

Atlantic sediment black carbon, total organic carbon, and stable carbon ratio (13C) values from samples collected using a multi-corer and box corer from multiple cruises throughout the Atlantic between 1994 and 2010

Website: <https://www.bco-dmo.org/dataset/908373>

Data Type: Cruise Results

Version: 1

Version Date: 2023-09-14

Project

- » [Concentrations and source assessment of black carbon across tropical Atlantic air and sediment](#) (Tropical Atlantic Black Carbon)
- » [The Black Carbon Cycle: Budget and Fluxes of Black Carbon in South Atlantic Sediments](#) (Black Carbon Cycle)

Contributors	Affiliation	Role
Lohmann, Rainer	University of Rhode Island (URI)	Principal Investigator
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Abstract

These data include sediment black carbon and total organic carbon concentrations and stable carbon ratio (13C) values. These data were collected on multiple cruises in throughout the Atlantic; specifically, in the Amazon Delta (EN-480; July 2010), Sierra Leone Rise (EN-481; August 2010), Niger Delta (GeoB 4901, GeoB 4903, GeoB 4904, GeoB 4905, GeoB 4907, and GeoB 4908; February/March 1998), Senegal Delta (GeoB 9501; April/May 2003), and Northwest Argentina Basin (GeoB 2814; July/August 1994). Sediments were collected using multi-corer and box corer samples and kept frozen until analysis. Total organic carbon and black carbon concentrations and stable carbon ratio values were determined on an isotope ratio mass spectrometer coupled to an elemental analyzer. The black carbon fraction was determined using the chemothermal oxidation at 375°C method. These data help better constrain pyrogenic carbon accumulation rates into Atlantic sediments. These data were published in St.Laurent, et al. (2023).

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Coverage

Spatial Extent: N:16.8344 E:312.5156 S:-37.6181 W:9.3844

Temporal Extent: 1994-07-26 - 2010-08-13

Methods & Sampling

Sediment samples were collected via a 4-barrel multi-corer (R/V Endeavor) and box corer (GeoB; samples previously collected from the Department of Geosciences at Bremen University, see MARUM GeoB Core Repository <https://www.marum.de/en/Infrastructure/MARUM-GeoB-Core-Repository.html>). Sediments collected on the R/V Endeavor were segmented into 1-2 cm sections, dried in a drying oven (35°C) and homogenized via mortar and pestle; sediments from GeoB had previously been segmented into 1-10cm sections, freeze-dried and ground with a mortar and pestle. All sediments were decalcified using 10% hydrochloric acid and kept frozen until processed. Black carbon was isolated using the chemothermal oxidation at 375°C method.

Instruments:

Sediment samples from the GeoB cores were quantified using an Elementar Vario MICRO cube elemental analyzer coupled to an Isoprime100 isotope ratio-mass spectrometer (IR-MS); sediments collected on EN-480 and EN-481 were analyzed on a Carlo Erba elemental analyzer coupled to a GV Optima 588 system IR-MS. The detection limit of both instruments was 100 ng of carbon.

Location

Amazon Delta (approximately: 4 N, 47 W; 2400-3500m); Sierra Leone Rise (approximately: 7 N, 20 W; 2800-3800m), Niger Delta (approximately: 1 N, 8 E; 1200-3000m), Senegal Delta (approximately: 17 N, 17 W; 330 m), and Northwest Argentina Basin (approximately: 37 S, 39 W; 5000m)

Cruise or Deployment

R/V Endeavor (EN-480, EN-481; July/August 2010); GeoB (4901, 4903, 4904, 4905, 4907, 4908; February/March 1998), GeoB (9501; April/May 2003), GeoB (2814, July/August 1994)

* R/V Endeavor cruises were attached to this dataset as "Deployments."

* Collection information for the GeoB samples previously collected from the Department of Geosciences at Bremen University can be found in table "Atlantic Sediment Cruise Information" in the Supplemental Files section of this dataset.

Data Processing Description

Data were analyzed using Microsoft Excel and R (version 4.1.1).

BCO-DMO Processing Description

* Sheet 1 of "Atlantic Sediment BC.xlsx" was imported into the BCO-DMO data system.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]

* Date format converted to ISO 8601 format.

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Data Files

File
908373_v1_altantic_sediment_black_carbon.csv (Comma Separated Values (.csv), 16.28 KB) MD5:6d337d24412c4f4f7a6dfae6f6e31b88
Primary data table for 908373 version 1.

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Supplemental Files

File

Atlantic Sediment Cruise Information

filename: atlantic_sediment_cruise_information.csv

(Comma Separated Values (.csv), 1.45 KB)
MD5:7550cf1e6430ae47a3ce9ec960ef189f

Cruise information table. This includes a description of R/V Endeavor cruises and GeoB core samples previously collected from the Department of Geosciences at Bremen University (obtained from sediment repository (PANGAEA, <https://www.pangaea.de/>) see MARUM GeoB Core Repository <https://www.marum.de/en/Infrastructure/MARUM-GeoB-Core-Repository.html>).

Cruise_ID = cruise identifier

Cruise_name_AltID = Alternate cruise name (or GeoB core id)

Vessel_Name = Vessel name (or if sample was from the Pangaea sediment repository)

Start_Date = cruise start date

End_Date = cruise end date

Location_Sampling_area = geolocation name of the cruise

Chief_Scientist_name = Chief scientist name

Cruise DOI = the DOI for the cruise (if available).

Datasets = Which datasets in the BCO-DMO "Related Dataset" group included samples from the cruise. See Related Datasets section.

Comments = The date and month of the collection

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Related Publications

R Core Team (2021). R: A language and environment for statistical computing. R v4.1.1. R Foundation for Statistical Computing, Vienna, Austria. Available from <https://www.R-project.org/>
Software

St. Laurent, K., Cantwell, M., & Lohmann, R. (2023). New insights on black carbon in pelagic Atlantic sediments. Marine Chemistry, 104312. <https://doi.org/10.1016/j.marchem.2023.104312>
Results

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Related Datasets

IsRelatedTo

Lohmann, R., St. Laurent, K. A. (2023) **Atlantic sediment petrography analysis data from multi-corer samples collected in the Amazon Delta and Sierra Leone Rise during R/V Endeavor cruises EN-480 and EN-481 in 2010**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-10-02 doi:10.26008/1912/bco-dmo.908380.1 [[view at BCO-DMO](#)]
Relationship Description: Datasets from the same cruises published as part of the same study "New insights on black carbon in pelagic Atlantic sediments." published in St. Laurent, et al. (2023).

Lohmann, R., St. Laurent, K. A. (2023) **Atlantic sediment polycyclic aromatic hydrocarbon (PAH) concentrations from samples collected using a multi-corer and box corer from multiple cruises throughout the Atlantic between 1994 and 2010**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-09-14 doi:10.26008/1912/bco-dmo.908357.1 [[view at BCO-DMO](#)]
Relationship Description: Datasets from the same cruises published as part of the same study "New insights on black carbon in pelagic Atlantic sediments." published in St. Laurent, et al. (2023).

St. Laurent, K. A., Lohmann, R. (2023) **Atlantic sediment radiocarbon from multi-corer samples collected in the Amazon Delta and Sierra Leone Rise during R/V Endeavor cruises EN-480 and EN-481 in 2010**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-09-14 doi:10.26008/1912/bco-dmo.908387.1 [[view at BCO-DMO](#)]

Relationship Description: Datasets from the same cruises published as part of the same study “New insights on black carbon in pelagic Atlantic sediments.” published in St. Laurent, et al. (2023).

References

University of Bremen (n.d.) MARUM GeoB Core Repository (n.d.) Accessed Oct. 5th, 2023 from <https://www.marum.de/en/Infrastructure/MARUM-GeoB-Core-Repository.html>

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Parameters

Parameter	Description	Units
Site	Numerical sediment core name	unitless
Depth_Interval	sediment depth interval	centimeters below seafloor (cmbsf)
Date	Core date	unitless
Lat	Core sample location latitude	decimal degrees
Lon	Core sample location longitude	decimal degrees
Total_Organic_Carbon	Total Organic Carbon; % (total organic carbon/sediment)	percent (%)
Black_Carbon	Black Carbon measured by chemothermal oxidation. % (black carbon/sediment)	percent (%)
d13C_Total_Organic_Carbon	stable carbon isotope ratio of the total organic carbon sediment fraction (d13C)	per mil (0/00)
d13C_Black_Carbon	stable carbon isotope ratio of the black carbon sediment fraction (d13C)	per mil (0/00)

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Instruments

Dataset-specific Instrument Name	Elementar Vario MICRO cube
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	Elementar Vario MICRO cube elemental analyzer coupled to an Isoprime100 isotope ratio-mass spectrometer (IR-MS)
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	Carlo Erba elemental analyzer
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	Carlo Erba elemental analyzer coupled to a GV Optima 588 system IR-MS
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	Isoprime100
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Elementar Vario MICRO cube elemental analyzer coupled to an Isoprime100 isotope ratio-mass spectrometer (IR-MS)
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	GV Optima 588
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Carlo Erba elemental analyzer coupled to a GV Optima 588 system IR-MS
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).

Deployments

EN480

Website	https://www.bco-dmo.org/deployment/910748
Platform	R/V Endeavor
Start Date	2010-07-13
End Date	2010-07-23

EN481

Website	https://www.bco-dmo.org/deployment/910750
Platform	R/V Endeavor
Start Date	2010-07-25
End Date	2010-08-19

Project Information

Concentrations and source assessment of black carbon across tropical Atlantic air and sediment (Tropical Atlantic Black Carbon)

Coverage: Tropical North Atlantic Ocean

NSF Award Abstract:

Black carbon is formed during the incomplete burning of fuels (e.g., the black clouds of smoke emitted by buses and trucks). Black carbon does not degrade easily in the environment and can be transported long distances, even reaching the seafloor. Yet the fluxes of black carbon in the environment are not well known, particularly in the oceans. Rivers are considered the dominant source of black carbon to the oceans. However, recent results suggest that there may be regions of the ocean where the atmospheric delivery of black carbon may be important. This study investigates whether biomass burning (e.g., wildfires) in Africa is a source of black carbon to the tropical Atlantic Ocean. The unique molecular and isotopic properties of black carbon will be used to identify black carbon in the atmosphere, water and sediment in the study region. Sediment, water column and atmospheric particles will be collected during a 3-week research cruise across the tropical Atlantic Ocean. Two different approaches will be used to quantify black carbon in the environment. The research is relevant and timely for our understanding of the carbon cycle, a key component of our ability to forecast climate and its change. The project supports a graduate student and provide opportunities for high school students participating in the SMILE Program (Science and Math Investigative Learning Experiences). This project is jointly funded by the Chemical Oceanography Program and the Established Program to Stimulate Competitive Research (EPSCoR).

Surface sediment samples will be collected at ten sites across the tropical Atlantic Ocean in a region known to be impacted by biomass burning events (wildfires) in Africa. Appropriate locations for sediment sampling will be identified using state-of-the-art ship equipment to ensure a successful coring operation. Once collected, the black carbon and organic carbon fractions of the sediment will be isolated and measured. A range of isotopic and molecular marker approaches will be used to identify the likely source of these carbon fractions. The central hypothesis is that the black carbon residing in the sediment of the tropical Atlantic Ocean is derived from biomass burning and delivered through atmospheric deposition. Carbon derived from recent biomass burning contains C-14 isotopes that indicate 'young' (or recently produced) carbon, while carbon from fossil fuels ('old carbon') has no C-14 due to radioactive decay. To further assess the origin of the black carbon in

the region, water column and atmospheric particles will be collected during the research cruise. The origin of the atmospheric black carbon particles (biomass burning or fossil fuel emissions) will be established through a collaboration with colleagues in Sweden. The broader impacts of this research include the engagement of high school students through The SMILE Program (Science and Math Investigative Learning Experiences) at the University of Rhode Island. The project also provides training opportunities for graduate and undergraduate students, with a focus on recruitment of students from under-represented groups.

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.

The Black Carbon Cycle: Budget and Fluxes of Black Carbon in South Atlantic Sediments (Black Carbon Cycle)

Coverage: South Atlantic

NSF abstract:

This award is funded under the American Recovery and Reinvestment Act of 2009 (Public Law 111-5).

In this study, researchers at the University of Rhode Island will attempt to determine the origin and fluxes of black carbon (BC) in marine sediments from the South Atlantic. Black carbon in the atmosphere is a key driver of global climate change; it is second only to CO₂ in its contribution to global warming. The proposed work is thus relevant and timely for our understanding of the carbon cycle, a key component of our ability to forecast climate and its change. The major sources of BC on the global scale are fossil fuel and biomass burning, which are both prominent in Africa and South America. Hence, it is proposed to account for soot BC, char and charcoal residing in sediments from the South Atlantic by combining thermal, chemical and petrographic isolation methods.

This project has three main hypotheses: (1) Soot BC constitutes a significant fraction of the total organic carbon in deep sea sediments of the South Atlantic, and dominates total BC in those sediments; (2) Biomass burning is the dominant source of the soot BC present in deep sea sediments of the South Atlantic; and (3) For the South Atlantic, atmospheric deposition of soot BC is as important as riverine inputs.

This study represents a first attempt to account for BC sinks on an Ocean scale. It thus holds promise to make a major step forward towards being able to mass balance sources and sinks of BC. Previous studies suggest that BC reaches the oceans predominantly from riverine sources. In the case of the South Atlantic, the research team hypothesizes that atmospheric transport and deposition is at least as important. The proposed research will compare different BC determination procedures for deep sea sediments, thereby improving our understanding of the different constituents of the BC cycle. Similarly, organic marker molecules are often used for source apportionment. This study will explore if this still holds true for deep sea sediment samples, as preliminary data found discrepancies arising from molecular marker analysis and isotopic analysis. Lastly, accounting for soot BC in deep sea sediments will also aid in identifying more of the uncharacterized sedimentary OC .

Broader Impacts: The results of this work are expected to aid atmospheric and earth system science modelers in refining their atmospheric and oceanic transport models for BC, including its relation to global climate change. The project will enhance infrastructure for research and education by establishing research collaboration between URI and international partners at the University of Bremen, the MPI for Meteorology, Hamburg, and the University of Tuebingen.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1924191
NSF Division of Ocean Sciences (NSF OCE)	OCE-0851044

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