CTD data collected at the Hydrostation S site in the Sargasso Sea from 1988 onward

Website: https://www.bco-dmo.org/dataset/860014
Data Type: Cruise Results
Version: 1
Version Date: 2021-09-07

Project
» The Panulirus Hydrographic Stations (Hydrostation S) (Hydrostation S)

Contributors	Affiliation	Role
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Coverage

Spatial Extent: **N**:32.983 **E**:-63.288 **S**:30.154 **W**:-66.799
Temporal Extent: 1988-10-26 - 2016-12-19

Dataset Description

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 biweekly cruises to the site known as Hydrostation S (32°10′N 64°30′W).

Methods & Sampling

CTD profiles at the Hydrostation S site have been collected since station #643 in October 1988 and although there have been some changes during the past thirty-two 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., 1997).

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

Data processing:
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.

Instrument calibration:
CTD sensor calibration*:* Temperature, conductivity and dissolved oxygen sensors are routinely returned to SeaBird every 6-9 months for routine calibration, while the pressure unit is calibrated following full service of the underwater SBE 9 unit every 18-24 months. Auxiliary instruments (fluorometer, tranmissometer, PAR) are sent for calibration every 12 months.

Quality control data access note:
Data fields that have a WHPO quality flag =3 hav been deemed questionable by the PIs, so any individual accessing the data should be aware that they are accessing data of questionable quality.

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- replaced NaN and -999 with the fill value 'nd'

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Data Files

File
ctd_hydrostation_s.csv (Comma Separated Values (.csv), 233.79 MB) MD5:9e91f3e78310c869ba8ff578d553adb3 Primary data file for dataset ID 860014

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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

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. http://eprints.soton.ac.uk/id/eprint/361194
Methods

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Parameters

Parameter	Description	Units
Cruise_type_text	Description of the cruise type	unitless
Cast_ID	Cast ID	unitless
Cruise_number	Cruise number	unitless
Cast_number	Cast number	unitless
Decimal_year	Decimal year	year
ISO_Datetime_deployed	Date and time the CTD was deployed (following ISO8601 format)	unitless
Decimal_date_deployed	Date deployed in yyyymmdd format	unitless
Decimal_day_deployed	Decimal day of deployment	unitless
ISO_Datetime_recovered	Date and time the CTD was recovered (following ISO8601 format)	unitless
Decimal_date_recovered	Date recovered in yyyymmdd format	unitless
Longitude_CTD_deployed	Longitude at deployment (west is negative)	decimal degrees
Latitude_CTD_deployed	Latitude of deployment	decimal degrees
Longitude_CTD_recovered	Longitude of recovery (west is negative)	decimal degrees
Latitude_CTD_recovered	Latitude of recovery	decimal degrees
Filename	Name of the originators' file	unitless
Info_filename	File from which additional information was obtained	unitless
Latitude	Latitude	decimal degrees
Longitude	Longitude (west is negative)	decimal degrees
Pressure	Pressure	decibar (dbar)
Depth	Depth	meters (m)
Beam_Attenuation_Coefficient	Beam Attenuation Coefficient	per meter (1/m)
Conductivity	Conductivity	Siemens per meter (S/m)
Dissolved_Oxygen	Dissolved Oxygen	micromole per kilogram (umol/kg)
Fluorescence	Fluorescence	relative fluorescence units (RFU)
PAR	Photosythetically Active Radiation (PAR)	microeinsteins per meter squared per second (uE/m2/s)
Salinity	Salinity	PSS-78
Temperature	Temperature (ITS-90)	degrees Celsius

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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	Chelsea 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	Biospherical PAR sensor
Generic Instrument Name	Photosynthetically Available Radiation Sensor
Generic Instrument Description	A PAR sensor measures photosynthetically available (or active) radiation. The sensor measures photon flux density (photons per second per square meter) within the visible wavelength range (typically 400 to 700 nanometers). PAR gives an indication of the total energy available to plants for photosynthesis. This instrument name is used when specific type, make and model are not known.

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	Wetlabs 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

The Panulirus Hydrographic Stations (Hydrostation S) (Hydrostation S)

Website: http://www.bios.edu/research/projects/hydrostation-s/

Coverage: Sargasso Sea at 31 50'N 64 10'W

Hydrostation S (also known as Panulirus hydrographic station) is recognized as one of the most important sustained ocean time-series sites in the world. Located about 25 km southeast of Bermuda in the North Atlantic Ocean, this site has oceanographic measurements dating back to 1954, when Henry Stommel and co-workers initiated repeat biweekly hydrographic observations.

The most recent project awards and abstracts are listed below. A detailed **history of funding** with summary of all project awards for Hydrostation S (Panulirus Hydrographic stations) can be found here (PDF format): https://datadocs.bco-dmo.org/docs/305/Hydrostation_S/data_docs/Hydrostation_S_funding_history.pdf

Years 70-74:
NSF Award OCE-2122606 Abstract:

This project continues hydrographic observations at Hydrostation S, extending the time-series of ocean data to almost 70 years. Hydrostation S (formerly known as the Panulirus site), located about 25 km southeast of Bermuda in the North Atlantic Ocean, is one of the longest open-ocean hydrographic stations in the world. This

program of repeat biweekly hydrographic observations began in 1954 and now, in its seventh decade, has proved to be the catalyst for numerous studies of ocean physics, biological processes and biogeochemistry. Sustained observations of the ocean, such as those from Hydrostation S, remain critically important to establish rates of change to provide quantitative empirical data for myriad regional and global ocean synthesis and modeling of ocean processes and future ocean change. Hydrostation S program and its data are considered as a service to the community, being openly distributed and subsequently have been an invaluable resource in understanding processes and patterns of variability in the ocean, as well as education, mentorship and outreach activities.

The major objective of the proposal is to continue Hydrostation S into the eighth decade with numerous questions related to warming and cooling, salinification and freshening, deoxygenation and insights on biogeochemical changes over time. This program constitutes frequent water column sampling of temperature, salinity, and dissolved oxygen (and indirectly, sampling of important ocean carbon time–series) of the North Atlantic subtropical gyre at the Hydrostation S site. Such work is complementary to other sustained observations such as the Bermuda Atlantic Time–series Study (BATS) and Ocean Flux Program (OFP). The project entails a similar sampling format that has been followed for the past 68 years. Hydrostation S also supports the longest global ocean CO2 and acidification time-series (from 1983 to present).

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.

Years 65-69:
NSF Award OCE-1633125 Abstract:
The physical properties of the ocean from the surface layers to the abyssal water masses are changing in concert with natural and anthropogenically influenced physical forcing and sustained observations of the ocean are critically important to establish these rates of change. One of the longest open-ocean hydrographic stations in the world is maintained at the Hydrostation S site (formerly known as the Panulirus site) located about 25 km southeast of Bermuda in the North Atlantic Ocean. This repeat biweekly hydrographic observations was initiated by Henry Stommel and co-workers in 1954. Now, in its seventh decade, it continues to be recognized as one of the most important sustained ocean time-series and provides an invaluable metric for the long-term state of the North Atlantic subtropical gyre in relation to the meridional overturning circulation, western boundary transport, and gyre recirculation. For example, the upper ocean warming trend has strengthened (about 0.8° C since the 1970's) while the deep Labrador Sea has cooled by a few tenths of a degree. The signature of deoxygenation has been observed at Hydrostation S in the upper ocean (about 7 micro-moles/kg/decade decrease in dissolved oxygen) as well as an intensification and expansion of the oxygen minimum zone. These changes suggest that the North Atlantic subtropical gyre is experiencing deoxygenation as in the Pacific Ocean as a result of increased upper ocean stratification and reduced solubility of oxygen in warmer waters. The Hydrostation S program and its data set are managed as a service to the ocean community, being openly distributed and used as a resource in understanding processes and patterns of variability in the ocean, as well as for education, mentorship and outreach activities. The Hydrostation S project will contribute to the research and training of six research specialists and research technicians at BIOS and contribute to the research projects of at least three Ph.D. students through on-going educational partnership with Princeton University and the University of Southampton in the U.K. The one-day Hydrostation S research cruises are an ideal platform for testing new sensors and for providing hand-on training to undergraduate students enrolled in summer programs.

The Hydrostation S project is designed to address the overarching hypothesis that the physical properties of the upper-ocean to deep-ocean are changing in concert with natural and anthropogenically influenced physical forcing. Sustained observations of the ocean, such as those from Hydrostation S, remain critically important to establish rates of change to provide quantitative empirical data for myriad regional and global ocean synthesis and modeling of ocean processes and future ocean change. The major objective of Hydrostation S into the seventh decade is to continue the frequent water column sampling of temperature, salinity, and dissolved oxygen (and indirectly, sampling of important ocean carbon time?series) of the North Atlantic subtropical gyre. Such work is complementary to other sustained observations such as the Bermuda Atlantic Time-series Study (BATS) and Ocean Flux Program (OFP). As for the past five years, two CTD profiles will be conducted to better capture the deep-water variability while maintaining all the previous discrete depths. The first CTD cast will profile to full ocean depth (3,200-3,500 m) while the second CTD cast will profile from the surface to 500 m to allow for biogeochemical instrumentation not rated for full ocean depth and to support ancillary studies of ocean physics, biological processes and biogeochemistry. A secondary objective will be to build upon the collaborative comparison of physical data collected as part of two autonomous sensor projects. In the latter stages of the project, as ocean glider deployment becomes more sustainable and reliable, collaborative and

comparative efforts will be used to test the capability of ocean gliders to provide data of sufficient quality to detect long-term oceanic change in a "virtual" mooring time-series mode. The robust and highly accurate Hydrostation S data will be used to test the capability of emerging technologies over the next five to ten years.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1633125
NSF Division of Ocean Sciences (NSF OCE)	OCE-2122606

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