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.

Website: https://www.bco-dmo.org/dataset/928684
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)

Contributors	Affiliation	Role
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Abstract
This is oceanographic profiles generated by Clio, an Autonomous Underwater Vehicle (AUV) focused on biogeochemical sampling. Clio was deployed on the R/V Atlantis CliOMZ AT50-10 expedition from Golfito, Costa Rica to San Diego, USA from May - June of 2023. The dataset contains processed profiling sensor data from the initial vehicle descent (i.e., the “first profile”). This profile data contains all sensors binned into 0.5 m depth increments.

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Coverage

Spatial Extent: **N**:25.079886 **E**:-88.97062 **S**:-10.026301 **W**:-118.098373
Temporal Extent: 2023-05-04 - 2023-06-06

Methods & Sampling

The AT50-10 cruise contains Clio dives 031-050. Each dive has a processed first profile, which includes processed data from the first descent to maximum depth for a particular dive. This profile data contains all sensors interpolated onto the same time base, binned into 0.5 m depth increments.

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).

BCO-DMO Processing Description

* Combined all first processed profiles from AT50-10 into 1 file.

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Data Files

File
928684_v1_clioprocessed.csv (Comma Separated Values (.csv), 4.88 MB) MD5:7e0d8381c4b876eb008a8b4b2e19e3cf Primary data file for dataset ID 928684, version 1

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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

IsDerivedFrom

Saito, M. A., Dalpe, A., Jakuba, M., Breier, J., Moore, N. (2024) **Raw Sensor files 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.925614.1 [view at BCO-DMO]
Relationship Description: Has processed data from the first profile.

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.

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Parameters

Parameter	Description	Units
CRUISE_ID	cruise name	unitless
DIVE_ID	clio dive number, sequential	unitless
SUBMERGE_TIME_UTC	time of last Iridium update before submerging	unitless
SUBMERGE_LAT	latitude of last Iridium update before submerging	decimal degrees
SUBMERGE_LON	longitude of last Iridium update before submerging	decimal degrees
LeftBinDepth	upper threshold of bin	meters
RightBinDepth	lower threshold of bin	meters
CTDtemp	temperature as measured by the CTD	celsius
CTDsal	salinity as measured by the CTD	psu, practical salinity unit
CTDpress	pressure as measured by the CTD	decibar
CTDconduct	conductivity as measured by the CTD	Siemens/meter
OptO2	oxygen concentration as measured by the optode	micromolar , uM
FluoChl	chlorophyll concentration as measured by the fluorometer	micrograms per deciliter
FluoTurb	turbidity as measured by the fluorometer	Nephelometric Turbidity unit
TransCalcBeam	calculated beam attenuation coefficient	m^-1
SunaNitrate	nitrate concentration as measured by the suna	micromolar, uM

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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 areference 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 O2 concentration can be determined. Accuracy +/- 1.5% or 2uM; precision +/- 0.2 uM.

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.whoi.edu/site/deepsubmergencelab/clio/

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 rage 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 autonomus (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 intgrated 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=60762467717

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 15NO2- 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.

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Funding

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

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