Two decibar-averaged CTD profiles collected at Bermuda Atlantic Time Series sites in the Sargasso Sea ongoing from 1988 (BATS project)

Website: https://www.bco-dmo.org/dataset/3918
Data Type: Cruise Results
Version: 5
Version Date: 2023-04-12

Project
» Bermuda Atlantic Time-series Study (BATS)

Programs
» Ocean Carbon and Biogeochemistry (OCB)
» U.S. Joint Global Ocean Flux Study (U.S. JGOFS)
» Ocean Time-series Sites (Ocean Time-series)

Contributors	Affiliation	Role
Bates, Nicholas	Bermuda Institute of Ocean Sciences (BIOS)	Principal Investigator
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Coverage

Spatial Extent: **N**:36.662 **E**:-61.166 **S**:19.225 **W**:-74.6
Temporal Extent: 1988-10-20 - 2022-12-16

Dataset Description

Please note: The data presented here are in "as-received" format and have not yet been processed by BCO-DMO.

Profiles of basic CTD measurements of (Pressure, Depth, Temperature, Conductivity, and Salinity) are reported along with dissolved oxygen, beam attenuation, and relative fluorescence, at one-decibar averages. The profiles were collected during monthly hydrographic cruises to the BATS site at 31° 40' N 64° 10'W and during biweekly cruises to a neighbouring location (32°10′N 64°30′W), known as Hydrostation "S."

Methods & Sampling

CTD profiles at the BATS site have been collected since the inception of the program in October 1988 and although there have been some changes during the past thirty years as a result of new instrumentation or methodologies, the general sampling procedures have been consistent with those detailed in the BATS method manual version # 4 (Knap et al., 1996).

In summary, the CTD is operated as per SeaBird's suggested methods with data collection at the full scan rate of 24 Hz. The CTD is powered up and allowed to stabilize at 12 m prior to profiling and once stable (typically 4 minutes) the CTD is brought back to the surface from which point the profile begins with typical descent rates of 0.7-1.0 m/s, depending on weather conditions. Water samples are collected on the upcast and prior to triggering bottles the CTD is kept at the desired depth for a minimum of 60 seconds to ensure that entrainment from the following wake has subsided. Once the water sample is taken the CTD immediately continues with the upcast at an ascent rate of 0.7-1.0 m/s.

Data Processing Description

Current preliminary version: 2023-04-07 has not been processed by BCO-DMO

CTD data processing typically follows the procedures outlined in Knap et al., 1996 and can be divided into two major stages: (1) CTD signal conversion and dynamic sensor correction, and; (2) static drift corrections and empirical field calibrations. Stage 1 is performed using SeaBird's SEASOFT software and some Matlab scripts, while stage 2 is performed completely in the Matlab environment. The basic steps of stage 1 are: preliminary CTD sensor quality check; determination of the dynamic coefficients associated with time alignment and thermal mass problems; application of pressure filter and velocity filter (0.3 m/s); application of digital filters for erroneous signal removal; and finally average to 2 Hz ready for stage 2 processing. The processing steps in stage 2 include: static drift corrections as determined from the sensor calibration history; empirical field calibration of the conductivity and oxygen sensors; final QC analysis; and bin average downcast data to 2 dbar. Following experience of profiling with the SBE–35RT temperature probes, appropriate routines are being implemented to assess performance of the SBE–03f units against the SBE–35 and implement correction procedures. It should be noted that only downcast data are processed and reported, except for the marker data during bottle fires on the upcast.

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- merged deployment and recovery information from supplemental info files into the data using the cast_ID
- created the following additional columns: info_filename, filename, cruise_type, cruise_number, cast_number, and cruise_type_text.
- replaced NaN and -999 with the fill value 'nd'.
- combined 'Date deployed' and 'Time CTD deployed GMT' into ISO_datetime_deployed.
- combined 'Date recovered' and 'Time CTD recovered GMT' into ISO_datetime_recovered.
- converted longitude values from degrees West to degrees East (mutliplied by -1).

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Data Files

File
BATS_v005_CTD_data filename: v005_exports.zip (ZIP Archive (ZIP), 63.77 MB) MD5:f567367d71a516626ebf152180d657c2 Compiled files for 'meta' (metadata), 'mask' (quality flags, and 'data'. These are preliminary "as received" and have not yet been processed and combined by BCO-DMO

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Related Publications

Knap, A.H., Michaels, A.F., Steinberg, D.K., Bahr, F., Bates, N.R., Bell, S., Countway, P., Close, A.R., Doyle, A.P., Dow, R.L., Howse, F.A., Gundersen, K., Johnson, R.J., Kelly, R., Little, R., Orcutt, K., Parsons, R., Rathburn, C., Sanderson, M. and Stone, S. (1997) BATS Methods Manual, Version 4 Woods Hole, MA, US. U.S. JGOFS Planning Office 136pp. *Chapter 16. Determination of Dissolved Organic Carbon by a High Temperature Combustion/Direct Injection Technique.* Updated by R.Parsons 4/1997, pp. 99-109.
https://eprints.soton.ac.uk/361194/#chapter16
Methods

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Parameters

Parameter	Description	Units
Beam_Attenuation_Coefficient	Beam Attenuation Coefficient	per meter (1/m)
Conductivity	Conductivity	Siemens per meter (S/m)
Depth	Depth	meters (m)
Dissolved_Oxygen	Dissolved Oxygen	micromole per kilogram (umol/kg)
Fluorescence	Fluorescence	relative fluorescence units (RFU)
Latitude	latitude with north positive	decimal degrees
Longitude	longitude with east positive	decimal degrees
PAR	Photosythetically Active Radiation (PAR)	microeinsteins per meter squared per second (uE/m2/s)
Pressure	Pressure	decibar (dbar)
Salinity	salinity	PSS-78
Temperature	Temperature (ITS-90)	degrees Celsius
cast_ID	cast ID	unitless
decimal_year	decimal year	year
filename	name of the originators file	unitless
Decimal_date_deployed	Date deployed in yyyymmdd format	unitless
Decimal_date_recovered	Date recovered in yyyymmdd format	unitless
Decimal_day_deployed	decimal day deployed	unitless
Latitude_CTD_deployed	latitude deployed with north positive	decimal degrees
Latitude_CTD_recovered	latitude recovered with north positive	decimal degrees
Longitude_CTD_deployed	longitude deployed with west positive	decimal degrees
Longitude_CTD_recovered	longitude recovered with west positive	decimal degrees
info_filename	file from which	unitless
ISO_datetime_deployed	date and time the CTD was deployed following ISO8601 format	unitless
ISO_datetime_recovered	date and time the CTD was recovered following ISO8601 format	unitless
cruise_type	type of cruise	unitless
cruise_number	cruise number	unitless
cast_number	cast number	unitless
cruise_type_text	a text description of the cruise type	unitless

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Instruments

Dataset-specific Instrument Name	CTD Sea-Bird 911
Generic Instrument Name	CTD Sea-Bird 911
Generic Instrument Description	The Sea-Bird SBE 911 is a type of CTD instrument package. The SBE 911 includes the SBE 9 Underwater Unit and the SBE 11 Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 and SBE 11 is called a SBE 911. The SBE 9 uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 and SBE 4). The SBE 9 CTD can be configured with 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	CTD Sea-Bird 911+
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	SeaBird 9/11+ CTD equipped with dual SBE-03f temperature sensors, SBE-04 conductivity sensors, and SBE45 dissolved oxygen sensors
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	Fluorometer
Generic Instrument Name	Fluorometer
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	SBE 43 Dissolved Oxygen Sensor
Generic Instrument Name	Sea-Bird SBE 43 Dissolved Oxygen Sensor
Generic Instrument Description	The Sea-Bird SBE 43 dissolved oxygen sensor is a redesign of the Clark polarographic membrane type of dissolved oxygen sensors. more information from Sea-Bird Electronics

Dataset-specific Instrument Name	
Generic Instrument Name	Sea-Bird SBE-3 Temperature Sensor
Generic Instrument Description	The SBE-3 is a slow response, frequency output temperature sensor manufactured by Sea-Bird Electronics, Inc. (Bellevue, Washington, USA). It has an initial accuracy of +/- 0.001 degrees Celsius with a stability of +/- 0.002 degrees Celsius per year and measures seawater temperature in the range of -5.0 to +35 degrees Celsius. more information from Sea-Bird Electronics

Dataset-specific Instrument Name	
Generic Instrument Name	Sea-Bird SBE-4 Conductivity Sensor
Generic Instrument Description	The Sea-Bird SBE-4 conductivity sensor is a modular, self-contained instrument that measures conductivity from 0 to 7 Siemens/meter. The sensors (Version 2; S/N 2000 and higher) have electrically isolated power circuits and optically coupled outputs to eliminate any possibility of noise and corrosion caused by ground loops. The sensing element is a cylindrical, flow-through, borosilicate glass cell with three internal platinum electrodes. Because the outer electrodes are connected together, electric fields are confined inside the cell, making the measured resistance (and instrument calibration) independent of calibration bath size or proximity to protective cages or other objects.

Dataset-specific Instrument Name	Transmissometer
Generic Instrument Name	Transmissometer
Generic Instrument Description	A transmissometer measures the beam attenuation coefficient of the lightsource over the instrument's path-length. This instrument designation is used when specific manufacturer, make and model are not known.

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Deployments

BATS_cruises

Website	https://www.bco-dmo.org/deployment/58883
Platform	Unknown Platform
Report	http://bats.bios.edu/bats-data/
Start Date	1988-10-20
Description	Bermuda Institute of Ocean Science established the Bermuda Atlantic Time-series Study with the objective of acquiring diverse and detailed time-series data. BATS makes monthly measurements of important hydrographic, biological and chemical parameters throughout the water column at the BATS Study Site, located at 31 40N, 64 10W. **Methods & Sampling** 2019-05-29 update.

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Project Information

Bermuda Atlantic Time-series Study (BATS)

Website: http://bats.bios.edu

Coverage: Northwest Sargasso Sea at 31 deg 40' N, 64 deg 10' W

A full description of the BATS research program (including links to the processed BATS data) is available from the BATS Web site (see above for Project URL/ Project Website links). Any data contributed from selected ancillary projects are listed (linked) in the 'Datasets Collection' section below.

Collaborative Research: The Bermuda Atlantic Time-series Study: Sustained Biogeochemical, Ecosystem and Ocean Change Observations and Linkages in the North Atlantic (Years 31-35) ***Awards OCE-1756105, OCE-1756054, and OCE-1756312)***
NSF award abstract
Long-term observations over several decades are a powerful tool for investigating ocean physics, biology, and chemistry, and the response of the oceans to environmental change. The Bermuda Atlantic Time-Series Study, known as BATS, has been running continuously since 1988. The research goals of the BATS program are: (1) to improve our understanding of the time-varying components of the ocean carbon cycle and the cycles of related nutrient elements such as nitrogen, phosphorus, and silicon; and, (2) to identify the relevant physical, chemical and ecosystem properties responsible for this variability. In addition, the BATS program has strong and diverse broader impacts, contributing to the field of ocean sciences by providing high quality ocean observations and data for seagoing scientists and modelers, and a framework through which researchers can conceive and test hypotheses. This award will support the operations of the BATS program for five more years.

The primary BATS research themes are as follows: (1) Quantify the role of ocean-atmosphere coupling and climate variability on air-sea exchange of CO2, and carbon export to the ocean interior; (2) Document trends and the controls on the interannual to decadal scale variability in carbon and nutrient cycles to their coupling in the surface and deep ocean via the Redfield Ratio paradigm; (3) Quantify the response of planktonic community structure and function, and impact on biogeochemical cycles to variability in surface fluxes and dynamical processes; (4) Facilitate development, calibration and validation of next generation oceanographic sensors, tools and technologies; and, (5) Generate a dataset that can be utilized by empiricists, modelers and students. This research integrates ocean physics, chemistry and biology into a framework for understanding oceanic processes and ocean change in the North Atlantic subtropical gyre. The existing 29 years of BATS data provide robust constraints on seasonal and interannual variability, the response of the Sargasso Sea ecosystem to natural climate variability, and signal detection of potential ocean changes. This project would extend the BATS program through years 31-35 to address a series of ten interlinked questions through integrated research approaches and a multitude of collaborative efforts. In addition to the themes above, and embedded into the ten questions and approaches, the BATS team will focus on, for example, coupling of particle production and biogeochemistry; revisiting the complexities of the biological carbon pump; oxygen

decline; and changes in the hydrography, physics, ocean carbon cycle and biogeochemistry of the Sargasso Sea. The highest quality data observation and collection will be maintained and used to address these questions. Importantly, a wide range of collaborations at the BATS site, spanning the physical and biogeochemical disciplines, will aid these broad goals. Strong links to community stakeholders, and close collaboration (including methods intercomparisons and personnel exchanges) with the Hawaii Ocean Time-series are proposed. This work will extend the research findings of the project into educational and training opportunities within and beyond the oceanographic community, including training and mentorship of both undergraduate and graduate students.

Please see the BATS Web site (http://bats.bios.edu) for additional information.

List of References (PDF)

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Program Information

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.

U.S. Joint Global Ocean Flux Study (U.S. JGOFS)

Website: http://usjgofs.whoi.edu/

Coverage: Global

The United States Joint Global Ocean Flux Study was a national component of international JGOFS and an integral part of global climate change research.

The U.S. launched the Joint Global Ocean Flux Study (JGOFS) in the late 1980s to study the ocean carbon cycle. An ambitious goal was set to understand the controls on the concentrations and fluxes of carbon and associated nutrients in the ocean. A new field of ocean biogeochemistry emerged with an emphasis on quality measurements of carbon system parameters and interdisciplinary field studies of the biological, chemical and physical process which control the ocean carbon cycle. As we studied ocean biogeochemistry, we learned that our simple views of carbon uptake and transport were severely limited, and a new "wave" of ocean science was born. U.S. JGOFS has been supported primarily by the U.S. National Science Foundation in collaboration with the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, the Department of Energy and the Office of Naval Research. U.S. JGOFS, ended in 2005 with the conclusion of the Synthesis and Modeling Project (SMP).

Ocean Time-series Sites (Ocean Time-series)

Coverage: Bermuda, Cariaco Basin, Hawaii

Program description text taken from Chapter 1: Introduction from the **Global Intercomparability in a Changing Ocean: An International Time-Series Methods Workshop** report published following the workshop held November 28-30, 2012 at the Bermuda Institute of Ocean Sciences. The full report is available from the workshop Web site hosted by US OCB: http://www.whoi.edu/website/TS-workshop/home

Decades of research have demonstrated that the ocean varies across a range of time scales, with anthropogenic forcing contributing an added layer of complexity. In a growing effort to distinguish between natural and human-induced earth system variability, sustained ocean time-series measurements have taken on a renewed importance. Shipboard biogeochemical time-series represent one of the most valuable tools scientists have to characterize and quantify ocean carbon fluxes and biogeochemical processes and their links to changing climate (Karl, 2010; Chavez et al., 2011; Church et al., 2013). They provide the oceanographic community with the long, temporally resolved datasets needed to characterize ocean climate, biogeochemistry, and ecosystem change.

The temporal scale of shifts in marine ecosystem variations in response to climate change are on the order of several decades. The long-term, consistent and comprehensive monitoring programs conducted by time-series sites are essential to understand large-scale atmosphere-ocean interactions that occur on interannual to decadal time scales. Ocean time-series represent one of the most valuable tools scientists have to characterize and quantify ocean carbon fluxes and biogeochemical processes and their links to changing climate.

Launched in the late 1980s, the US JGOFS (Joint Global Ocean Flux Study; http://usjgofs.whoi.edu) research program initiated two time-series measurement programs at Hawaii and Bermuda (HOT and BATS, respectively) to measure key oceanographic measurements in oligotrophic waters. Begun in 1995 as part of the US JGOFS Synthesis and Modeling Project, the CARIACO Ocean Time-Series (formerly known as the CArbon Retention In A Colored Ocean) Program has studied the relationship between surface primary production, physical forcing variables like the wind, and the settling flux of particulate carbon in the Cariaco Basin.

The objective of these time-series effort is to provide well-sampled seasonal resolution of biogeochemical variability at a limited number of ocean observatories, provide support and background measurements for process-oriented research, as well as test and validate observations for biogeochemical models. Since their creation, the BATS, CARIACO and HOT time-series site data have been available for use by a large community of researchers.

Data from those three US funded, ship-based, time-series sites can be accessed at each site directly or by selecting the site name from the Projects section below.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0752336

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