Chlorophyll-a concentrations in seawater collected near the BATS station during R/V Atlantic Explorer cruises AE2113 (July 2021) and AE2303 (January 2023)

Website: https://www.bco-dmo.org/dataset/929873
Data Type: Cruise Results
Version: 1
Version Date: 2024-06-20

Project
» Collaborative Research: Seasonal Variability in refractory dissolved organic carbon fluxes associated with primary marine aerosol emitted from the oceans (Carbon Flux and Aerosol Emissions)

Programs
» United States Surface Ocean Lower Atmosphere Study (U.S. SOLAS)
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
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Abstract
This dataset includes the concentrations of Chlorophyll a (Chl a) determined in 0.2 µm-filtered seawater samples collected from the Bermuda Atlantic Time-series Study (BATS) station during a summer cruise in 2021 and a winter cruise in 2023. The Chl a concentration in each sample was quantified by fluorescence under subdued lighting using a Turner Designs model AU-10 fluorometer by Dr. Joanna Kinsey. This dataset was compiled by Dr. Lei Xue under the supervision of Dr. David Kieber at the State University of New York, College of Environmental Science and Forestry. These data were used to evaluate the seasonal variation of primary productivity at the BATS station. This work is part of a larger study to understand the seasonal variability in the fraction of refractory organic carbon in primary marine aerosol at the BATS station.

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Coverage

Location: Bermuda Atlantic TimeSeries Study (BATS) station

Spatial Extent: **N**:31.69 **E**:-64.156 **S**:31.652 **W**:-64.202
Temporal Extent: 2021-07-23 - 2023-01-28

Methods & Sampling

Seawater samples were collected using Niskin bottles from CTD casts taken at the Bermuda Atlantic Time-series Study (BATS) station aboard the R/V Atlantic Explorer during a summer cruise in 2021 (AE2113) and a winter cruise in 2023 (AE2303). Seawater samples were collected in pre-cleaned opaque brown polyethylene bottles and then analyzed for chlorophyll a (Chl-a) following extraction into 90% acetone:10% high purity water according to the method outlined in Welschmeyer, 1994. Briefly, after a seawater sample was collected from the CTD rosette, a known volume of that seawater was filtered through a 25 mm diameter GF/F glass fiber filter under subdued lighting and at ~100 mm Hg pressure differential. Samples were filtered within 30 min of sample collection. The filter-funnel walls were then rinsed with previously filtered seawater. The filter was folded with a flat-tipped forcep and placed in a borosilicate test tube that was tightly capped. The test tube was wrapped in Al foil and frozen. Once several samples were processed and stored this way, they were removed from the freezer and 4 mL of 90% (v/v) acetone (Burdick and Jackson, spectrophotometric grade) diluted with high-purity laboratory water (Milli-Q water from a Barnstead water system) was added. The samples were vigorously shaken, wrapped in Al foil, and returned to the freezer without letting the samples return to room temperature. The Chl-a extracted overnight in the freezer (ca. 12 hr) in the dark. Chl-a in the acetone extracts was quantified by fluorescence under subdued lighting using a Turner Designs model AU-10 fluorometer. Samples were removed from the freezer and warmed to room temperature in the dark prior to analysis.

Data Processing Description

Chlorophyll a Concentration Calculation: To obtain chlorophyll-a concentrations, blank-corrected fluorescence values obtained from the AU-10 fluorometer were converted to micrograms of Chl-a per liter (ug/L Chl-a) by using the standard curve equation obtained from calibration with an authentic Chl-a standard diluted in 90% acetone prior to the cruise. Secondary solid standards were analyzed daily during the cruise to ensure that the calibration of the AU-10 fluorometer remained constant. Concentrations were corrected based on the filtered and extract volumes, as well as dilution factors, when needed.

AU-10 fluorometer calibrations were completed by the Bermuda Institute of Ocean Sciences (BIOS) staff. For AE2113 a slope of 0.00041236 was used with an acid ratio of 1.859. For AE2303 a slope of 0.0032515 was used with an acid ratio of 1.80671.

BCO-DMO Processing Description

- Imported data from two source files into the BCO-DMO data system. Concatenated files “AE2303_Chl a data.xlsx" and “AE2113_Chl a data.xlsx" to create a single data table.
- Combined date and time columns and converted to ISO8601 date format – from m.d.yyyy hh:mm to yyyy-mm-dd hh:mm
- Added column for cruise ID
- Converted latitude and longitude values to decimal degrees (where south and west directions are negative)
- Renamed fields to comply with BCO-DMO naming conventions
- Removed local time field

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Data Files

File
929873_v1_chl_a.csv (Comma Separated Values (.csv), 5.52 KB) MD5:1134254cdbfde145e43842739755ff70 Primary data file for dataset ID 929873, version 1

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Related Publications

Welschmeyer, N. A. (1994). Fluorometric analysis of chlorophyll a in the presence of chlorophyll b and pheopigments. Limnology and Oceanography, 39(8), 1985–1992. doi:10.4319/lo.1994.39.8.1985
Methods

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Parameters

Parameter	Description	Units
Cruise_ID	Cruise ID	unitless
Sampling_ISO_Datetime_UTC	Date and time of CTD sample collected	unitless
CTD_Filename	File of CTD deployment	unitless
Latitude	Latitude of sample collection	decimal degrees
Longitude	Longitude of sample collection	decimal degrees
Station	Sampling station	unitless
Cast	CTD cast number	unitless
CTD_Bottle	Number of Niskin bottle from the CTD cast	unitless
Salinity	Salinity from CTD Sensor	part per thousand (ppt)
Temperature	Temperature of water from CTD Sensor	degree Celsius
Sampling_Depth	Depth below surface from CTD Sensor	meter (m)
Volume_Filtered	Sample volume filtered for Chl a measurement	milliliter (ml)
Dilution_Factor	The magnitude of dilution made for filtered sample	unitless
Extraction_Volume	Volume of acetone used for Chl a extraction	milliliter (ml)
Chl_a	Concentration of Chlorophyll a	microgram per liter (ug/L)

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Instruments

Dataset-specific Instrument Name	CTD rosette equipped with Sea-Bird Electronic sensors
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	Seawater samples were collected from casts using CTD Sea-Bird SBE 911+.
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

Dataset-specific Instrument Name	30 L Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Seawater samples were obtained using 30 L Niskin bottles attached to a CTD rosette.
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.

Dataset-specific Instrument Name	Turner Designs model AU-10 fluorometer
Generic Instrument Name	Turner Designs Fluorometer 10-AU
Dataset-specific Description	The Turner Designs 10-AU Field Fluorometer was used to measure Chlorophyll fluorescence. The 10AU Fluorometer can be set up for continuous-flow monitoring or discrete sample analyses. A variety of compounds can be measured using application-specific optical filters available from the manufacturer.
Generic Instrument Description	The Turner Designs 10-AU Field Fluorometer is used to measure Chlorophyll fluorescence. The 10AU Fluorometer can be set up for continuous-flow monitoring or discrete sample analyses. A variety of compounds can be measured using application-specific optical filters available from the manufacturer. (read more from Turner Designs, turnerdesigns.com, Sunnyvale, CA, USA)

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Deployments

AE2113

Website	https://www.bco-dmo.org/deployment/860681
Platform	R/V Atlantic Explorer
Start Date	2021-07-22
End Date	2021-08-01

AE2303

Website	https://www.bco-dmo.org/deployment/929877
Platform	R/V Atlantic Explorer
Report	https://www.rvdata.us/search/cruise/AE2303
Start Date	2023-01-18
End Date	2023-01-28

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Project Information

Collaborative Research: Seasonal Variability in refractory dissolved organic carbon fluxes associated with primary marine aerosol emitted from the oceans (Carbon Flux and Aerosol Emissions)

Coverage: Bermuda Atlantic Time-series Study (BATS) station

NSF Award Abstract:

Collaborative Research: Seasonal variability in refractory dissolved organic carbon fluxes associated with primary marine aerosol emitted from the oceans

The oceans hold a massive quantity of organic carbon that is greater than all terrestrial organic carbon biomass combined. Nearly all marine organic carbon is dissolved. On average, it is thousands of years old, chemically stable, and carried throughout the entire ocean several times before complete removal. However, little is known about the processes that produce and remove this old carbon, referred to as refractory dissolved organic carbon (RDOC). One potential removal pathway involves RDOC adhering onto the surfaces of rising bubbles produced by breaking waves. The bubbles ultimately burst at the sea surface, ejecting tiny particles (primary marine aerosol, “PMA”) that carry the RDOC into the atmosphere. Most of this PMA organic carbon is associated with the smallest particles (less than 1 µm diameter) that drift in the atmosphere for several days to weeks. During this time, RDOC in these particles can be degraded photochemically (by sunlight), partially transported landward, and/or returned to the sea. When this RDOC is converted to inorganic carbon (e.g., carbon dioxide) or degraded to more reactive constituents in the atmosphere, it is effectively removed from the marine RDOC reservoir. Based on preliminary results, the annual rate at which RDOC is removed from the ocean by this process is similar to all other known RDOC losses (interactions with particles, biological degradation, and hydrothermal circulation), except for photochemical degradation in seawater. Building on this prior research, this project will identify seasonal changes in the removal of RDOC from the oceans through this process during three research cruises to the northwestern Atlantic Ocean. Results from this project will provide important findings about the coupled ocean-atmosphere loss of RDOC and improve understanding of the role of RDOC in the global carbon cycle and Earth's climate. The research will involve two early career faculty, and will provide training for undergraduate, graduate, and postdoctoral researchers.

Radiocarbon (C-14) measurements indicate that RDOC comprises 19 to 40 % of the organic carbon associated with PMA produced by bursting bubbles at the sea surface. Injection of RDOC into the atmosphere in association with PMA is a potentially important process that removes as much as 2 to 20 Tg RDOC yr-1 from the oceans. This project will measure seasonal variations in the PMA-mediated emission of marine RDOC to the

atmosphere by quantifying: (1) the fraction of RDOC in PMA OC and (2) its relationship to the abundance of biologically produced labile and semi-labile dissolved organic matter in near surface seawater. These relationships will be evaluated at the Bermuda Atlantic Time-series Station during three research cruises (one in July, two in January). During the cruises, the investigators will measure: (1) the natural abundance C-14 values for PMA and its organic source materials in seawater; (2) the dynamic and equilibrium surface tension and physical properties of seawater, including bubble size distributions; (3) concentrations of major ions, organic carbon, carbohydrates, peptides and proteins, and surfactants in PMA; and (4) chromophoric dissolved organic matter (CDOM) and the concentrations of dissolved organic carbon, chlorophyll a, major ions, carbohydrates, peptides and proteins, and surfactants in near-surface seawater and in the sea-surface microlayer. Based on these chemical measurements and physical properties, this study will reveal the magnitude and potential controls on RDOC inputs into the atmosphere as a component of PMA.

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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Program Information

United States Surface Ocean Lower Atmosphere Study (U.S. SOLAS)

Website: http://www.us-solas.org/

Coverage: Global

The Surface Ocean Lower Atmosphere Study (SOLAS) program is designed to enable researchers from different disciplines to interact and investigate the multitude of processes and interactions between the coupled ocean and atmosphere.

Oceanographers and atmospheric scientists are working together to improve understanding of the fate, transport, and feedbacks of climate relevant compounds, and also weather and hazards that are affected by processes at the surface ocean.

Oceanographers and atmospheric scientists are working together to improve understanding of the fate, transport, and feedbacks of climate relevant compounds.

Physical, chemical, and biological research near the ocean-atmosphere interface must be performed in synergy to extend our current knowledge to adequately understand and forecast changes on short and long time frames and over local and global spatial scales.

The findings obtained from SOLAS are used to improve knowledge at process scale that will lead to better quantification of fluxes of climate relevant compounds such as CO2, sulfur and nitrogen compounds, hydrocarbons and halocarbons, as well as dust, energy and momentum. This activity facilitates a fundamental understanding to assist the societal needs for climate change, environmental health, weather prediction, and national security.

The US SOLAS program is a component of the International SOLAS program where collaborations are forged with investigators around the world to examine SOLAS issues ubiquitous to the world's oceans and atmosphere.

Â» International SOLAS Web site

Science Implementation Strategy Reports

US-SOLAS (4 MB PDF file)
Other SOLAS reports are available for download from the US SOLAS Web site

Ocean Carbon and Biogeochemistry (OCB)

Website: http://us-ocb.org/

Coverage: Global

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF.

The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems.

The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO2 and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two.

The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen conditions in the coastal and open oceans.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2023104

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