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

Website: https://www.bco-dmo.org/dataset/908357
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
St. Laurent, Kari Ann	University of Rhode Island (URI)	Student
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
These data include sediment polycyclic aromatic hydrocarbon (PAH) concentrations. 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. Polycyclic aromatic hydrocarbon concentrations were determined by gas chromatography mass spectrometry. A total of 24 PAH analytes were quantified using ChemStation software. These data help better constrain pyrogenic carbon sources and PAH 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.

Instruments:
Homogenized sediments were extracted with an accelerated solvent extractor (Dionex ASE 350) in 6 cycles at 150°C using a 50/50 mix of hexane and acetone. Prior to extraction, d10-acenapthene, d10-phenanthrene, d12-chrysene, and d12-perylene were added to each sample to assess recovery. Solvent extracts were evaporated to 1 mL using a rotary evaporator and purified through a column containing 2 mg of activated silica with 45 mL of a 30/70 solvent mixture of dichloromethane and hexane. Extracts were evaporated with N2 gas to 50 µL and an injection surrogate of p-terphenyl was added before analysis on an Agilent 6890 Series gas chromatograph coupled to a 5973 Mass Selection Detector (GC-MS).

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

24 PAH analyzes were quantified using ChemStation software.

BCO-DMO Processing Description

* 5 sheets named by location name in "Atlantic_Sediment_PAH.xlsx" were imported into the BCO-DMO data system.
* Individual location tables were combined into one table with an additional column "Location" to capture the site name provided by the sheet name.
* PAH values rounded to two decimal places as discussed with the submitter. There was variable formatting imported from the original excel file so two decimal place format was used.

* 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]
** example: column "1,5-Dimethyl Napthalene" became "Napthalene_1_5_Dimethyl" with column description "Polycyclic aromatic hydrocarbon (PAH) 1,5-Dimethyl Napthalene"

* Date format converted to ISO 8601 format.

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Data Files

File
Atlantic Sediment PAH filename: 908357_v1_atlantic_sediment_pah.csv (Comma Separated Values (.csv), 18.98 KB) MD5:7e291a0fc91202527423d77f265c42bc Primary data table for dataset 908357 version 1

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Supplemental Files

File
Atlantic Sediment Cruise Information filename: altantic_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

Agilent. (n.d.). Chromatography Data Systems: OpenLab ChemStation. Retrieved from https://www.agilent.com/en/product/software-informatics/analytical-software-suite/chromatography-data-systems/openlab-chemstation
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 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.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-09-14 doi:10.26008/1912/bco-dmo.908373.1 [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 petrography analysis data from mult-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).

St. Laurent, K. A., Lohmann, R. (2023) **Atlantic sediment radiocarbon from mult-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
Location	Location name	unitless
Site	Numerical sediment core name (includes cruise identifier)	unitless
Average_Depth	Average sediment depth	cenitmeters below seafloor (cmbsf)
Date	Core date in ISO 8601 format	unitless
Lat	Core sample location latitude	decimal degrees
Lon	Core sample location longitude	decmial degrees
Napthalene	Polycyclic aromatic hydrocarbon (PAH) Napthalene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Napthalene_2_Methyl	Polycyclic aromatic hydrocarbon (PAH) 2-Methyl Napthalene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Acenapthylene	Polycyclic aromatic hydrocarbon (PAH) Acenapthylene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Acenapthene	Polycyclic aromatic hydrocarbon (PAH) Acenapthene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Biphenyl	Polycyclic aromatic hydrocarbon (PAH) Biphenyl	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Napthalene_1_5_Dimethyl	Polycyclic aromatic hydrocarbon (PAH) 1,5-Dimethyl Napthalene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Flourene	Polycyclic aromatic hydrocarbon (PAH) Flourene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Napthalene_2_3_5_Trimethyl	Polycyclic aromatic hydrocarbon (PAH) 2,3,5-Trimethyl Napthalene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Phenanthrene	Polycyclic aromatic hydrocarbon (PAH) Phenanthrene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)

Anthracene	Polycyclic aromatic hydrocarbon (PAH) Anthracene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Flourene_2_Methyl	Polycyclic aromatic hydrocarbon (PAH) 2-Methyl Flourene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Dibenzothiophene	Polycyclic aromatic hydrocarbon (PAH) Dibenzothiophene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Phenanthrene_1_methyl	Polycyclic aromatic hydrocarbon (PAH) 1-methyl phenanthrene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Anthracene_9_Methyl	Polycyclic aromatic hydrocarbon (PAH) 9-Methyl anthracene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Fluoranthene	Polycyclic aromatic hydrocarbon (PAH) fluoranthene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Pyrene	Polycyclic aromatic hydrocarbon (PAH) pyrene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Phenanthrene_4_5_Dimethyl	Polycyclic aromatic hydrocarbon (PAH) 4,5-Dimethyl Phenanthrene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Phenanthrene_3_6_Dimethyl	Polycyclic aromatic hydrocarbon (PAH) 3,6-dimethyl Phenanthrene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Pyrene_1_methyl	Polycyclic aromatic hydrocarbon (PAH) 1-methyl pyrene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Retene	Polycyclic aromatic hydrocarbon (PAH) Retene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Perylene	Polycyclic aromatic hydrocarbon (PAH) Perylene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Perylene_Benzo_g_h_i	Polycyclic aromatic hydrocarbon (PAH) Benzo(g,h,i)perylene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Pyrene_Indeno_1_2_3_c_d	Polycyclic aromatic hydrocarbon (PAH) Indeno(1,2,3-c,d)pyrene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)
Anthracene_Dibenzo_a_h	Polycyclic aromatic hydrocarbon (PAH) Dibenzo(a,h)anthracene	nanograms polycyclic aromatic hydrocarbon per gram of sediment (ng PAH/ g Sediment)

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Instruments

Dataset-specific Instrument Name	Dionex ASE 350
Generic Instrument Name	Accelerated Solvent Extractor
Generic Instrument Description	Accelerated solvent extraction (ASE) is a method for extracting various chemicals from a complex solid or semisolid sample matrix. The process uses high temperature and pressure, which results in the extraction taking less time and requiring less solvent, and possibly also giving better analyte recovery, than traditional methods that use less extreme conditions.

Dataset-specific Instrument Name	Agilent 6890 Series gas chromatograph coupled to a 5973 Mass Selection Detector (GC-MS)
Generic Instrument Name	Gas Chromatograph Mass Spectrometer
Generic Instrument Description	Instruments separating gases, volatile substances or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay by a mass spectrometer.

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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

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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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