing for quality evaluation of the method used in the cited references.

2.7 Definitions of POC composition variables and units

In MOREPOC v1.0, all data are either taken directly from references or calculated from the reference data. POC content (POC%), and total nitrogen content (TN%) are reported as dry weight percentage (%). Besides, POC concentration in river water (mg/L) can be calculated using SPM concentration reported as dry weight per liter (mg/L) and percentage content of POC (%).,

Most importantly, the fundamental component of MOREPOC v1.0 consists in an extensive dataset for stable carbon isotope values (δ^{13}C, in ‰ relative to VPDB) and radiocarbon compositions (provided as both Δ^{14}C in ‰ or as F^{14}C; see below). Conventional Radiocarbon Ages (RCA) are given in MOREPOC v1.0 following Stuiver and Polach (1977), using the Libby half-life of 5,567 years with the mean life of 8,033 for ^{14}C. RCA is expressed in units of years before present (BP), with year zero being 1950"

$$\mathrm{RCA} = -8033 \ln (F^{14}\mathrm{C}) \tag{1}$$

Δ^{14}C value, which is defined as the relative difference between the absolute international standard (the base year 1950) and sample activity corrected for age and mass-dependent fractionation (Stuiver and Polach, 1977), is reported in MOREPOC v1.0 as well. A positive Δ^{14}C indicates the presence of "bomb carbon", whereas a negative Δ^{14}C indicates that the radioactive decay of C overwhelms any incorporation of bomb carbon into the sample. The Δ^{14}C calculation is defined as equation 2:

$$\Delta^{14}\mathrm{C}\ (\text{in ‰}) = \left[F^{14}\mathrm{C} * exp\left(\frac{1950-yr}{8267}\right) - 1\right] * 1000 \tag{2}$$

Where *yr* is the year when the sediment was collected, 8,267 is the true mean life of ^{14}C using the Cambridge half-life of 5,730 years.

Lastly, if available, the aluminum-to-silicon mass ratio (Al/Si) is provided in MOREPOC v1.0 as well. This elemental ratio is an efficient proxy for the particle size of riverine sediment (Bouchez et al., 2011; Galy et al., 2007; Hilton et al., 2015).

2.8 Extent of MOREPOC v1.0

Although MOREPOC v1.0 features data from river systems worldwide (except the Antarctic), it does not offer the same degree of representativeness for all the continents with, for instance, an over-representation of Asian rivers and an underrepresentation of rivers of Europe and Oceania (Table. 1).

MOREPOC v1.0 database does not compile elemental and dual isotopic compositions of molecular compounds (plant-wax fatty-acid and lignin-phenol), thermal labile fractions, or black carbon. However, such complementary data could be incorporated into future versions.

3. Global riverine POC patterns

3.1 Trends of δ^{13}C and Δ^{14}C in MOREPOC v1.0

The mobilization of terrestrial organic matter into fluvial systems depends on the interplay between tectonics, climate, geomorphology, lithology, and anthropogenic activities, all controlling to some extent the amount and composition of riverine POC (Blair and Leithold, 2010; Eglinton et al., 2021).

Riverine POC displays significant heterogeneity in elemental and isotopic carbon compositions around the globe (Figures 1 and 2). δ^{13}C values (n=3,244) ranges from -38‰ to -17‰ with an average value of -26.2‰. As shown in Figure 2, the majority of the data falls between -28‰ to -24‰ (n=1,759, 54.2% of total entries), which is consistent with the overall isotopic signature of the terrestrial biosphere of -26±7‰ (Schidlowski et al., 1988). The age of riverine POC spans from "modern" (that is, recording bomb-derived carbon) to "ancient" (strongly influenced by fossil petrogenic source), with Δ^{14}C values (n=2,018) ranging from -990.1‰ to 147.7‰ with a statistical average of -380.3‰. A large fraction of the Δ^{14}C values (n=775, 38.4% of total entries) falls within the range -300‰ to 0‰, this range dominates the database in Marwick et al (2015) as well (n=278, 52.3% of Marwick's total entries). The MOREPOC v1.0 dataset is on average more ^{14}C depleted than that of Marwick et al (2015).

Around the globe, the most ancient POC (Δ^{14}C = -990‰) is found in small mountainous rivers in Taiwan (Hilton et al., 2010), in which the entirety of POC is derived from the erosion of sedimentary rocks. In the riverine POC dataset of MOREPOC v1.0, bomb carbon signals are abundant (Δ^{14}C > 0‰), particularly for African rivers in tropical regions such as Athi-Galana-Sabaki, Tana, Zambezi, and Congo (Marwick et al., 2015; Spencer et al., 2012); rivers in North America including Hudson, Siuslaw, and York; rivers draining to the Hudson Bay (Leithold et al., 2006; Raymond and Bauer, 2001; Godin et al., 2017; Longworth et al., 2007); and the Andean Amazon (Mayorga et al., 2005; Townsend-Small et al., 2007). The most depleted ^{13}C signatures (less than -35‰) are observed for POC from Arctic rivers, such as the Ob', Yukon, and Kolyma (Holmes et al., 2021). The highest δ^{13}C values (higher than -22‰) are found in rivers from Africa (Athi-Galana-Sabaki, Betsiboka, and Tana; Marwick et al., 2015; Tamooh et al., 2013) and mountainous rivers (*e.g.*, Taiwan, upper Ganges, Minjiang; Hilton et al., 2010; Galy et al., 2007; Galy et al., 2008b; Wang et al., 2019).

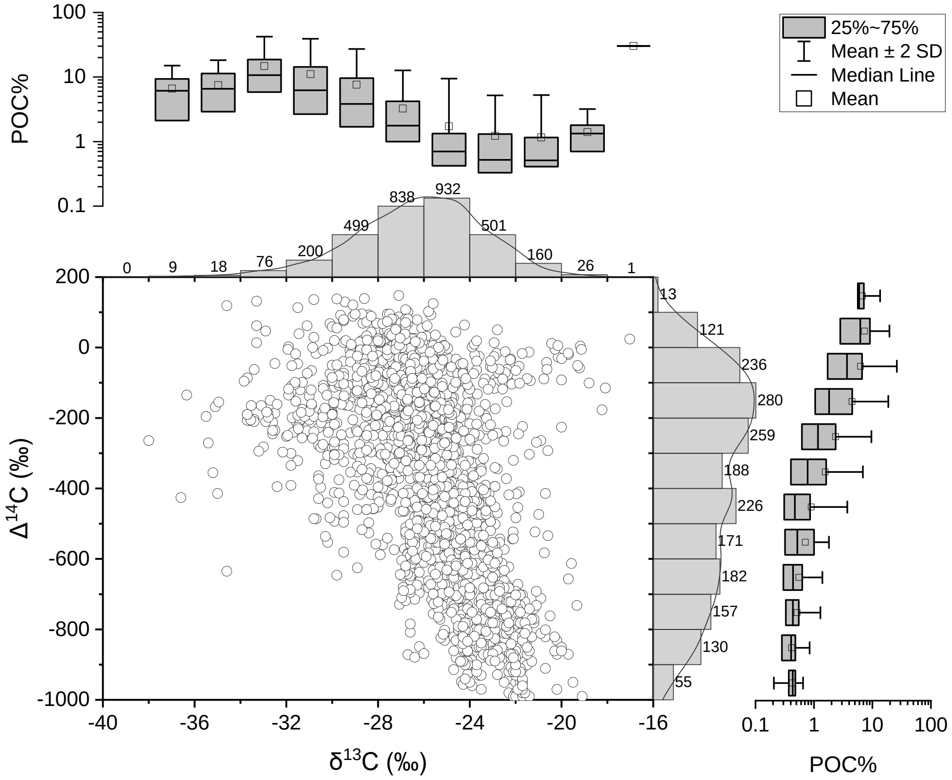


Figure 2: $\delta^{13}C$ versus $\Delta^{14}C$ of MOREPOC v1.0 (n=1,860). Frequency distribution histograms for $\delta^{13}C$ (x-axis) and $\Delta^{14}C$ (y-axis) are shown, with $\delta^{13}C$ values binned every -2.5‰ from -40‰ to -15‰, and $\Delta^{14}C$ values binned every -50‰ from -1000‰ to 200‰. Each bin is labeled with the number of samples it hosts. Solid lines represent the corresponding probability density functions. Box charts represent the statistical analysis of POC% in each bine of $\delta^{13}C$ (x-axis) and $\Delta^{14}C$ (y-axis).

As observed in the global compilation in Figure 2, elemental and isotopic data of POC show an inverse relationship between $\delta^{13}C$ and $\Delta^{14}C$, and generally an increasing POC content with higher radiocarbon activity of POC. Indeed, OC from sedimentary rocks (*i.e.*, dead OC with $\Delta^{14}C$=-1000‰ by definition) usually has ^{13}C-enriched signature compared to recent biomass. Eroded material from sedimentary rocks thus has lower POC content, is ^{14}C-depleted and has relatively high OC ^{13}C signatures. This global pattern stems from the global dominance of C3 plants in the studied catchments (Figure 2). However, it can also be observed that POC-rich riverine SPM can be relatively enriched at ^{13}C, *i.e.*, $\delta^{13}C$ values larger than -20‰ (Figure 2 and Figure 3). This pattern indicates the presence of an additional pool of ^{14}C- and ^{13}C-rich POC in the terrestrial environment (Cerling et al., 1997), consisting of modern C4-plants in catchments dominated by grasslands or savannah (*e.g.*, Marwick et al., 2015). The maximum values of $\delta^{13}C$ and $\Delta^{14}C$ of POC (dotted line in Figure 3) tend to be more depleted at high latitudes than at low latitudes. This might reflect the combined effects of increasing coverage of C4 plants in tropical regions and the input of pre-aged OC_{bio} from degrading permafrost at high latitude (Cerling et al., 1997; Still et al., 2003).

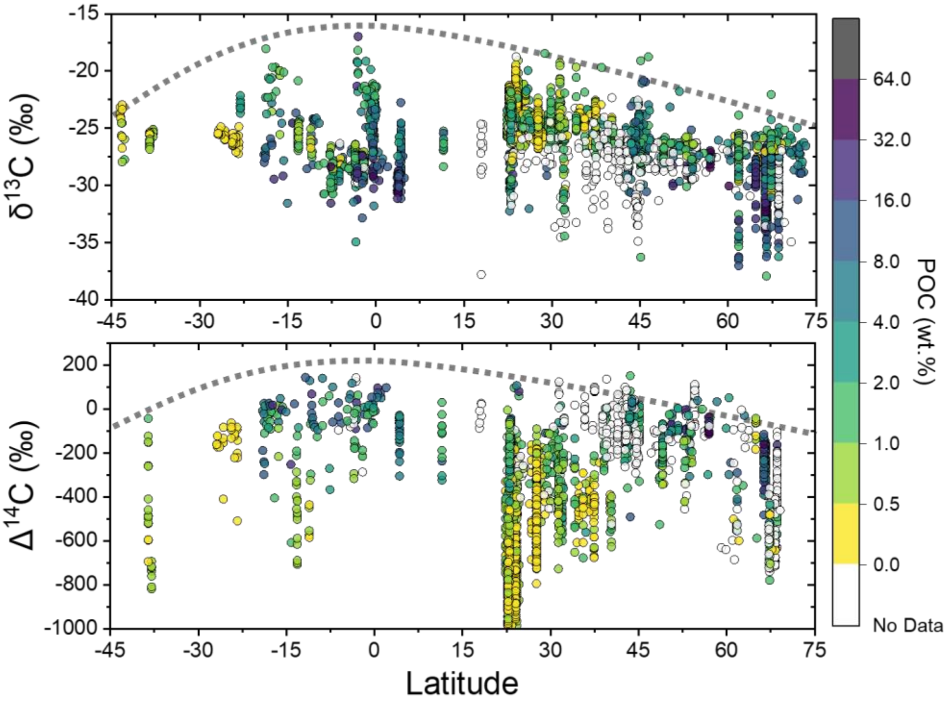


Figure 3: Latitudinal trends in δ^{13}C (n=3,064) and Δ^{14}C (n=1,944) in MOREPOC v1.0. Colors indicate POC content (wt. %). Dotted lines represent upper envelopes of δ^{13}C and Δ^{14}C values of POC.

3.2 Relationships between riverine SPM and POC

MOREPOC v1.0 features data from rivers with SPM concentrations ranging from 0.35 to 199,000 mg/L and POC concentration from 0.01% to 91.67%. SPM and POC concentrations (both expressed in mg/L; n=2,044) are positively correlated (Figure 4). However, the global trend shows that an increase in SPM concentration is accompanied by a decrease in POC content (in %) (Ittekkot, 1998; Ludwig et al., 1996; Meybeck, 1993). In MOREPOC v1.0, large SPM concentrations (over 10,000 mg/L) are generally observed in mountainous rivers, such as the Choshui and Liwu rivers in Taiwan (Hilton et al., 2008; Kao et al., 2014), the Santa Clara River (USA) (Masiello and Druffel, 2001), or the Minjiang (a major tributary of the upper Changjiang, China) (Wang et al., 2019). The Huanghe is an exception in that it has very large SPM concentrations in its middle reaches where it drains the Chinese Loess Plateau (Qu et al., 2020; Hu et al., 2015). Although the sediment of highly turbid rivers is typically POC-poor, high sediment concentrations generate the largest POC load (Figure 4). This observation also underlines the importance of sediment transport near the channel bottom in large rivers where SPM concentration is usually much higher than at the surface (cite studies with depth profiles showing high SPM at the bottom), as well as the role of stochastic events leading to high-turbidity episodes such as storms, landslides, or earthquakes (Hilton et al., 2008). Small SPM concentrations (less than 10 mg/L) are characteristic of rivers draining either high-latitude or tropical areas, in which typical POC content is relatively high (Gao et al., 2007; Holmes et al., 2021).

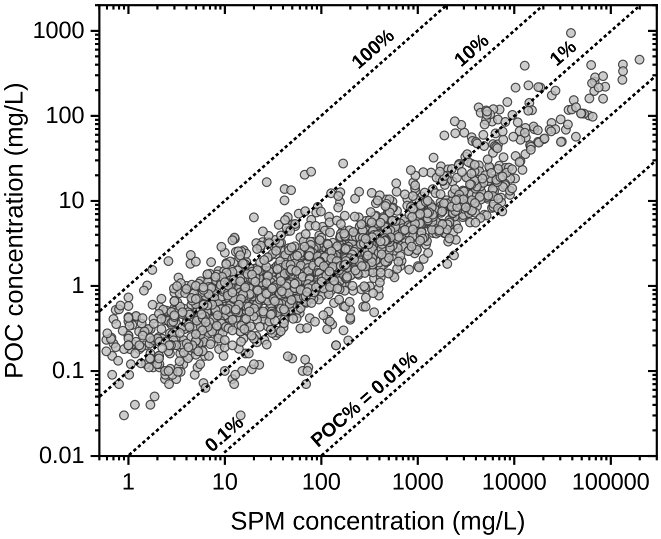
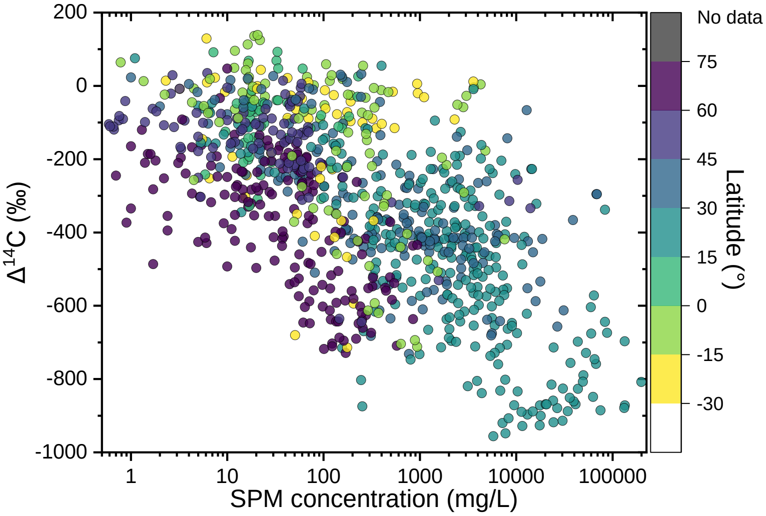


Figure 4: River SPM concentration vs. POC concentration (n=2,041), both expressed in mg/L. Dotted lines represent contours of constant POC content.

Globally, POC becomes ^{14}C-depleted with increasing suspended sediment load (Figure 5) and decreasing POC content (Figure 6). These relationships are most likely caused by the dilution of POC$_{bio}$ by POC$_{petro}$ in areas of strong erosion (Leithold et al., 2016). However, for a given SPM concentration, a large range of ^{14}C composition can be observed. For example, rivers draining low-latitude, tropical regions (especially 10°N – 10°S; *e.g.*, African rivers) or high-latitude regions (60°N - 75°N; *e.g.*, Siberian Arctic rivers) are usually characterized by relatively low SPM concentration and abundant POC composition. However, in general, riverine POC from the low-latitude African rivers is much younger compared to that from the Arctic Siberian regions. This difference most likely stems from the contrasting radiocarbon activities and turnover of the soil organic carbon (SOC) between these two regions, which are primarily driven by climate (Eglinton et al., 2021; Marwick et al., 2015; Wild et al., 2019; Vonk et al., 2015).

The MOREPOC v1.0 dataset also reveals that under a given climate river systems can be heterogeneous in terms of SPM concentration and associated POC composition. For example, amongst circum-Arctic rivers, the Mackenzie River has a relatively large SPM concentration of 162 mg/L on average (n=118) with 2.4% POC (n=109) characterized by a fairly low Δ^{14}C (average value of -571‰, n=130; Hilton et al., 2015; Schwab et al., 2020; Holmes et al., 2021; Campeau et al., 2020). In contrast, the Yenisei River only has an average SPM concentration of 5.7 mg/L (n=83) but much higher POC content (17.4%, n=81) and Δ^{14}C value (-264‰, n=27; Holmes et al., 2021). Such difference suggests that lithology can play an important role in riverine POC composition by providing a substantial fraction of fossil OC (Hilton et al., 2015). On the other hand, small mountainous rivers such as those in Taiwan or those draining the Himalayas show large SPM concentrations and low POC contents with low radiocarbon activities. These regions characterized by active tectonics, steep slopes, and intense precipitation, act as global hotspots for sediment production (Milliman and Farnsworth, 2011).



245 **Figure 5: POC $\Delta^{14}C$ vs. SPM concentration (n=913). Colors indicate the latitude of the sampling location. Note the log-scale used for SPM concentration.**

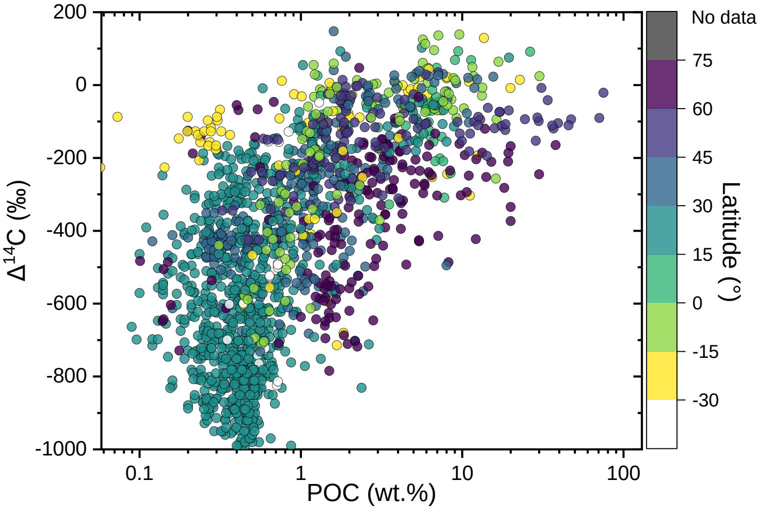


Figure 6: $\Delta^{14}C$ values vs. POC content (n=1,610). Colors indicate the latitude of the sampling location. Note the log-scale used for 250 **POC content.**

4. Database availability

MOREPOC v1.0 database is publicly available on the Zenodo repository in machine-readable formats as Excel spreadsheet (.xslx), comma limited table (.csv), and GIS shapefile at https://doi.org/10.5281/zenodo.6541925 (Ke et al., 2022).

5. Conclusions

In this paper, we introduce MOREPOC, the largest and most comprehensive database for riverine suspended particulate matter (SPM) concentration and particulate organic carbon (POC) composition, including POC and total nitrogen (TN) content, stable carbon isotope (^{13}C), cosmogenic-radioactive carbon isotope (^{14}C), as well as aluminum-to-silicon (Al/Si) mass ratios. MOREPOC will benefit the scientific community carrying out research on riverine POC sources, transport, and fate as well as Earth system modelers. Combined with ocean sediment databases, such as CASCADE (Circum-Arctic Sediment Carbon DatabasE, Martens et al., 2021) or MOSAIC (Modern Ocean Sediment Archive and Inventory of Carbon, Van der Voort et al., 2021), MOREPOC will enable a better understanding of the fate of POC from source to sink. Existing environmental raster global datasets for climate, geomorphology, lithology, tectonics, hydrology, and land use, also offer promising prospects for the use of MOREPOC for identifying the controls on POC fluxes and composition, in particular using advanced statistical analysis or machine learning techniques. Future updates of MOREPOC should include new bulk POC parameters as well as data on molecular fractions, thermal labile fractions, or specific components such as black carbon or fossil carbon, which should, in turn, provide additional insight into the alteration of riverine POC from source to sink, an essential feature of the global carbon cycle.

Author contribution

YK collected the MOREPOC data and conceptualized, designed, structured, and filled the database. YK and DC contributed to the database checking. YK prepared the manuscript. YK drafted and coordinated the manuscript with input from DC, JB, and CQ.

Competing interests

The authors declare that they have no conflict of interest.

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