CTD data from the Puerto Rico Trench collected with the Deep Autonomous Profiler (DAP) on R/V Endeavor cruise EN622 during September 2018

Website: https://www.bco-dmo.org/dataset/892686
Data Type: Cruise Results
Version: 1
Version Date: 2023-03-29

Project
» An Autonomous Ocean Profiling and Water Sampling System for 0 to 11 km of Water Depth (DAP Test PR Trench)

Contributors	Affiliation	Role
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Abstract
These data are from a series of deep CTD casts in the Puerto Rico Trench. The data were collected with the Deep Autonomous Profiler (DAP), deployed from R/V Endeavor on cruise EN622 during September 2018.

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Coverage

Spatial Extent: **N**:19.793 **E**:-65.34 **S**:18.85 **W**:-66.49
Temporal Extent: 2018-09-15 - 2018-09-22

Dataset Description

This is a series of deep CTD casts in the Puerto Rico Trench. The data were collected with the Deep Autonomous Profiler (DAP). The DAP system and example profiles are described in Muir et al. (2021).

Methods & Sampling

The Deep Autonomous Profiler (DAP) was tested in the Puerto Rico Trench for a total of nine dives during September 2018. The DAP was deployed from R/V Endeavor (cruise EN622). The tests verified the vehicle's operations, checked the sensor accuracy at depth, and demonstrated the utility of the adaptive water sampling method.

Figure 2 of Muir et al. (2021) depicts the operational steps of the DAP. In summary, using drop weights, the

profiler descends at a nominal speed of 60 meters per minute through the water column, collecting CTD data. Upon reaching the bottom, a timer is activated and an onboard algorithm processes the descent profile to set the trigger depths for any sample bottles set with an adaptive criteria. Bottom water samples can also be collected according to any preset delays.

The bottom time can vary anywhere from 5 minutes to 18 hours, depending on the objective of each dive and the amount of time allocated to the ascent and descent. A burn wire is used to release the drop weights when the planned bottom time limit is reached. During the ascent, at a nominal speed of 60 meters per minute, the Niskin bottles are triggered at any preset depths specified in the mission file or at adaptively calculated depths based on downcast data. When the DAP surfaces, a radio beacon, Iridium beacon, strobe, radar reflector, and flag are used for recovery by the ship.

For comparison, the shipboard CTD data is available from Rolling Deck to Repository (R2R) as DOI: 10.7284/134455.

Data Processing Description

BCO-DMO Processing:
- concatenated downcasts, upcasts, and bottom data into one file for each type;
- in those concatenated files, converted date/time field to ISO 8601 format;
- bundled the other files into .zip folders by file type.

Data Organization and File Naming Conventions:
There are several files available here. As stated above, the following three files were generated by BCO-DMO by concatenating the original .csv files provided for each part of each cast:

dap_downcasts_en622.csv = all of the downcast data (profiler going to the bottom);
dap_bottom_casts_en622.csv = all of the data from the portion of the casts where the DAP was resting at the bottom;
dap_upcasts_en622.csv = all of the upcast data (profiler returning to the surface).

In these there concatenated files, the csv_file_name column indicates the original .csv file name. These names correspond to the date and time of the cast (e.g. "20180915_121737_DOWN" = 2018-09-15 12:17:37).

The **Supplemental Files** here include the following Sea-Bird Files. Note that these files have similar date file names as the .csv files, but the times are a little bit off from the .csv files. This is because of when the vehicle's logging and the CTD logging were started.

bmp_files.zip = images of plots made using Sea-Bird software. Plots include sound velocity vs depth; and oxygen and temperature vs depth for each DAP cast.

cnv_files.zip = the Sea-Bird SBE 9 .cnv files for each DAP cast. Each file starts with standard Sea-Bird headers.

hex_files.zip = the Sea-Bird .hex files for each DAP cast.

The original .csv files (one per cast) are provided in **down_casts.zip**, **bottom_casts.zip**, and **up_casts.zip**. The .csv files in these folders have headers starting with latitude and longitude on row 1 and the column names on row 2.

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Related Publications

Muir, L., Roman, C., Casagrande, D., and D'Hondt, S. (2021) The Deep Autonomous Profiler (DAP), a Platform for Hadal Profiling and Water Sample Collection. Journal of Atmospheric and Oceanic Technology, vol. 38, no. 10, pp. 1833–1845, 2021. doi:10.1175/JTECH-D-20-0139.1. URL: https://journals.ametsoc.org/view/journals/atot/38/10/JTECH-D-20-0139.1.xml
Methods

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Related Datasets

IsRelatedTo

Rolling Deck To Repository. (2020). CTD (Conductivity, Temperature, Depth) data collected during research cruise EN622 using a Sea-Bird SBE-911+ instrument system onboard the platform RV Endeavor (Version 1) [Data set]. Rolling Deck to Repository (R2R) Program. https://doi.org/10.7284/134455

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Parameters

Parameter	Description	Units
csv_file_name	Name of csv file	unitless
latitude	Latitude of deployment (from first row of csv file)	decimal degrees North
longitude	Longitude of deployment (from first row of csv file)	decimal degrees East
time_julian_day	Time of deployment as julian day	days
ISO_DateTime_UTC	Date and time (UTC) of deployment in ISO 8601 format	unitless
abs_pressure	Absolute pressure	decibars (dbars)
depth	Depth	meters (m)
temperature	Water temperature	degrees Celsius
pot_temperature	Potential temperature	degrees Celsius
conductivity	Conductivity	Siemens per meter (S/m)
salinity	Salinity	practical salinity units (psu)
density	Density	kilograms per cubic meter (kg/m^3)
oxygen	Oxygen concentration	milligrams per liter (mg/L)
sound_speed	Sound speed	meters per second (m/s)

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Instruments

Dataset-specific Instrument Name	DAP
Generic Instrument Name	Deep Autonomous Profiler
Generic Instrument Description	The Deep Autonomous Profiler (DAP) is described in detail in the following publication: Muir, L., Roman, C., Casagrande, D., and D'Hondt, S. (2021) The Deep Autonomous Profiler (DAP), a Platform for Hadal Profiling and Water Sample Collection. Journal of Atmospheric and Oceanic Technology, vol. 38, no. 10, pp. 1833–1845, 2021. doi:10.1175/JTECH-D-20-0139.1. URL: https://journals.ametsoc.org/view/journals/atot/38/10/JTECH-D-20-0139.1.xml To summarize: DAP is a full-ocean-depth profiler rated to 11 kilometers. It was designed to expand the capabilities of a CTD system to the full ocean depth (11 km) by removing the constraints associated with wire-based operations. Removing the tether allows the vehicle to autonomously profile and sample seawater into the hadal region. Because it only requires the ship for deployment and retrieval, the ship can perform other tasks while the DAP is underway. The only source of communication to the DAP while deployed are the acoustic releases. The DAP is built around a 24-bottle Sea-Bird SBE 32 rosette for 10- or 12-Liter Niskin bottles. The large aluminum bottle-support rings from the standard rosette were modified to reduce weight and are held by the vehicle's custom frame. Syntactic foam provides buoyancy and drop weights are used for descent. The DAP stands 3.2 meters tall and has a mass of approximately 1400 kilograms (kg) in air empty and 1700 kg when full of water. The titanium electronics bottle, tested to 960 decibars (dBar) in a pressure facility, was designed to house the embedded Raspberry Pi computer and power circuitry. This computer logs data from the SBE 9plus CTD and SBE 43 oxygen sensor, sends commands to the SBE 32 sampler carousel to trigger the sample bottles, and controls the burnwire release. Power for a nominal 24-hour operating time is provided by a 24-volt, 40-amp-hour oil-filled DeepSea Power and Light SeaBattery. Using drop weights, the profiler descends at a nominal speed of 60 meters per minute through the water column, collecting CTD data. Upon reaching the bottom, a timer is activated and an onboard algorithm processes the descent profile to set the trigger depths for any sample bottles set with an adaptive criteria. Bottom water samples can also be collected according to any preset delays. The bottom time can vary anywhere from 5 minutes to 18 hours. During the ascent, at a nominal speed of 60 meters per minute, the Niskin bottles are triggered at any preset depths specified in the mission file or at adaptively calculated depths based on downcast data. When the DAP surfaces, a radio beacon, Iridium beacon, strobe, radar reflector, and flag are used for recovery by the ship. The vehicle can currently hold up to 24 Niskin bottles, and up to four pressure-maintaining sample bottles provided by the Scripps Institution of Oceanography.

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Deployments

EN622

Website	https://www.bco-dmo.org/deployment/892694
Platform	R/V Endeavor
Start Date	2018-09-13
End Date	2018-09-22
Description	More information on this cruise is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/EN622

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Project Information

An Autonomous Ocean Profiling and Water Sampling System for 0 to 11 km of Water Depth (DAP Test PR Trench)

NSF Award Abstract:
This project will build an autonomous system that measures physical, chemical and biological properties and samples seawater throughout the full global range of ocean depths (0 to 11 km below sea level). Because this system will be deployable over this entire depth range, it will significantly advance understanding of deep-sea chemistry, watermass structure and planktonic ecosystems at all water depths. Because the system will profile and sample deep water autonomously, it will replace human-guided wire-based operations for oceanic profiling and water sampling at any depth. Consequently, it will significantly reduce the time and expense required for on-site operations by allowing shipboard science parties to undertake other deck operations simultaneously with water-column sampling and profiling. Most uniquely, the proposed system will make pervasive study of the very deep (6000-11000 mbsl) ocean feasible for the first time. At completion of this project, the system will be made available to the scientific community as a shared-use instrument.

This autonomous system will profile the physical and chemical properties of the entire water column during the trip from sea surface to seafloor and back again. During the return trip, it will take up to 24 water samples with modified Niskin bottles and pressure-retaining water samplers. Sampling strategies will be flexible and easily programmed to autonomously take samples at specific depth horizons (e.g., 10 depths spaced between 100 and 10000 meters) or adaptively based on transitions recorded and automatically identified in salinity, temperature, density or oxygen content. The system will be tested in the laboratory and at sea on two trial expeditions in the second project year. The trial expeditions for this system will provide field opportunities, samples and data for scientists and students to study deep-sea biological, chemical and physical processes in the western North Atlantic and a deep-sea trench (probably the Puerto Rico Trench). The expeditions will focus on creating opportunities for students from URI and minority-dominated institutions, especially in Puerto Rico, where the second expedition may begin and end. The project will introduce undergraduate and graduate students to design of oceanographic instruments and sea-going research through: (i) an Ocean Engineering design class based on the proposed instrument development, (ii) inclusion of undergraduate and graduate students on the expeditions, (iii) ship tours and presentations in the port region(s), (iv) study by other graduate students of samples and data from the expeditions. Finally, the project will provide a stipend and tuition for graduate student training in scientific instrument design and software development. These efforts will address NSF Broader Impact criteria in several ways, including participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM) and development of a diverse, globally competitive STEM workforce.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1635466

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