Chromophoric Dissolved Organic Matter Napierian Absorption Coefficients for Open Ocean Blue Water Samples from the North Atlantic Subtropical Gyre from R/V Atlantic Explorer AE1707, AE1829, AE1820, AE1905 at Bermuda Atlantic Time Series Stations (BATS) f

Website: https://www.bco-dmo.org/dataset/927300
Data Type: Cruise Results
Version: 1
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Project
» Transforming our understanding of DIC Photoproduction in Oceanic Waters (MODIE)

Contributors	Affiliation	Role
Brandes, Jay	Skidaway Institute of Oceanography (SkIO)	Principal Investigator
Miller, William	University of Georgia (UGA)	Co-Principal Investigator
Powers, Leanne	Chesapeake Biological Laboratory (CBL)	Co-Principal Investigator
Stubbins, Aron	Skidaway Institute of Oceanography (SkIO)	Co-Principal Investigator
Ma, Kun	Skidaway Institute of Oceanography (SkIO)	Student, Contact, Data Manager
Newman, Sawyer	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
These data are chromophoric dissolved organic matter (CDOM) Naperian absorption coefficients (ag) of seawater from the North Atlantic subtropical gyre, collected as a part of the OCE-1635618 project, “Transforming our understanding of DIC Photoproduction in Oceanic Waters”. The goal of the project was to investigate and constrain the photoproduction rates and efficiencies of dissolved inorganic carbon (DIC) from photochemical degradation of dissolved organic carbon in the open ocean, which could provide better estimates of DIC photoproduction flux in the open ocean and improve carbon budget modeling. The surface (1 m) and deep (3000 m) seawater samples were collected using Niskin bottles mounted on a CTD rosette, for photoirradiation experiments, during Bermuda Atlantic Time-series Study (BATS) cruises in May 2017, July 2018, October 2018, and April 2019 aboard the R/V Atlantic Explorer. ag were measured with spectrophotometers.

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Coverage

Location: North Atlantic Subtropical Gyre
Spatial Extent: **N**:32.15643 **E**:-64.02183 **S**:31.49222 **W**:-64.73008

Temporal Extent: 2017-05-13 - 2019-04-07

Methods & Sampling

Water sampling details

Water samples were gravity filtered from Niskin bottles through 0.2 µm Whatman Polycap 36 AS nylon membrane cartridge filters, directly into combusted borosilicate glass bottles. Filtered sample waters were stored in the dark at 4°C until measurements. Sample waters were left in the dark at room temperature (~20°C) so they were back to room temperature before absorbance measurements.

These seawater samples were collected for photochemical degradation experiments, and water samples at the various BATS stations had similar optical properties, for example, similar absorbance at 325 nm. Therefore, which stations we collected samples from were largely determined by the cruise schedule, scientific tasks performed by the core BATS crew, and weather, i.e., where CTDs can be cast that allowed us ample time to directly filter water from the Niskin bottles.

We also wanted to compare the photoproduction of dissolved inorganic carbon (DIC) between seawater at the surface and at depth, as the deep water may have different photodegradation history and different dissolved organic carbon composition, and thus have different DIC photoproduction rates and efficiencies. Therefore, we collected water samples from the surface (1 m) and at depth (3000 m).

Measurement details

Absorbance ($A(\lambda)$) of the water samples were measured at 250–800 nm at 1.0 nm intervals, in triplicate. May 13th, 2017 samples were measured in 10-cm-pathlength quartz spectrophotometric cuvettes with an Agilent 8453 UV-visible spectrophotometer with ChemStation software; July 17th, 2018 samples were measured in a World Precision Instruments UltraPath capillary cell set at 50 cm pathlength using a Maya Pro 2000 spectrophotometer with SpectraSuite software, and the rest of the samples were measured in the same UltraPath capillary cell set at 200 cm pathlength using the same Maya spectrophotometer.

Milli-Q water was similarly measured to use as blanks. The absorbance spectra of the sample water were first corrected by subtracting the absorbance spectra of blanks (Milli-Q water) from the absorbance spectra of the sample water; the absorbance spectra of the sample water were further corrected for potential offsets and instrument drift by subtracting the average absorbance at 690–710 nm. The corrected absorbance spectra ($A(\lambda)$corr) of the sample water generated from these corrections were converted to Napierian absorption coefficients ($a_g(\lambda)$; m^{-1}; represented in this dataset as CDOM_absorption_a_g), using the following equation: $a_g(\lambda) = A(\lambda)\text{corr} \ln 10 / L$, where L (m) is the pathlength.

The May 13th, 2017 samples were measured in 10-cm-pathlength cuvettes with the Agilent spectrophotometer because these samples were T0 samples of a photoirradiation experiments, the water was photoirradiated in these 10-cm-pathlength cuvettes, and the absorbance were also measured in these cuvettes, which only works on the Agilent spectrophotometer, which has a 10-cm-pathlength cuvette holder.

Data Processing Description

Data Corrections and Conversions

The average absorbance spectra of blanks were subtracted from the absorbance spectra of the sample water.

Absorbance spectra were further corrected for potential offsets and instrument drift by subtracting the average absorbance at 690–710 nm.

$A(\lambda)$ was converted to Napierian absorption coefficients ($a_g(\lambda)$; m^{-1}), using the following equation: $a_g(\lambda) = A(\lambda) \ln 10 / L$, where L (m) is the pathlength.

Data Processing Software

- Importing and correcting absorbance measurements (A(λ))
- Converting A(λ) to Napierian absorption coefficients (ag(λ))
- R-3.3.3, R-3.4.4, R-3.5.3, R-3.6.2, R-3.6.3, R-4.2.1

- Package ‘stringr’:
  - Wickham H (2023). _stringr: Simple, Consistent Wrappers for Common String Operations_. R package version 1.5.1, <https://CRAN.R-project.org/package=stringr>.

BCO-DMO Processing Description

- Latitude and longitude values were joined to the dataset for BATS station sites

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Data Files

File
927300_v1_north_atlantic_cdom_absorption_coefficients.csv (Comma Separated Values (.csv), 528.91 KB) MD5:012a4b113377ebc965135a7ead0dbd82 Primary data file for dataset ID 927300, version 1

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Parameters

Parameter	Description	Units
BATS_station	Name of the Bermuda Atlantic Time-series Study (BATS) station where the sample was obtained.	unitless
BATS_station_Latitude	Latitude of the BATS station where the sample was obtained in decimal degrees; a positive value indicates a Northern coordinate.	decimal degrees
BATS_station_Longitude	Longitude of the BATS station where the sample was obtained in decimal degrees; a negative value indicates a Western coordinate.	decimal degrees
Sample_date	Date sample was collected.	unitless
Sample_depth_m	Depth from which the sample was taken.	meters (m)
lambda	Wavelength at which the absorbance was measured.	nanometer (nm)
CDOM_absorption_a_g	Chromophoric dissolved organic matter (CDOM) Naperian absorption coefficients (ag)	meters^(-1)
Sample_no	Sample from the same location, depth and date was collected into different bottles, and for some of the samples, each bottle was measured for absorbance separately, in which case, sample numbers were given to the subsamples from each bottle. For example, 3 means this is a third bottle of the same sample taken from the same location, depth and date.	unitless

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Instruments

Dataset-specific Instrument Name	Maya Pro 2000 spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	Chromophoric dissolved organic matter absorbance measurements were made from samples taken from July 17, 2018 were analysed SpectraSuite software using a Maya Pro 2000 spectrophotometer with SpectraSuite software.
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

Dataset-specific Instrument Name	Agilent 8453 UV-visible spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	Chromophoric dissolved organic matter absorbance measurements were made from samples taken May 13, 2017 with an Agilent 8453 UV-visible spectrophotometer with ChemStation software.
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

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Deployments

AE1707

Website	https://www.bco-dmo.org/deployment/927308
Platform	R/V Atlantic Explorer
Start Date	2017-05-08
End Date	2017-05-14
Description	Cruise information and original data are available form the NSF R2R data catalog.

AE1829

Website	https://www.bco-dmo.org/deployment/927311
Platform	R/V Atlantic Explorer
Start Date	2018-10-17
End Date	2018-10-24
Description	Cruise information and original data are available form the NSF R2R data catalog.

AE1820

Website	https://www.bco-dmo.org/deployment/927310
Platform	R/V Atlantic Explorer
Start Date	2018-07-17
End Date	2018-07-23
Description	Cruise information and original data are available from the NSF R2R data catalog.

AE1905

Website	https://www.bco-dmo.org/deployment/878763
Platform	R/V Atlantic Explorer
Start Date	2019-04-07
End Date	2019-04-14
Description	See more at R2R: https://www.rvdata.us/search/cruise/AE1905

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Project Information

Transforming our understanding of DIC Photoproduction in Oceanic Waters (MODIE)

Coverage: South Atlantic Bight, Bermuda BATS, Hawaii HOT

NSF Award Abstract:
Photoproduction describes chemical reactions which use the energy of sunlight to change the molecular structure of one product to another. This process has been shown to play an important role in the coastal ocean changing dissolved organic carbon (DOC) to dissolved inorganic carbon (DIC); however, minimal information is available on the extent to which this process takes place in the open ocean. The main obstacle to obtaining DIC production data for open ocean waters is the inability to measure the small DIC production rates against the large background of seawater DIC. Currently the most common method for high precision measurement of DIC production has unacceptable detection limits to resolve this difference. Researchers from the University of Georgia have developed MoDIE (Moderate DI13C Isotope Enrichment), a novel means of determining low levels of DIC produced in the open ocean with high precision. As part of this project, they plan to refine their MoDIE method and obtain measurements of DIC photoproduction in open ocean waters (i.e, South Atlantic Bight, North Atlantic Ocean and North Pacific Ocean subtropical gyres). Results from this work will provide improved estimates of DIC photoproduction in the open ocean which in turn will improve existing models of carbon cycling.

The broader impacts of this project are particularly exciting. The proponents plan to create an exhibit at the University of Georgia Marine Extension public aquarium to teach the general public about ocean color and marine carbon cycling. In addition, they plan to participate in the Skidaway Institute for Oceanography ?Marine Science Day? open house to share their science with the public and incorporate results into their class curricula. One of the researchers is a first-time investigator who plans to incorporate education and training of undergraduate and graduate students in the project. Finally, undergraduate interns from underrepresented groups will be involved in the project to give them research experience and help with retention in a science discipline and career.

Photoproduction of dissolved inorganic carbon (DIC) from dissolved organic carbon (DOC) has been shown to be a non-negligible process in the marine carbon cycle; however, it is still unclear the extent and importance of this process to the overall carbon cycle in the open ocean (blue water chemistry). The major issue causing this uncertainty is the lack of available methods with acceptable detection limits. The high background of DIC in the open ocean (2mM) makes it difficult to measure the photoproduced portion of DIC when the detection limits are high. Additionally, the current best method requires pre-stripping samples of background DIC, which could introduce unnecessary errors by over manipulating samples. This project will develop a new method called MoDIE (Moderate DI13C Isotope Enrichment) to get accurate measurements of DIC photoproduction in the open ocean. MoDIE works by enriching a sample in 13C and monitoring the dilution of DI13C under irradiation using liquid chromatography-isotope ratio mass spectrometry (LC-IRMS). By removing the need for pre-sample treatment and introducing a highly precise measurement technique, the researchers will be able to compare their techniques with published methods of photochemical DIC detection and put forth more accurate estimate of marine DIC photoproduction in the global ocean. This will greatly improve marine carbon cycle models.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1635618

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