

Raw Sensor files from AUV Clio taken on R/V Atlantis (CliOMZ AT50-10 expedition) from Golfoito Costa Rica to San Diego USA in May-June 2023.

Website: <https://www.bco-dmo.org/dataset/925614>

Data Type: Cruise Results

Version: 1

Version Date: 2024-09-09

Project

» [Collaborative Research: Underexplored Connections between Nitrogen and Trace Metal Cycling in Oxygen Minimum Zones Mediated by Metalloenzyme Inventories](#) (CliOMZ)

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|---------------------------------|---|------------------------------------|
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Abstract

This dataset contains raw profiling sensor data generated by the Autonomous Underwater Vehicle (AUV) Clio during the CliOMZ AT50-10 expedition. Each dive has csv and mat files associated with the logged output from each sensor. The data is provided at the native rate provided by each sensor.

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Coverage

Spatial Extent: N:25.094033 E:-88.964731 S:-10.052473 W:-118.11032

Temporal Extent: 2023-05-04 - 2023-06-06

Methods & Sampling

Data is logged onboard the vehicle as Lightweight Communications and Marshalling (LCM) format. For ease of distribution, raw data from the onboard sensors was converted from LCM to Matlab (.mat) files, the .mat files are included in the files section. This raw data was also converted to .csv format and included in the data

package (see data section).

Oboard sensors include: CTD (SBE 49 FastCAT CTD), fluorometer (Wetlabs Fluorometer FLNTURTD-3151), optode (AANDERAA Oxygen Optode 4831), SUNA nitrate sensor (SUNA V2 - Submersible Ultraviolet Nitrate Analyzer) and transmissometer (SEA-BIRD SCIENTIFIC C-Star Transmissometer).

Each dive has an associated "firstProfile.csv" which includes processed data from the first descent to maximum depth for a particular dive (dataset 928684, see related datasets). This profile data contains all sensors interpolated onto the same time base. Each SUPR sampler has an associated summary csv which includes average sensor data values calculated over a specific valve's pumping time. (dataset 928720, see related datasets).

Data Processing Description

Each dive has csv and mat files associated with the logged output from each sensor. The data is provided at the native rate provided by each sensor, see data section.

BCO-DMO Processing Description

* Added matlab, csv and parameter description as supplemental data to this landing page.

Problem Description

- * Clio031: No data due to ballast issues
- * Clio032: BUSHBABY was inadvertently programmed with an incorrect port number for the last sample. The port number should have been 4. Optode failed to record data below 400 m
- * Clio033: Incubation chamber bags did not fill
- * Clio036: BUSHBABY started pumping too early on port 8 & 9
- * Clio041: Vehicle surface an hour early due to a missed sample at 140 m.

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Data Files

| File |
|--|
| AT50-10_clio031-clio050_RawData_CSVFormat filename: sensor_data.zip (ZIP Archive (ZIP), 420.68 MB) MD5:fd54d1d5ce23565d0c32a486802f243b Converted raw data files of CLIO data taken during AT50-10 in csv format. Data ordered in folders by CLIO dive: clio031 - clio050. Each folder contains ctd, fluo, opt, trans and suna files. |

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Supplemental Files

| File | |
|--|---|
| AT50-10_clio031-clio050_RawData_MatFormat filename: mat.zip Raw data files of CLIO data taken during AT50-10 in matlab format. Data ordered in folders by CLIO dive: clio031 - clio050. Each folder contains css, ctd, elm, flui, opt, prn, profile_chl, pump_windows_bb, pump_windows_tc and trans data. | (ZIP Archive (ZIP), 2.60 GB) MD5:425a8e6edaf6f9045fcb98e6f01c6ad6 |
| flntud_calibration_sn3151.pdf filename: supplementary_files/sensor_calibration/flntud_calibration_sn3151.pdf Sensor calibration sheet | (Portable Document Format (.pdf), 49.71 KB) MD5:7b6850225399db21df0a6a112775eb7e |
| sensors_parameters.xlsx Description of parameters in the raw files. | (Microsoft Excel, 13.60 KB) MD5:7d27c365432f8c02e7ed05d81552441e |

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Related Publications

Jakuba, M. V., & Dalpe, A. J. (2024). Clio Operations Report for the AT50-10 Saito Cruise. Woods Hole Oceanographic Institution. <https://doi.org/10.1575/1912/69648>
Results

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Related Datasets

IsSourceOf

Saito, M. A., Dalpe, A., Jakuba, M., Breier, J., Moore, N. (2024) **Processed first profiles of sensor data from AUV Clio taken on R/V Atlantis (CliOMZ AT50-10 expedition) from Golfito Costa Rica to San Diego USA in May-June 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-09-09 doi:10.26008/1912/bco-dmo.928684.1 [[view at BCO-DMO](#)]
Relationship Description: Raw log and vehicle sensor data.

IsRelatedTo

Saito, M. A., Dalpe, A., Jakuba, M., Breier, J., Moore, N. (2024) **Log file from AUV Clio taken on R/V Atlantis (CliOMZ AT50-10 expedition) from Golfito Costa Rica to San Diego USA in May-June 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-09-09 doi:10.26008/1912/bco-dmo.929764.1 [[view at BCO-DMO](#)]
Relationship Description: Dive log, containing location and dates for each dive.

Saito, M. A., Dalpe, A., Jakuba, M., Breier, J., Moore, N. (2024) **Summaries of tigerclaw and bushbaby tracers from AUV Clio taken on R/V Atlantis (CliOMZ AT50-10 expedition) from Golfito Costa Rica to San Diego USA in May-June 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-09-09 doi:10.26008/1912/bco-dmo.928720.1 [[view at BCO-DMO](#)]

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

| | |
|---|--|
| Dataset-specific Instrument Name | AANDERAA Oxygen Optode 4831 |
| Generic Instrument Name | Aanderaa 4831 oxygen optode |
| Generic Instrument Description | A dissolved oxygen sensor which provides analogue (0-5V) and digital output (RS-232) to third party data loggers, gliders and floats. Measurement based on the ability of selected substances to act as dynamic fluorescence quenchers. The fluorescent indicator is a special platinum porphyrin complex embedded in a gas permeable foil that is exposed to the surrounding water. In this standard model, a black optical isolation coating protects the complex from sunlight and fluorescent particles in the water. This sensing foil is attached to a window providing optical access for the measuring system from inside a watertight housing. The foil is excited by modulated blue light, and the phase of a returned red light is measured. For improved stability the 4831 optode also performs a reference phase reading by use of a red LED that does not produce fluorescence in the foil. This model is fitted with a standard sensing foil. By linearizing and temperature compensating, with an incorporated temperature sensor, the absolute O ₂ concentration can be determined. Accuracy +/- 1.5% or 2µM; precision +/- 0.2 µM. |
| Dataset-specific Instrument Name | |
| Generic Instrument Name | AUV Clio |
| Generic Instrument Description | Clio is an autonomous underwater vehicle (AUV) created to accomplish the dual goals of global ocean mapping and biochemistry sampling. The ability to sample dissolved and particulate seawater biochemistry across ocean basins while capturing fine-scale biogeochemical processes sets it apart from other AUVs. Clio is designed to efficiently and precisely move vertically through the ocean, drift laterally to observe water masses, and integrate with research vessel operations to map large horizontal scales up to a depth of 6,000 meters. More information is available at https://www2.who.edu/site/deepsubmergencelab/cli/ |
| Dataset-specific Instrument Name | SUNA V2 - Submersible Ultraviolet Nitrate Analyzer |
| Generic Instrument Name | Satlantic Submersible Ultraviolet Nitrate Analyser V2 |
| Generic Instrument Description | The SUNA V2 UV nitrate sensor monitors nutrient concentrations in real-time. This sensor measures nitrate over a wide range of environmental conditions, from blue-ocean nitraclines to storm runoff in rivers and streams. Applications include: Long-term nutrient monitoring, Coastal water profiling, Water quality monitoring, and pollution detection. Full UV spectrum range for maximum accuracy. Real-time nitrate calculation with real-time temperature/salinity compensation. The SUNA V2 incorporates the proven MBARI-ISUS nitrate measurement technology, which is based on the absorption characteristics of nitrate in the UV light spectrum. It has the option of 10 or 5 mm pathlength, a wavelength range of 190 - 370 nm, and a depth rating of 500 m. |

| | |
|---|--|
| Dataset-specific Instrument Name | SBE 49 FastCAT CTD |
| Generic Instrument Name | Sea-Bird SBE 49 FastCAT CTD Sensor |
| Generic Instrument Description | The SBE 49 FastCAT is a CTD sensor for use in autonomous platforms. It contains a SBE 3P temperature sensor, a SBE 4C conductivity sensor and a strain-gauge pressure sensor as standard. It can operate in autonomous (16 Hz per sec) or polled mode (transmits each sample). The sensor is depth-rated to 350 m (plastic housing) or 7000 m (titanium housing). Accuracy: +/- 0.002 deg C (temperature), +/- 0.0003 S/m (conductivity), 0.1% of full scale range (pressure). |

| | |
|---|---|
| Dataset-specific Instrument Name | SEA-BIRD SCIENTIFIC C-Star Transmissometer |
| Generic Instrument Name | WET Labs {Sea-Bird WETLabs} C-Star transmissometer |
| Generic Instrument Description | The C-Star transmissometer has a novel monolithic housing with a highly integrated opto-electronic design to provide a low cost, compact solution for underwater measurements of beam transmittance. The C-Star is capable of free space measurements or flow-through sampling when used with a pump and optical flow tubes. The sensor can be used in profiling, moored, or underway applications. Available with a 6000 m depth rating. More information on Sea-Bird website: https://www.seabird.com/c-star-transmissometer/product?id=6076246717 |

| | |
|---|--|
| Dataset-specific Instrument Name | Wetlabs Fluorometer FLNTURTD-3151 |
| Generic Instrument Name | WetLabs FLNTU |
| Generic Instrument Description | The WetLabs ECO FLNTU is a dual-wavelength, single-angle sensor for simultaneously determining both chlorophyll fluorescence and turbidity. It detects light scattered by particles suspended in water, generating an output voltage proportional to turbidity or suspended solids. Scaling factors are used to convert the voltage readings to values representing chlorophyll concentration and turbidity expressed in Nephelometric Turbidity Units (NTUs). |

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Deployments

AT50-10

| | |
|-------------------|---|
| Website | https://www.bco-dmo.org/deployment/916122 |
| Platform | R/V Atlantis |
| Report | https://www.rvdata.us/search/cruise/AT50-10 |
| Start Date | 2023-05-02 |
| End Date | 2023-06-09 |

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Project Information

Collaborative Research: Underexplored Connections between Nitrogen and Trace Metal Cycling in Oxygen Minimum Zones Mediated by Metalloenzyme Inventories (CliOMZ)

Coverage: Eastern Tropical Pacific

NSF abstract:

Though scarce and largely insoluble, trace metals are key components of sophisticated enzymes (protein molecules that speed up biochemical reactions) involved in biogeochemical cycles in the dark ocean (below 1000m). For example, metalloenzymes are involved in nearly every reaction in the nitrogen cycle. Yet, despite direct connections between trace metal and nitrogen cycles, the relationship between trace metal distributions and biological nitrogen cycling processes in the dark ocean have rarely been explored, likely due to the technical challenges associated with their study. Availability of the autonomous underwater vehicle (AUV) Clio, a sampling platform capable of collecting high-resolution vertical profile samples for biochemical and microbial measurements by large volume filtration of microbial particulate material, has overcome this challenge. Thus, this research project plans an interdisciplinary chemistry, biology, and engineering effort to test the hypothesis that certain chemical reactions, such as nitrite oxidation, could become limited by metal availability within the upper mesopelagic and that trace metal demands for nitrite-oxidizing bacteria may be increased under low oxygen conditions. Broader impacts of this study include the continued development and application of the Clio Biogeochemical AUV as a community resource by developing and testing its high-resolution and adaptive sampling capabilities. In addition, metaproteomic data will be deposited into the recently launched Ocean Protein Portal to allow oceanographers and the metals in biology community to examine the distribution of proteins and metalloenzymes in the ocean. Undergraduate students will be supported by this project at all three institutions, with an effort to recruit minority students. The proposed research will also be synergistic with the goals of early community-building efforts for a potential global scale microbial biogeochemistry program modeled after the success of the GEOTRACES program, provisionally called "Biogeoscapes: Ocean metabolism and nutrient cycles on a changing planet".

The proposed research project will test the following three hypotheses: (1) the microbial metalloenzyme distribution of the mesopelagic is spatially dynamic in response to environmental gradients in oxygen and trace metals, (2) nitrite oxidation in the Eastern Tropical Pacific Ocean can be limited by iron availability in the upper mesopelagic through an inability to complete biosynthesis of the microbial protein nitrite oxidoreductase, and (3) nitrite-oxidizing bacteria increase their metalloenzyme requirements at low oxygen, impacting the distribution of both dissolved and particulate metals within oxygen minimum zones. One of the challenges to characterizing the biogeochemistry of the mesopelagic ocean is an inability to effectively sample it. As a sampling platform, we will use the novel biogeochemical AUV Clio that enables high-resolution vertical profile samples for biochemical and microbial measurements by large volume filtration of microbial particulate material on a research expedition in the Eastern Tropical Pacific Ocean. Specific research activities will be orchestrated to test the hypotheses. Hypothesis 1 will be explored by comparison of hydrographic, microbial distributions, dissolved and particulate metal data, and metaproteomic results with profile samples collected by Clio. Hypothesis 2 will be tested by incubation experiments using $^{15}\text{NO}_2^-$ oxidation rates on Clio-collected incubation samples. Hypothesis 3 will be tested by dividing targeted nitrite oxidoreductase protein copies by qPCR (quantitative polymerase chain reaction)-based nitrite oxidizing bacteria abundance (NOB) to determine if cellular copy number varies with oxygen distributions, and by metalloproteomic analyses of NOB cultures. The demonstration of trace metal limitation of remineralization processes, not just primary production, would transform our understanding of the role of metals in biogeochemical cycling and provide new ways with which to interpret sectional data of dissolved and particulate trace metal distributions in the ocean. The idea that oxygen may play a previously underappreciated role in controlling trace metals due not just to metals' physical chemistry, but also from changing biological demand, will improve our ability to predict trace metal distributions in the face of decreasing ocean oxygen content.

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.

Funding

| Funding Source | Award |
|--|-----------------------------|
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1924554 |

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