Heterotrophic Production Rates collected from CliOMZ AT50-10 in the Eastern Pacific Ocean from May to June 2023 (CliOMZ project)

Website: https://www.bco-dmo.org/dataset/948411
Data Type: Cruise Results
Version: 1
Version Date: 2025-01-13

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
These data include heterotrophic production rates measured on R/V Atlantic (CliOMZ AT50-10 expedition) from Golfito, Costa Rica to San Diego, USA in May-June 2023. Instruments used were a CTD profiler and a scintillation counter (Perkin-Elmer Tri-Carb 2910 TR).

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Coverage

Location: Eastern Tropical and Subtropical Pacific Ocean
Spatial Extent: **N**:-90.0002 **E**:9.181 **S**:-101.4507 **W**:-9.9999
Temporal Extent: 2023-05-04 - 2023-05-28

Methods & Sampling

Discrete water samples were collected using a rosette sampler equipped with 24×10 L Niskin bottles. Different depths were sampled ranging from 55 meters to 1500 meters. Water was dispensed into 2 mL microcentrifuge tubes in the laboratory. Microbial heterotrophic production was measured via the incorporation of [3H]-leucine into microbial biomass using a modified version of the microcentrifuge method (Baetge et. al., 2021). [3H]-leucine (specific activity 44.9 Ci mmol-1; Perkin Elmer) was added to 1.7 mL of sample at a final concentration of 20 nM and incubated for 2-3 h at in situ temperature. For each depth and station, triplicate live incubations and one killed control, to which 100 µL of trichloroacetic acid (TCA) was added immediately, were carried out. Incubations were terminated by addition of cold 100 µL 100% TCA and stored at 4°C until extraction following established procedures (Baetge et. al., 2021). DPM were measured on a scintillation counter (Perkin-Elmer Tri-Carb 2910 TR) for 2 min, and [3H]-leucine incorporation rates were

converted to units of carbon using a conversion factor of 1.5 kg C (mol leucine incorporated)-1 (Simon and Azam 1989).

Data Processing Description

The mean DPM of the samples were corrected for the DPM of the blank and converted into leucine incorporation over time. Leucine incorporation rates were converted to units of carbon using a conversion factor of 1.5 kg C (mol leucine incorporated)-1 (Simon and Azam 1989).

BCO-DMO Processing Description

- Converted the primary data file from a variable width plain text file to a CSV file.

Problem Description

No problems or issues reported from the dataset authors.

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Related Publications

Baetge, N., Behrenfeld, M. J., Fox, J., Halsey, K. H., Mojica, K. D. A., Novoa, A., Stephens, B. M., & Carlson, C. A. (2021). The Seasonal Flux and Fate of Dissolved Organic Carbon Through Bacterioplankton in the Western North Atlantic. Frontiers in Microbiology, 12. https://doi.org/10.3389/fmicb.2021.669883
Methods

Simon, M., & Azam, F. (1989). Protein content and protein synthesis rates of planktonic marine bacteria . Marine Ecology Progress Series, 51, 201–213. doi:10.3354/meps051201
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Perkin-Elmer Tri-Carb 2910 TR
Generic Instrument Name	Liquid Scintillation Counter
Dataset-specific Description	Disintegrations per minute (DPM) were counted in a scintillation counter (Perkin-Elmer Tri-Carb 2910 TR).
Generic Instrument Description	Liquid scintillation counting is an analytical technique which is defined by the incorporation of the radiolabeled analyte into uniform distribution with a liquid chemical medium capable of converting the kinetic energy of nuclear emissions into light energy. Although the liquid scintillation counter is a sophisticated laboratory counting system used the quantify the activity of particulate emitting (ß and a) radioactive samples, it can also detect the auger electrons emitted from 51Cr and 125I samples. Liquid scintillation counters are instruments assaying alpha and beta radiation by quantitative detection of visible light produced by the passage of rays or particles through a suitable scintillant incorporated into the sample.

Dataset-specific Instrument Name	24x10 L Niskin Bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Discrete water samples were collected using a rosette sampler equipped with 24×10 L Niskin bottles.
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

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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-1924512

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