CTD Bottle Data from R/V Sally Ride cruise SR2114 in the Eastern Tropical North Pacific, December 2021–January 2022 (N-loss in the ETNP ODZ project)

Website: https://www.bco-dmo.org/dataset/984479
Data Type: Cruise Results
Version: 1
Version Date: 2025-09-17

Project
» Collaborative Research: Multiyear autonomous measurement of N-loss in the ETNP ODZ (N-loss in the ETNP ODZ)

Contributors	Affiliation	Role
Altabet, Mark A.	University of Massachusetts Dartmouth SMAST (UMASSD-SMAST)	Principal Investigator
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Abstract
This dataset contains results from Niskin bottle samples collected during CTD casts taken for nutrient concentration as well as the N isotopic composition of nitrate (NO3-). Corresponding CTD data measured at the same depths as the bottle samples are also included within the primary data file. CTD casts were carried out at fixed stations along the ship's track to calibrate float sensor results as well as document variability associated with mesoscale features. The associated cruise on the R/V Sally Ride, cruise SR2114, took place between 21 Dec 2021 and 21 Jan 2022 along a track between Costa Rica and San Diego, USA, transecting the oxygen-deficient zone (ODZ) of the Eastern Tropical North Pacific. This cruise was in support of an NSF-funded project to develop an autonomous float array to study nitrogen loss (N-loss) processes in this region.

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Coverage

Location: Eastern Tropical North Pacific
Spatial Extent: **N**:31.57852 **E**:-87.3972 **S**:8.58626 **W**:-118.62994
Temporal Extent: 2021-12-24 - 2022-12-01

Methods & Sampling

Sampling was conducted using a standard Sea-Bird CTD/Niskin rosette system. Hydrographic data were

processed with Sea-Bird software following standard procedures. Dissolved oxygen (O_2) was measured with an SBE43 sensor, beam attenuation with a WET Labs C-STAR transmissometer, and fluorescence with a WET Labs ECO fluorometer. Concentrations of nitrate (NO_3^-), nitrite (NO_2^-), phosphate (PO_4^{3-}), and silicate (SiO_4^{4-}) were measured at sea using a Seal AQ400 discrete autoanalyzer with standard chemical methods. The isotopic composition of nitrate was determined on samples returned to the laboratory, following the procedures described in Altabet et al. (2019). Samples for nitrate isotope analysis were preserved by mild acidification and the addition of sulfamic acid to remove nitrite. Measurements were made using an IsoPrime isotope ratio mass spectrometer (IRMS) operated with IonVantage software.

BCO-DMO Processing Description

* In the primary data file (984479_v1_sr2114_ctd_bottle_data.csv), special characters and blank spaces in column/parameter names were removed and replaced with underscores ("_") to improve consistency and machine readability.
* Date values were reformatted from a two-digit year representation (%m-%d-%y) to the ISO 8601 standard format (%Y-%m-%d).
* Column names containing chemical species names have been changed from their chemical formulas (e.g., NO3-, NO2-, PO4-3, SiO3-1, O2, d15N–NO3-) to standardized, FAIR-compliant names (e.g., dissolved_nitrate, dissolved_nitrite, dissolved_phosphate, dissolved_silicate, dissolved_oxygen, and delta15N_dissolved_nitrate).
* Missing data values indicated as "#N/A" have been replaced in the data file with blank data values ("").

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Data Files

File	
984479_v1_sr2114_ctd_bottle_data.csv	(Comma Separated Values (.csv), 92.51 KB) MD5:207096db6a795ee48585e1cdcd0cd3e3
Primary data file for dataset ID 984479, version 1	

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Related Publications

Altabet, M. A., Wassenaar, L. I., Douence, C., & Roy, R. (2019). A Ti(III) reduction method for one-step conversion of seawater and freshwater nitrate into N2O for stable isotopic analysis of 15N/14N, 18O/16O and 17O/16O. Rapid Communications in Mass Spectrometry, 33(15), 1227–1239. Portico. https://doi.org/10.1002/rcm.8454
Methods

Gutiérrez-Bravo, J. G., Sánchez-Velasco, L., Jiménez-Rosenberg, S. P. A., Altabet, M. A., Méndez-Mendez, S., & Cambronero-Solano, S. (2024). Anoxic waters constrain the vertical distribution of fish developmental stages in an oxygen minimum zone. Limnology and Oceanography. Portico. https://doi.org/10.1002/lno.12594
Results

Lee, C. W. M., Altabet, M., Mnich, A., & Zhang, L. (2025). Using δ15N of Amino Acids and Nitrate to Investigate Particle Production and Transformation in the Ocean: A Case Study From the Eastern Tropical North Pacific Oxygen Deficient Zone. Global Biogeochemical Cycles, 39(1). Portico. https://doi.org/10.1029/2024gb008280 https://doi.org/10.1029/2024GB008280
Results

McNeil, C. L., D'Asaro, E. A., Altabet, M. A., Hamme, R. C., & Garcia-Robledo, E. (2023). Autonomous observations of biogenic N2 in the Eastern Tropical North Pacific using profiling floats equipped with gas tension devices. Frontiers in Marine Science, 10. https://doi.org/10.3389/fmars.2023.1134851
Results

Pietri, A., Altabet, M., Cowles, G. W., & D'Asaro, E. (2025). Meso- and Submesoscale Circulation Origins for Subsurface Oxygen Intrusions Into the Oxygen Deficient Zone of the Eastern Tropical North Pacific. Journal of Geophysical Research: Oceans, 130(8). Portico. https://doi.org/10.1029/2025jc022577

https://doi.org/10.1029/2025JC022577
Results

Sánchez-Velasco, L., García-De León, F. J., Ruvalcada-Aroche, E. D., Beier, E., Godínez, V. M., Jiménez-Rosenberg, S. P. A., Sánchez-Pérez, E. D., Contreras-Catala, F., Mnich, A., Verma, N., & Altabet, M. (2022). Vertical distribution of zooplankton groups, with an emphasis on fish larvae, in the oxygen minimum zone off southern México (December 2020). Journal of Marine Systems, 236, 103801. https://doi.org/10.1016/j.jmarsys.2022.103801
Results

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Related Datasets

IsRelatedTo

Gutiérrez-Bravo, J. G. (2024) **MOCNESS net data from R/V Sally Ride cruise SR2114 in the Eastern Tropical Pacific from December 2021 to January 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-09-06 doi:10.26008/1912/bco-dmo.930162.1 [view at BCO-DMO]
Relationship Description: These datasets were both collected during the R/V Sally Ride cruise SR2114.

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Parameters

Parameter	Description	Units
Event	Station number combined with the sequential over-the-side event number for that station.	unitless
Niskin	Niskin bottle number from which the sample was collected.	unitless
Date	Calendar date of the CTD cast.	unitless
Latitude	Latitude of the sample location derived from the associated bottle file. Values are reported in decimal degrees with positive values indicating northern hemisphere coordinates.	decimal degrees
Longitude	Longitude of the sample location, obtained from the associated bottle file. Values are reported in decimal degrees with negative values indicating western hemisphere coordinates.	decimal degrees
Pressure	Hydrostatic pressure at depth of sample collection.	decibar (dB)
Depth_m	Depth at which the Niskin bottle was closed.	meters (m)
Sigma_Theta	Potential density anomaly.	kilograms per cubic meter (kg/m3)

In_situ_Temp	Temperature measured directly at sampling depth (in situ) by the CTD sensor.	degrees Celcius ©
Potential_Temperature	Potential temperature of seawater, calculated from in situ temperature and pressure.	degrees Celcius ©
Salinity	Practical salinity of seawater.	PSU
Beam_Attenuation	Beam attenuation coefficient (c), describing the reduction of a collimated light beam per unit path length due to absorption and scattering.	reciprocal meters (m-1)
Fluorescence	Raw chlorophyll fluorescence signal from CTD fluorometer, reported in arbitrary units (a.u.); values are relative and not calibrated to concentration.	arbitrary units (a.u.)
dissolved_oxygen	Concentration of dissolved molecular oxygen (O2) in seawater, reported in micromoles per kilogram (µmol/kg).	micromoles per kilogram (umol/kg)
dissolved_nitrate	Concentration of dissolved nitrate (NO3-) in seawater, reported in micromoles per kilogram (µmol/kg).	micromoles per kilogram (umol/kg)
dissolved_nitrite	Concentration of dissolved nitrite (NO2-) in seawater, reported in micromoles per kilogram (µmol/kg).	micromoles per kilogram (umol/kg)
dissolved_phosphate	Concentration of dissolved phosphate (PO4-3) in seawater, reported in micromoles per kilogram (µmol/kg).	micromoles per kilogram (umol/kg)
dissolved_silicate	Concentration of dissolved silicate (SiO3-1, reported as silicic acid), in micromoles per kilogram (µmol/kg).	micromoles per kilogram (umol/kg)
delta15N_dissolved_nitrate	Natural 15N/14N of dissolved nitrate relative to atmospheric N2.	per mille (‰)

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Instruments

Dataset-specific Instrument Name	SeaBird CTD/Niskin Rosette System
Generic Instrument Name	CTD Sea-Bird
Dataset-specific Description	Sampling was done using a standard SeaBird CTD/Niskin Rosette system. Hydrographic data was processed using SeaBird software and standard procedures.
Generic Instrument Description	A Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics. This instrument designation is used when specific make and model are not known or when a more specific term is not available in the BCO-DMO vocabulary. Refer to the dataset-specific metadata for more information about the specific CTD used. More information from: http://www.seabird.com/

Dataset-specific Instrument Name	Isoprime IRMS
Generic Instrument Name	GV Instruments IsoPrime Isotope Ratio Mass Spectrometer
Dataset-specific Description	The isotopic composition of nitrate was determined on samples returned to the laboratory using procedures described Altabet et al. (2019). Samples for nitrate isotope analysis were preserved by mild acidification and addition of sulfamic acid to remove nitrite. An IsoPrime IRMS running IonVantage was used to make these measurements. The measurement principle for the N isotopic composition of nitrate was continuous flow IRMS with a precision of ±0.2‰.
Generic Instrument Description	The GV Instruments IsoPrime Isotope Ratio Mass Spectrometer is a laboratory benchtop isotope ratio mass spectrometer (IRMS), that operates in dual inlet or continuous flow modes. It forms part of the IsoPrime system which has a range of sample preparation and purification modules that can be coupled with the IsoPrime IRMS. The modules can analyse a range of samples (solids, liquids or gases) and each prepares the sample to be introduced into the IRMS as purified gases. The resultant prepared gases such as H2, CO2, CO, N2, SO2 or N2O are then ionised and analysed for their isotopic content by the IRMS. The instrument was originally manufactured GV instruments as part of the IsoPrime series, but this part of the business was sold to Isoprime Ltd (a group member of Elementar Analysensysteme GmbH) and this instrument has been superseded by more recent models.

Dataset-specific Instrument Name	SBE43 O2 Sensor
Generic Instrument Name	Sea-Bird SBE 43 Dissolved Oxygen Sensor
Dataset-specific Description	Oxygen measurements were taken by a SBE43 sensor and processed by SeaBird software.
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	Seal AQ400 Discrete Autoanalyzer
Generic Instrument Name	Seal Analytical AutoAnalyser 3HR
Dataset-specific Description	Nitrate (NO_3^-), nitrite (NO_2^-), phosphate (PO_4^{3-}), and silicate (SiO_4^{4-}) concentrations were measured at sea with a Seal AQ400 discrete autoanalyzer following standard chemical methods.
Generic Instrument Description	A fully automated Segmented Flow Analysis (SFA) system, ideal for water and seawater analysis. It comprises a modular system which integrates an autosampler, peristaltic pump, chemistry manifold and detector. The sample and reagents are pumped continuously through the chemistry manifold, and air bubbles are introduced at regular intervals forming reaction segments which are mixed using glass coils. The AA3 uses segmented flow analysis principles to reduce inter-sample dispersion, and can analyse up to 100 samples per hour using stable LED light sources.

Dataset-specific Instrument Name	WET Labs ECO Fluorometer
Generic Instrument Name	Wet Labs ECO-AFL/FL Fluorometer
Dataset-specific Description	Fluorescence was measured by a Wet Labs ECO fluorometer.
Generic Instrument Description	The Environmental Characterization Optics (ECO) series of single channel fluorometers delivers both high resolution and wide ranges across the entire line of parameters using 14 bit digital processing. The ECO series excels in biological monitoring and dye trace studies. The potted optics block results in long term stability of the instrument and the optional anti-biofouling technology delivers truly long term field measurements. more information from Wet Labs

Dataset-specific Instrument Name	WET Labs C-STAR Sensor
Generic Instrument Name	WET Labs {Sea-Bird WETLabs} C-Star transmissometer
Dataset-specific Description	Beam attenuation values were measured by a WET Labs C-STAR sensor.
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

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Deployments

SR2114

Website	https://www.bco-dmo.org/deployment/931391
Platform	R/V Sally Ride
Start Date	2021-12-23
End Date	2022-01-21
Description	Additional cruise information is available from R2R: https://www.rvdata.us/search/cruise/SR2114

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Project Information

Collaborative Research: Multiyear autonomous measurement of N-loss in the ETNP ODZ (N-loss in the ETNP ODZ)

NSF Award Abstract:
Several regions of the deep ocean naturally contain almost no oxygen. Because of this lack of oxygen, microbes living in these regions live in ways that differ from those in oxygenated waters consuming nitrate ions instead of oxygen for respiration. Use of nitrate for microbial respiration results in the production of nitrogen gas which is called denitrification. The resulting removal of nitrate has consequences for the whole ocean as nitrogen is an important nutrient controlling plant growth; however, whereas plants can use nitrogen in the form of nitrate, they cannot, with a few exceptions, use nitrogen gas. There remains a number of uncertainties regarding how much denitrification occurs in the ocean, what controls it, and how it varies in time and space. Traditional studies of ocean denitrification have been limited by the time ships can be at sea and the relatively small proportion of the ocean they can observe. Our project plans to remedy this problem by using vehicles called floats that can operate autonomously in the ocean for three years or more as they drift with currents over hundreds of kilometers. We will outfit ten floats with sensors to measure oxygen and nitrogen gas which will be placed throughout the oxygen-depleted region of the Pacific Ocean to the west of Mexico. This is the largest such region in the ocean from which we have two years of results from a prototype float which validated our approach. This study may well transform our understanding of ocean denitrification and ultimately benefit society as a whole through greater confidence in predictions of the ocean's nitrogen cycle and capacity to fix carbon dioxide under current and future conditions. Application and further development of float systems using commercially available technology will directly benefit successor studies, and more broadly showcase the use of water-following platforms to tackle difficult oceanographic problems. Advances from this study are expected to carry over to other disciplines including ocean biogeochemical modeling. Outreach activities, support for an early career scientist, and student training are included in the project. For the outreach activities, the investigators plan to tie into well-established after-school programs serving underrepresented populations in Massachusetts and established opportunities for public presentations using float related display materials at the University of Washington.

Oxygen deficient zones (ODZs), despite constituting a small fraction of total oceanic volume, play important roles in regulating global ocean carbon and nitrogen cycles including hosting 30 to 50% of the global loss of fixed nitrogen. Unfortunately, current uncertainty in ODZ nitrogen loss derives from substantial temporal and spatial variability in rates that remain under-sampled by ship-based measurements. While local regulation of nitrogen loss by oxygen and organic matter availability are well accepted, temporal/spatial variability in the nitrogen flux is likely a result of the influence of physical forcings such as remote ventilation, seasonal variability, and mesoscale eddies. Understanding how the impact of physical forcings on nitrogen loss as mediated through oxygen and organic flux will be required to fully understand the causes and consequences of any future ODZ expansion. To improve our understanding of ODZ nitrogen loss, we will carry out a multiyear, autonomous float-based observational program to address outstanding questions regarding bioavailable nitrogen loss in ODZs. As the largest ODZ and region of our pilot deployments, our operation area will be the Eastern Tropical N. Pacific (ETNP) where our study will determine over a multi-year period, in-situ nM-level oxygen and biogenic nitrogen on float profiles spanning geographic gradients in oxygen and surface productivity. For the first time, our study will also determine in situ nitrogen loss rates from changes in nitrogen concentration during 1 to 2 week Lagrangian float drifts along a constant density surface. A pilot 2 yr float deployment in the ETNP documents our ability to do so. Critically, our float-based approach more closely matches the frequency and distribution of observations to the expected variability in biogenic nitrogen

production as compared to prior work and will dramatically increase the data density for this region by acquiring >500 profiles/drifts for nitrogen and >1000 profiles for nM oxygen.

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-1851361

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