Size fractionated organic carbon and 13C at Bermuda Atlantic Time Series (BATS) from samples collected on R/V Atlantic Explorer cruise AE1920 in August 2019

Website: https://www.bco-dmo.org/dataset/1003038
Data Type: Cruise Results
Version: 1
Version Date: 2026-07-27

Project
» The fate of lysis products of picocyanobacteria contributes to marine humic-like chromophoric dissolved organic matter (Picocyanobacteria CDOM)

Contributors	Affiliation	Role
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Abstract
Size fractionated organic particle carbon and stable carbon isotopes were obtained on the R/V Atlantic Explorer at Bermuda Atlantic Time Series (BATS) (31°40'N, 64°10'W) in August 2019. For size fractionated particulate organic C analyses, water was obtained from Niskin bottles on a CTD rosette, by opening the bottom of the Niskin bottle. Water was gravity filtered through stacked mesh with the following pore sizes: 500 micrometers (um), 180 um, 53 um, 20 um, and 5 um. Each fraction was resuspended off the mesh and vacuum filtered onto pre-combusted GF/C filters (nominal pore size 1.2 um). Samples were wafted with HCl to remove carbonate and sent to the UC Davis Stable Isotope Facility (Davis, CA) for C and N analysis utilizing an elemental analyzer attached to an isotope ratio mass spectrometer. The samples were obtained to determine particle size to carbon concentration relationships for models, while also providing data for size fractionated microbial community analyses. Samples were collected by Jacob Cram of Horn Point Laboratory (University of Maryland Center for Environmental Science) and his lab members. Filters were prepped in the lab by Clara Fuchsman of Horn Point Laboratory, a part of the University of Maryland Center for Environmental Science. Data were analyzed by both Clara Fuchsman and Jacob Cram.

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Coverage

Location: Bermuda Atlantic Time Series (BATS)
Spatial Extent: **N**:31.6751 **E**:-64.1601 **S**:31.6665 **W**:-64.182
Temporal Extent: 2019-08-08 - 2019-08-12

Methods & Sampling

For size fractionated suspended particulate organic matter in August 2019, samples were obtained from Niskin bottles but were collected by opening the bottom of the Niskin bottle into an acid cleaned bucket. This ensured that particles that had sunk below the spigot of the Niskin bottle were included. 120 liters (L) of water was gravity filtered, in sequence, through nylon mesh (142-millimeter (mm) diameter) of decreasing pore size (500, 180, 53, 20 micrometers (µm)) and a subset of this 20 µm filtered water (~20 L) was then filtered through a 5 µm mesh. For mesh sizes 20 µm and above, the large diameter of the mesh and abundance of functional pore-space prevented clogging, and water flowed through the mesh quickly, indicating that clogging did not occur. Water filtered more slowly through the 5 µm mesh (on the order of 30 minutes). After filtration, each nylon mesh was back-rinsed with ~500 milliliters (mL) of prefiltered 60 kd filtered seawater to produce a resuspension of particulate matter from particles from each size class. The 60 kd filtered seawater had been produced by tangential flow filtration as a byproduct of virus isolation experiments on the same cruise. After back-rinsing, the resuspended particles were split with one half used for particulate matter measurements. In all cases, the actual volumes were carefully recorded and used for normalization during analysis. The resuspended particulate matter from each sample and size class was collected by vacuum filtration through a 1.2 µm nominal pore size, 25 mm diameter, GF/C glass fiber filter (Whatman WHA1822025). These filters had been previously pre-combusted for at least two hours at 400 degrees Celsius (°C). Two depths were sampled per cast, and multiple casts were combined to represent the station. Samples were immediately frozen.

At Horn Point, samples were dried at 40°C and stored in a desiccator. For processing, they were wafted with HCl overnight to remove carbonate, dried at 40°C, packed in both silver and tin capsules, and sent to the UC Davis Stable Isotope Facility for C and N analysis utilizing an Elemental Analyzer (Elementar Vario EL Cube) attached to an Isotope Ratio Mass Spectrometer (Isoprime VisION). Blank combusted GF/C filters were included in analyses and did not show measurable material.

For the 90-meter (m) sample, the entire Niskin rosette was fired at the same depth. Particles were fractionated for both size and sinking. In this case, the CTD sat on deck for one hour while the particles were allowed to settle. After one hour, the top ⅔ of each Niskin bottle were siphoned off and saved. Then the bottom ⅓ of each bottle was collected by opening the bottom of the Niskin bottle into an acid-cleaned bucket. The upper and lower fractions were then filtered using the size fractionation method described above.

Data Processing Description

Micrograms (ug) of C and N were converted to concentrations in Microsoft Excel using volumes filtered.

BCO-DMO Processing Description

- Imported original file "BATS_OrgC_13C_2.xlsx" into the BCO-DMO data processing system.
- Converted the "Date" column from "%d-%b-%y" format (e.g., "15-Jan-20") to ISO date format "%Y-%m-%d" in UTC.
- Converted "latitude" column from degrees-decimal minutes format (e.g., "31°45.0'N") to decimal degrees with North directional.
- Converted "longitude" column from degrees-decimal minutes format (e.g., "64°10.0'W") to decimal degrees with West directional.
- Rounded "latitude" and "longitude" to 4 decimal places, applying only to values with more precision than 4 digits and preserving trailing zeros.
- Saved the final file as "1003038_v1_bats_orgc_13c.csv".

Problem Description

For many of the samples, the N concentrations were below the detection limit. Therefore, we do not include N data here.

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Parameters

Parameter	Description	Units
Station	station sampled	unitless
latitude	Latitude of location sampled. degrees with a cardinal direction N.	decimal degrees
longitude	Longitude of location sampled. degrees with a cardinal direction W	decimal degrees
Date	date sampled	unitless
Depth	depth sampled	meters (m)
Section	Description of the part of the bottle sampled (e.g. 'Whole bottle', 'Bottom 1/3')	unitless
Size_Fraction	particle size range description (e.g. '>500','53-180'). Numbers in the size range description are in microns (um).	unitless
d13C_VPDB	isotopic composition of C. The stable carbon isotope ratio d13C relative to the Vienna Pee Dee Belemnite (VPDB) international standard.	permil (0/00)
Carbon	concentration of organic C	micromolar (uM)

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Instruments

Dataset-specific Instrument Name	Isoprime VisION
Generic Instrument Name	Elementar Isoprime Vision (IRMS) isotopic ratio mass spectrometer
Dataset-specific Description	At the UC Davis Stable Isotope Facility samples were analyzed utilizing an Elemental Analyzer (Elementar Vario EL Cube) attached to an Isotope Ratio Mass Spectrometer (Isoprime VisION).
Generic Instrument Description	A laboratory instrument. It is used for mesauring the ratios of stable isotopes in a variety of applications such as in honey, ecology, geology and petroleum applications. It can aid in the measurement of 2H, 13C, 15N, 18O and 34S stable isotopes. It uses a thorium coated filament, stainless steel vacuum chamber, 100 V amplification and purge and trap chromatography for the separation of gases. It is also capable of headspace analysis. It is able to perform bulk and compound specific analysis through combination with other Elementar and Agilent technologies such as gas chromatography and elemental analysis.

Dataset-specific Instrument Name	Elementar Vario EL Cube
Generic Instrument Name	Elementar Vario EL Cube elemental analyzer
Dataset-specific Description	At the UC Davis Stable Isotope Facility samples were analyzed utilizing an Elemental Analyzer (Elementar Vario EL Cube) attached to an Isotope Ratio Mass Spectrometer (Isoprime VisION).
Generic Instrument Description	A laboratory instrument used for quantifying organic elements. It can measure C, H, N and S and optionally O, Cl and TIC. It was first developed in 2006 as a successor to the vario EL III. It uses a high-temperature combustion unit that is able to complete sample digestion at up to 1200 deg C (or 1800 deg C at the point of combustion when tin foil is used) and a jet injection of oxygen directly to the sample during combustion. Separation of gas components are performed on up to 3 gas-selective columns which trap gases until they are heated up and the prior gas peak has reached the baseline during detection. It uses a Thermal Conductivity Detector (TCD) as standard. An infrared (IR) detector for sulfur and oxygen and electrochemical detector for chlorine are optionally available. The instrument can measure C / N elemental ratios of up to 12,000:1 and provides an elemental detection limit of < 40 ppm (TCD).

Dataset-specific Instrument Name	Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Samples were obtained from Niskin bottles.
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

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Deployments

AE1920

Website	https://www.bco-dmo.org/deployment/905112
Platform	R/V Atlantic Explorer
Start Date	2019-08-08
End Date	2019-08-13

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Project Information

The fate of lysis products of picocyanobacteria contributes to marine humic-like chromophoric dissolved organic matter (Picocyanobacteria CDOM)

Coverage: Bermuda Atlantic Time Series Station (BATS) and station Aloha, Hawaii

NSF Award Abstract:
This study focuses on the sources and composition of colored dissolved organic matter (CDOM) in the ocean. CDOM is a part of water that absorbs sunlight. This material is important because it filters out harmful ultraviolet radiation. Scientists use it to track the movement of carbon and other important biological and chemical processes in the ocean. Organisms such as algae living in the open ocean have been shown to be sources of CDOM, but the chemical composition of these algal natural products remains to be discovered. Recent results from studying common algae show that viruses may break down algal cells and release material that looks like CDOM. This study will use new tools to find out if viruses and algae are creating this material and study its chemical makeup. This project will support two graduate students and provide summer internships for undergraduates through the NSF Research Experiences for Undergraduates (REU) program. The investigators will participate in a range of education and outreach activities.

The sources and structural nature of marine CDOM within the oceans remain unclear and continue to be a subject of debate. Marine in situ sources of CDOM have been suggested and some have been confirmed, but thus far none could explain the ubiquitous appearance of the so called "humic-like" CDOM component. Unique features of this component include its unusual exponential behavior in ultraviolet-visible (UV-Vis) absorbance with the absorbance extending well above 400 nm, and the large Stoke's shift in fluorescence spectroscopy. Picocyanobacteria are ubiquitous in the World's Oceans and make up 50 % of the autotrophic marine primary production. Preliminary results showed that the picocyanobacteria Synechococcus and Prochlorococcus release CDOM that matched the "humic-like" appearance of globally observed marine CDOM after virus-induced lysis. The main focus of this study is the characterization of the optical properties and molecular composition of viral-lysed DOM (VDOM) from different strains of Synechococcus and Prochlorococcus and additionally Trichodesmium which was shown in a previous study to also release CDOM. Associations between the chemical characterization information and metagenomics and transcriptomics data will be investigated for picocyanobacteria in the Pacific and Atlantic Oceans. This study includes long-term incubation experiments to determine the persistence of picocyanobacteria-derived CDOM as well as changes in microbial communities and processes (gene expression) that are related to the degradation of VDOM during the incubation period.

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-1829888

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