

Radiocarbon, stable carbon isotope and C/N composition of Amazon River particulate organic carbon (POC) from samples collected aboard the R/V Mirage in May of 2023

Website: <https://www.bco-dmo.org/dataset/1002805>

Data Type: Other Field Results

Version: 1

Version Date: 2026-07-23

Project

» [Collaborative Research: What Happens to Terrestrial Organic Matter in the Ocean? Solving the Mystery Behind an Iconic Question](#) (MUDBENCS)

Contributors	Affiliation	Role
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Abstract

This dataset contains 48 samples of particulate organic carbon collected from the lower Amazon River from May 1st-12th, 2023. The tabulated data include sample number, date, latitude, longitude, sample type, fraction modern radiocarbon (Fm), $\Delta 14C$, $\delta 13C$, and molar C/N ratio for suspended sediment, bedload, and bank/flood-deposit samples. Sampling was conducted at discrete sites along the lower Amazon mainstem and nearby depositional environments, so spatial coverage is variable rather than uniform. Samples were collected in the field and analyzed to determine radiocarbon content, stable carbon isotopic composition, and elemental stoichiometry in order to evaluate the sources, transport pathways, and age of riverine organic carbon. The dataset will be useful to investigators studying carbon cycling, sediment dynamics, and organic matter provenance in large tropical river systems, and it may contribute to broader studies of land-to-ocean carbon transfer. The data were collected and interpreted by the study investigators.

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Coverage

Location: Amazon River delta near the city of Macapa (Brazil)

Spatial Extent: N:0.767 E:-49.8506 S:-0.2933 W:-51.019

Temporal Extent: 2023-05-01 - 2023-05-12

Dataset Description

Acronyms:

IRMS = Isotope Ratio Mass Spectrometer

MICADAS = Mini CARbon DAting System

NIST = National Institute of Standards and Technology

ETH = Eidgenössische Technische Hochschule (Swiss Federal Institute of Technology in Zurich)

POC = Particulate Organic Carbon

Fm = Fraction Modern radiocarbon
PES = Polyethersulfone (filter material)

Methods & Sampling

Riverine suspended sediment was collected in a 2023 sampling campaign aboard the R/V Mirage, via a depth-specific horizontal isokinetic sampler as in Rosengard et al. (2024), and buckets for surface sample collection. 9.5-95 L samples were collected and stored <24 hours in 9.5 L polyethylene bags before filtering through filtration units through PES filters (120mm; 0.2µm pore size) and frozen at -20 °C. Bed sediments were retrieved via bottom grab sampling. Bank sediments and flood deposits were scooped using a clean small metal shovel. Samples were stored in clean plastic bags and kept frozen at -20 °C.

Bed sediments were freeze-dried and homogenized, and suspended sediments were recovered from PES filters with MilliQ and freeze-dried. Sub-samples were taken for bulk organic carbon and nitrogen analyses, and ¹⁴C measurements. After decarbonation over HCl fumes (12N HCl) at 60°C for 72h, samples were measured on a Fisons elemental analyzer coupled to a Finnigan Delta-Plus isotope ratio mass spectrometer (IRMS) as described in Whiteside et al. (2011). All analyses were conducted in triplicate. The results only report the averages of the triplicate measurements. Analytical precision obtained by replicate measurements of NIST 2702 (Inorganics in Marine Sediment) was ±0.20‰ for δ¹³C. ¹⁴C measurement was completed at ETH Zurich on a MIni Carbon DAting System (MICADAS).

BCO-DMO Processing Description

Draft data:

- Loaded data from "BCO DMO upload_1.xlsx" (sheet "Table 1"), using row 1 as header, skipping row 2 with additional unit information. Loaded with "" and "nd" treated as missing values; table named "1002805_v1_amazon_isotopes_poc_cn".
- * Note: the skipped row 2 contained additional units information for the columns which is provided structurally in the BCO-DMO dataset under "parameters"
- Applied BCO-DMO metadata (descriptions, standard name IDs, supplied units) to columns: sample number, Date, Latitude, Longitude, sample type, C/N, δ¹³C, δ¹⁴C, Fm, and C_N; latitude and longitude flagged as primary parameters
- Renamed columns: "sample number" to sample_number, "Date" to date, "Latitude" to latitude, "Longitude" to longitude, "sample type" to sample_type, "C/N" to C_N
- Metadata comment lines in the data file were added to structured metadata fields. The loaded table was filtered so only column names and rows were imported from the source file.
- Date column imported as date with blank times. Stripped blank times from date column. Converted from Excel-parsed ISO datetime format (%Y-%m-%dT%H:%M:%S) to date-only string format (%Y-%m-%d), following ISO convention and removing blank time values
- Set column types: sample_number and sample_type as string; latitude, longitude, C_N, δ¹⁴C, Fm, δ¹³C as number; date with format %Y-%m-%d
- Numeric values imported from Excel imported as long decimals. Rounding applied so it matched the supplied format when viewed in Excel. Rounded latitude and longitude to 5 decimal places, Fm to 2 decimal places, δ¹³C and C_N to 1 decimal place, and δ¹⁴C to 0 decimal places (converted to integer);
- Reset types after rounding: δ¹⁴C as integer, all other numeric columns unchanged
- Output written to "1002805_v1_amazon_isotopes_poc_cn.csv"

Dataset Version 1:

- The data submitter revised the output from the draft described above "1002805_v1_amazon_isotopes_poc_cn.csv" and provided an updated file "1002805_v1_amazon_isotopes_poc_cn_VG.xlsx" which corrected one sample name and added a column for depth in meters.
- Loaded data from "1002805_v1_amazon_isotopes_poc_cn_VG.xlsx" (sheet 1, header row 1, skipping row 2) with missing values defined as empty string and "nd"
- Applied metadata (descriptions, standard name IDs, units) to columns: sample_number, sample_type, date, latitude, longitude, depth, δ¹³C, δ¹⁴C, Fm, C_N
- Converted date column from ISO datetime format ("%Y-%m-%dT%H:%M:%S") to "%Y-%m-%d" string output, formatted in ISO convention with blank time values removed
- Set column types: C_N, Fm, δ¹³C, latitude, longitude as number; δ¹⁴C, depth as integer; sample_number,

sample_type as string; date as date with format "%Y-%m-%d"

- Updated package-level metadata with field-level statistics (counts, min/max values) for the main table and a unique lat/lon table

- Output written to 1002805_v1_amazon_isotopes_poc_cn.csv

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Related Publications

Rosengard, S. Z., Moura, J. M. S., Spencer, R. G. M., Johnson, C., McNichol, A., Steen, A. D., & Galy, V. (2024). Depth-Partitioning of Particulate Organic Carbon Composition in the Rising and Falling Stages of the Amazon River. *Geochemistry, Geophysics, Geosystems*, 25(6). Portico. <https://doi.org/10.1029/2023gc011273>

<https://doi.org/10.1029/2023GEO011273>

Methods

Whiteside, J. H., Olsen, P. E., Eglinton, T. I., Cornet, B., McDonald, N. G., & Huber, P. (2011). Pangean great lake paleoecology on the cusp of the end-Triassic extinction. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 301(1-4), 1–17. doi:[10.1016/j.palaeo.2010.11.025](https://doi.org/10.1016/j.palaeo.2010.11.025)

Methods

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Parameters

Parameter	Description	Units
sample_number	sample ID	unitless
date	description	units
latitude	sampling location latitude	decimal degrees
longitude	sampling location longitude	decimal degrees
sample_type	sample type description (e.g. 'POC_SS'). Label suffixes: SS = suspended sediment; BL = bedload; bank = bank flood deposits	unitless
depth	sample depth	meters (m)
Fm	radiocarbon activity expressed as fraction modern	unitless
D14C	radiocarbon activity expressed as capital delta	per mil (‰)
d13C	stable C isotope composition (relative to VPDB).	per mil (‰)
C_N	carbon to nitrogen ratio (mol/mol)	unitless

Instruments

Dataset-specific Instrument Name	Fisons elemental analyzer
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	Fisons elemental analyzer coupled to a Finnigan Delta-Plus isotope ratio mass spectrometer (IRMS).
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	Finnigan Delta-Plus isotope ratio mass spectrometer (IRMS)
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Fisons elemental analyzer coupled to a Finnigan Delta-Plus isotope ratio mass spectrometer (IRMS).
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	Depth-specific horizontal isokinetic sampler (Rosengard et al., 2024)
Generic Instrument Name	no_bcodmo_term
Dataset-specific Description	Riverine suspended sediment was collected in a 2023 sampling campaign aboard the R/V Mirage, via a depth-specific horizontal isokinetic sampler as in Rosengard et al. (2024).
Generic Instrument Description	No relevant match in BCO-DMO instrument vocabulary.

Project Information

Collaborative Research: What Happens to Terrestrial Organic Matter in the Ocean? Solving the Mystery Behind an Iconic Question (MUDBENCS)

Coverage: Atlantic Ocean coastal waters, Brazil, French Guiana, Suriname

NSF Award Abstract:

The Amazon River is one of the largest and most important rivers in the world. It not only carries water through the Amazon rain forests, it also carries mud - lots of mud. This mud settles when the river joins the ocean, forming the Amazon delta. Waves and wind re-suspend some of this mud, which forms mud banks that slowly move from the coast of Brazil, to French Guiana, Suriname, and Guyana. Not only do these mud banks shape the coastlines of these areas, but they also serve as a storage for carbon that had been removed from the atmosphere by the Amazon rainforest, dropped to the forest floor and washed into the river, ultimately transported on particles of mud into the Amazon delta. Normally, this represents a transfer of carbon from the atmosphere to the sediment and rock record, hiding it away for thousands to millions of years and participating in the natural regulation of atmospheric carbon dioxide concentration. However, the Amazon's special case of mud banks that travel hundreds of miles along the coast has long been believed to stir up this carbon and release most of it back to the atmosphere. This idea has held for decades, but if wrong, may have a large impact on our understanding of the ocean's carbon cycle. This research will use new science and technology to change the way we look at river carbon cycling in the ocean by sampling the mud banks, ocean waters, and Amazon River waters more thoroughly than has been previously done, with the aim to understand and quantify the storage of land-derived carbon in marine mudbank sediments offshore the Amazon River. This research will serve as the core of two Ph.D. dissertations and will interface with the Woods Hole Partnership Educational Program (PEP) to provide under-represented minority college students an opportunity to gain practical experience in marine and environmental sciences. The project will also be incorporated into the Saint Petersburg Science Fest, an event that brings several thousand school children to University of South Florida campus during one weekend every autumn to showcase different research projects and initiatives.

Twenty years ago, John Hedges posed a seminal question pertaining to the role of the ocean in the carbon cycle: "what happens to terrestrial organic matter in the oceans?" That question was set upon a conundrum - because riverine organic matter is highly degraded, it should be expected to suffer minimal respiration in the ocean, yet by most accounts continental margins seem to be incinerators of terrestrial organic matter. However, much of this paradigm was originally built upon biogeochemical studies of the Amazon sub-aqueous delta and the mobile fluidized mudbanks along the Guianas coast. However, preliminary state of the art characterizations of organic carbon in Amazon River and mudbank sediments suggest that a fraction of terrestrial organic carbon is actually not refractory and as such is rapidly and efficiently oxidized in the ocean, whereas another fraction is refractory and is in fact quantitatively preserved in marine sediments. Overall, the data suggest an underestimation of burial efficiency in the realm of 50-100%. This proposal focuses on gaining a transformative mechanistic and quantitative understanding of the fate of terrestrial organic carbon in the coastal ocean offshore of the Amazon River. This will be done through i) sampling the marine province offshore of the Guianas coast (the Guianas mudbanks) as well as the Amazon River delta, using a shallow-draft research vessel and ii) using novel state of the art geochemical analysis of organic carbon - in particular ramped oxidation and compound specific radiocarbon analysis - and elemental composition to demonstrate the selective nature of terrestrial organic carbon oxidation and provide new estimates of burial efficiency of this system - with implications for the global inventory of terrestrial organic carbon in the ocean.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851309

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