CTD profile data from NCDC research cruise on the R/V Kilo Moana (KM2206) in the Subtropical North Pacific from June 5th to July 5th, 2022

Website: https://www.bco-dmo.org/dataset/969967
Data Type: Cruise Results
Version: 1
Version Date: 2025-07-25

Project
» Collaborative Research: Quantifying N2 fixation rates of noncyanobacterial diazotrophs and environmental controls on their activity (NCDN2FIX)

Contributors	Affiliation	Role
Arrigo, Kevin R.	Stanford University	Co-Principal Investigator
Turk-Kubo, Kendra	University of California-Santa Cruz (UCSC)	Co-Principal Investigator
Mills, Matthew M.	Stanford University	Scientist
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This data set is the CTD data from a research cruise conducted during the summer of 2022 and focused on measuring single-cell non-cyanobacterial diazotroph (NCD) N2 fixation rates from a variety of taxa living in well-lit, oxygen-rich coastal and oligotrophic surface waters in the North Pacific Ocean. Determining if NCD activity is an important missing N source in the global oceans has the potential to fill a critical gap in our understanding of the marine N cycle. The project principal investigators were Dr. Kendra Turk-Kubo (UCSC) and Dr. Kevin Arrigo (Stanford University). The primary data file of this dataset contains the 1m binned processed CTD files from the Summer 2022 research cruise to investigate N2 fixation rates of non-cyanobacterial diazotrophs in the North Pacific Ocean.

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Coverage

Location: North Pacific Ocean
Spatial Extent: **N**:35.8302 **E**:201.574 **S**:11.8738 **W**:175.904
Temporal Extent: 2022-06-06 - 2022-07-04

Methods & Sampling

The NCD cruise steamed northwest of Oahu until ~35°N, then transited west along ~35°N to ~170°E. We then transited S. to ~11°N, targeting frontal zones between mesoscale features based on sea surface height anomalies and enhanced chlorophyll features, before returning to Oahu. We had daily CTD casts where we deployed the CTD (<300 m). The CTD had sensors for measuring conductivity (calculated salinity),

temperature, depth, beam transmission, beam attenuation, photosynthetically active radiation, and fluorescence.

Data Processing Description

Data processed with Seabird CTD processing software (1m-binned). Software Version Seasave V 7.26.7.107. These data were concatenated and provided as Data File 969967_v1_ctd.csv in this dataset.

The data is also available in the following formats (See Supplemental Files):

* "km2206_binavg.cnv.zip" - The processed seabird .cnv file format. Example file: S18C02binavg.cnv contains data for station 18 cast 2.

* "KM2206_ct1.zip" - WHP Exchange format (standardized, text-based format (CSV) for exchanging hydrographic data, specifically for CTD (Conductivity-Temperature-Depth) and bottle samples). Parameter explanation can be found here: https://exchange-format.readthedocs.io/en/latest/parameters.html (Barna et al., 2024). Example file: KM2206_s18c02_ct1.csv contains data for station 18 cast 2. All files include suffix _ct1.csv indicating data from one cast.

WOCE Bottle Quality Codes

1: Bottle information unavailable.

2: No problems noted.

3: Leaking.

4: Did not trip correctly.

5: Not reported.

(6): (Significant discrepancy in measured values between Gerard and Niskin bottles.)

(7): (Unknown problem.)

(8): (Pair did not trip correctly. Note that the Niskin bottle can trip at an unplanned depth while the Gerard trips correctly and vice versa.)

9: Samples not drawn from this bottle.

BCO-DMO Processing Description

* Data within .csv files by cast (see supplemental file "KM2206_ct1.zip") were concatenated into a combined table (attached to this dataset as 969967_v1_ctd.csv) with LATITUDE,LONGITUDE,DEPTH,STNNBR,CASTNO,SECT_ID,DATE,TIME, EXPOCODE fields extracted from header comments in each .csv cast file and added as individual columns in the combined data table. The last row of each cast table "END_DATA" was not included in the combined table. An additional column Cruise_ID was added with KM2206 (identifier as used at R2R https://www.rvdata.us/search/cruise/KM2206).

Missing Data Identifiers:
* In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

In all cast files, the header contained:
CTD = "20220704ESSSTNFRDGVD" which was added to the instrument information for this dataset's metadata.

Related Publications

Barna, A., Swift, J., Diggs, S. (2024). Exchange Format 1.2.1 documentation: Parameters. Documentation version 2024-03-22 (1.2.1). Available from https://exchange-format.readthedocs.io/en/v1.2.1/parameters.html *Methods*

Parameters

Parameter	Description	Units
CRUISE_ID	Cruise identifier compatible with databases such as Rolling Deck to Repository (R2R)	unitless
EXPOCODE	The expedition code, a unique identifier for the cruise (ICES 4 character platform code then the cruise departure date in YYYYMDD format)	unitless
SECT_ID	Section name [WHP-Exchange format term]	unitless
STNNBR	Station number [WHP-Exchange format term]	unitless
CASTNO	Cast number [WHP-Exchange format term]	unitless
DATE	Cast date (GMT). [WHP-Exchange format term]	unitless
TIME	Cast time (GMT). [WHP-Exchange format term]	unitless
ISO_DateTime_UTC	Cast DateTime with timezone (ISO 8601 format)	unitless
LATITUDE	Cast latitude [WHP-Exchange format term]	unitless
LONGITUDE	Cast longitude [WHP-Exchange format term]	unitless
DEPTH	Assumed to be max-depth of the cast [WHP-Exchange format term]	unitless
CTDPRS	1m binned water pressure, sensor: Digiquartz with TC [WHP-Exchange format term]	decibars (DBAR)
CTDPRS_FLAG_W	Data quality flag as defined by WOCE bottle codes (see "Data Processing" section)[WHP-Exchange format term]	unitless

CTDTMP	1m binned water temperature in degrees C, sensor 1: Temperature [ITS-90, deg C] [WHP-Exchange format term]	degrees Celsius (degC)
CTDTMP2	1m binned water temperature in degrees C, sensor 2: Temperature [ITS-90, deg C] [WHP-Exchange format term]	degrees Celsius (degC)
CTDSAL	1m binned salinity in practical salinity unit [PSU] measured with conductivity [WHP-Exchange format term]	practical salinity units (PSU)
CTDSAL2	1m binned salinity measured with conductivity [WHP-Exchange format term]	practical salinity units (PSU)
CTDOXY	1m binned oxygen concentration, sensor1: SBE 43 [WHP-Exchange format term]	micromoles per kilogram (umol/kg)
CTDOXY2	1m binned oxygen concentration, sensor2: SBE 43 [WHP-Exchange format term]	micromoles per kilogram (umol/kg)
FLUOR	1m binned fluorescence (relative units, unitless), sensor- Seapoint fluorometer [WHP-Exchange format term]	unitless
BEAM_TRANS	1m binned percent beam transmission, sensor - Wet Labs C-Star [WHP-Exchange format term]	percent (%)
BEAM_ATTEN	1m binned beam attenuation, sensor- Wet Labs C-Star [WHP-Exchange format term]	per meter (unit 1/M)
PAR	1m binned photosynthetically active radiation, sensor Biospherical/Licor [WHP-Exchange format term]	micromoles of photons per meter squared per second (umol photons/m^2/sec)

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	SeaBird SBE-911+ CTD = "20220704ESSSTNFRDGVD"
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

Deployments

KM2206

Website	https://www.bco-dmo.org/deployment/969968
Platform	R/V Kilo Moana
Start Date	2022-06-05
End Date	2022-07-05

Project Information

Collaborative Research: Quantifying N2 fixation rates of noncyanobacterial diazotrophs and environmental controls on their activity (NCDN2FIX)

Coverage: Scripps Institution of Oceanography, Tropical and Subtropical Pacific, Chukchi and Beaufort Sea

NSF Award Abstract:
Nitrogen (N) is an important element in the ocean that limits the growth of the microscopic marine plants, phytoplankton. Estimates suggest N inputs and losses may not be balanced in the modern ocean, and thus an underestimation of N inputs may explain this imbalance. The conversion of gaseous N2 to biologically available N (N2 fixation) is the largest source of new N to the ocean. It is possible that the "missing" N can be explained by identifying new sources of N2 fixation. N2 fixation relies on a group of microorganisms, termed "diazotrophs", that utilize N2 for growth, unlike other marine microorganisms. Diazotrophs fall into two groups, cyanobacterial diazotrophs, which are able to derive energy through photosynthesis, and non-cyanobacterial diazotrophs (NCDs), which require a non-light-based energy source. Next to nothing is known about the ecology and biology of NCDs, except that they are ubiquitous in the ocean and contain the nitrogen fixing gene, but no direct measurements of their N2 fixation activity exist. Recent molecular advances for studying organisms at the single cell level now makes the measurement of N2 fixation by NCDs possible. This study is focused on determining whether marine NCDs are actually fixing N2 in the environment and understanding how their N2 fixation is modulated. Determining if NCD activity is an important missing N source in the global oceans has the potential to fill a critical gap in our understanding of the marine N cycle. This project supports

early career STEM researchers including a graduate student and a postdoctoral scientist, as well as undergraduate students through several programs including UCSC's California Alliance for Minority Participation (CAMP).

Nitrogen fixation, the microbial process of converting N2 into biologically available ammonia, is an important source of N in the oceans. Historically, research has focused on the most conspicuous diazotrophs, such as Trichodesmium, but the discovery of unicellular cyanobacterial and non-cyanobacterial diazotrophs (NCDs) in the open ocean revealed a broader diversity than previously thought. Much of what is known about NCDs is restricted to presence, abundance estimates and transcriptional activity from gene surveys. NCDs are globally distributed throughout coastal and oligotrophic environments, however, it is not known whether NCDs supply N to support primary productivity. Measurements of marine NCDs are needed to determine if NCDs are actively fixing N2. This study is focused on measuring single cell NCD N2 fixation rates from a variety of taxa living in well-lit, oxygen-rich coastal and oligotrophic surface waters in the North Pacific and Arctic Oceans. The investigators are using a cultivation-independent technique called geneFISH to microscopically visualize and localize NCDs and measuring the incorporation of 15N2 into single cells using nanoscale secondary ion mass spectrometry. Beyond measuring in situ NCD N2 fixation rates, experiments are being conducted to determine environmental controls on single cell NCD N2 fixation (light, temperature, dissolved organic matter, dissolved inorganic N, and iron). Obtaining single cell NCD N2 fixation rates from a range of taxa, under different experimental conditions and in coastal and oligotrophic environments will provide information to link their presence to N2 fixation activity, determine the quantitative significance of NCDs in the marine environment, and set the stage for their inclusion in biogeochemical models.

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-2023498
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