Total dissolved nitrogen (TDN) concentrations and δ15N measurements from samples collected on R/V Nathaniel B. Palmer GO-SHIP cruises NBP1706 and NBP1707 in the South Pacific from Jul 3 to Sep 30, 2017

Website: https://www.bco-dmo.org/dataset/986627
Data Type: Cruise Results
Version: 1
Version Date: 2025-11-25

Project
» Collaborative Research: Dissolved organic phosphorus controls on marine nitrogen fixation and export production (DOP N2 fixation and export production)

Contributors	Affiliation	Role
Knapp, Angela N.	Florida State University (FSU)	Principal Investigator
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Abstract
This dataset includes total dissolved nitrogen (TDN) concentrations and their d15N measurements from samples collected in the upper ~300 m along the 2017 GO-SHIP P06 transect from 3 July to 30 September 2017 on R/V Nathaniel B. Palmer GO-SHIP cruises NBP1706 and NBP1707. Samples were collected roughly every 2 degrees of longitude across the transect. Samples were measured using persulfate oxidation of the TDN in the sample to nitrate, and then using the denitrifier method to measure the d15N of the resulting nitrate.   Dissolved organic nitrogen (DON) is the dominant form of bioavailable nitrogen in the euphotic zone of subtropical gyres, where nitrate (NO3-) concentrations are low. However, identifying regions where DON consumption may support surface ocean productivity remains challenging due to the relatively narrow range in euphotic zone DON concentrations. These paired measurements of TDN concentrations and their d15N values will help resolve patterns of DON production and consumption across the largest subtropical ocean gyre.

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Coverage

Location: South Pacific between Australia and Chile along 30 degrees south latitude
Spatial Extent: **N**:-30.0795 **E**:284.2545 **S**:-32.5051 **W**:153.9994
Temporal Extent: 2017-07-03 - 2017-09-30

Methods & Sampling

Total dissolved nitrogen (TDN) samples were collected from Niskin bottles deployed on a CTD rosette. All samples were filtered through a PES filter with 0.2 µm nominal pore size and frozen at -20 ˚C until analysis in the lab at Florida State University. We used the persulfate oxidation approach adapted from Knapp et al., 2005 to convert all TDN to nitrate, and the resulting nitrate concentration was determined using a chemiluminescent method, which quantitatively reduces NO_3^-+NO_2^- to NO gas in a heated, acidic vanadium (III) solution (Braman & Hendrix, 1989). DON concentrations were computed by the difference between TDN and NO_3^-+NO_2^- concentrations, with NO_3^-+NO_2^- concentrations measured at sea using colorimetric methods (Armstrong et al., 1967) and reported at CCHDO Hydrographic Data Office (2023).

After TDN concentration analysis, each TDN sample was acidified to a pH = ~4, and the TDN $\delta^{15}N$ was measured by the "denitrifier" method (Sigman et al., 2001; Casciotti et al., 2002; McIlvin & Casciotti, 2011; Weigand et al., 2016). In samples with measurable NO_3^-+NO_2^- concentration, the $\delta^{15}N$ of DON can be calculated by mass balance by subtracting the concentration and $\delta^{15}N$ of NO_3^-+NO_2^- from the TDN concentration and TDN $\delta^{15}N$ measurements (Knapp et al., 2005).

BCO-DMO Processing Description

- Imported "P062017TDNd15N.csv" into the BCO-DMO system
- Replaced spaces and special characters with underscores in keeping with BCO-DMO guidelines
- Exported file as "986627_v1_p06_tdn_d15n.csv"

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Data Files

File
986627_v1_p06_tdn_d15n.csv (Comma Separated Values (.csv), 34.14 KB) MD5:3514be92705fd8f92c78ae9b539928a9 Primary data file for dataset ID 986627, version 1

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Related Publications

Armstrong, F. A. J., Stearns, C. R., & Strickland, J. D. H. (1967). The measurement of upwelling and subsequent biological process by means of the Technicon Autoanalyzer® and associated equipment. Deep Sea Research and Oceanographic Abstracts, 14(3), 381–389. doi:10.1016/0011-7471(67)90082-4
Methods

Braman, R. S., & Hendrix, S. A. (1989). Nanogram nitrite and nitrate determination in environmental and biological materials by vanadium(III) reduction with chemiluminescence detection. Analytical Chemistry, 61(24), 2715–2718. doi:10.1021/ac00199a007
Methods

Casciotti, K. L., Sigman, D. M., Hastings, M. G., Böhlke, J. K., & Hilkert, A. (2002). Measurement of the Oxygen Isotopic Composition of Nitrate in Seawater and Freshwater Using the Denitrifier Method. Analytical Chemistry, 74(19), 4905–4912. doi:10.1021/ac020113w
Methods

Knapp, A. N., Sigman, D. M., & Lipschultz, F. (2005). N isotopic composition of dissolved organic nitrogen and nitrate at the Bermuda Atlantic Time-series Study site. Global Biogeochemical Cycles, 19(1). doi:10.1029/2004gb002320
Methods

McIlvin, M. R., & Casciotti, K. L. (2011). Technical Updates to the Bacterial Method for Nitrate Isotopic Analyses. Analytical Chemistry, 83(5), 1850–1856. doi:10.1021/ac1028984
Methods

Sigman, D. M., Casciotti, K. L., Andreani, M., Barford, C., Galanter, M., & Böhlke, J. K. (2001). A Bacterial Method for the Nitrogen Isotopic Analysis of Nitrate in Seawater and Freshwater. Analytical Chemistry, 73(17), 4145–4153. doi:10.1021/ac010088e
Methods

Weigand, M. A., Foriel, J., Barnett, B., Oleynik, S., & Sigman, D. M. (2016). Updates to instrumentation and protocols for isotopic analysis of nitrate by the denitrifier method. Rapid Communications in Mass Spectrometry, 30(12), 1365–1383. doi:10.1002/rcm.7570
Methods

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Related Datasets

References

CCHDO Hydrographic Data Office. (2023). CCHDO Hydrographic Data Archive [Data set]. UC San Diego Library Digital Collections. https://doi.org/10.6075/J0CCHAM8

Mecking, S. (2017). P06W 2017 [Data set]. CCHDO: CLIVAR and Carbon Hydrographic Data Office. https://doi.org/10.7942/C2PH20

Speer, K. (2017). P06W 2017 [Dataset]. CCHDO: CLIVAR and Carbon Hydrographic Data Office. https://doi.org/10.7942/C2JQ02

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Parameters

Parameter	Description	Units
EXPOCODE	Expedition Code Number	unitless
SECT_ID	US GO-SHIP Section Identification code	unitless
STNNBR	Station number where sample was collected	unitless
CASTNO	CTD Cast number	unitless
Niskin_bottle_number	Niskin bottle number	unitless
DATE	Date of sample collection	unitless
LATITUDE	Latitude of sample collection, Negative is South	decimal degree
LONGITUDE	Longitude of sample collection, Negative is West	decimal degree
CTDPRS	CTD Pressure	decibars
CTDSAL	CTD Salinity	practical salinity units
CTDTMP	CTD Temperature	degrees centigrade
NITRAT_plus_NITRIT	nitrate+nitrite concentration	micromolar (µM)
TDN	Total dissolved nitrogen concentration	micromolar (µM)
TDN_d15N	Total dissolved nitrogen isotopic composition	Per mil units relative to atmospheric N2 gas

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Instruments

Dataset-specific Instrument Name	Thermo 42i chemiluminescent NOx box
Generic Instrument Name	Chemiluminescence NOx Analyzer
Dataset-specific Description	TDN concentration was measured on a Thermo 42i chemiluminescent NOx box. Sample concentrations were calibrated with standards that bracketed sample concentrations.
Generic Instrument Description	The chemiluminescence method for gas analysis of oxides of nitrogen relies on the measurement of light produced by the gas-phase titration of nitric oxide and ozone. A chemiluminescence analyzer can measure the concentration of NO/NO2/NOX. One example is the Teledyne Model T200: https://www.teledyne-api.com/products/nitrogen-compound-instruments/t200

Dataset-specific Instrument Name	CTD
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	Total dissolved nitrogen (TDN) samples were collected from Niskin bottles deployed on a CTD rosette.
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

Dataset-specific Instrument Name	Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Total dissolved nitrogen (TDN) samples were collected from Niskin bottles deployed on a CTD rosette.
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.

Dataset-specific Instrument Name	Thermo Delta V Advantage Isotope Ratio Mass Spectrometer
Generic Instrument Name	Thermo Fisher Scientific DELTA V Advantage isotope ratio mass spectrometer
Dataset-specific Description	TDN d15N was measured on a Thermo Delta V Advantage Isotope Ratio Mass Spectrometer. Sample isotopic composition was calibrated using standard bracketing techniques with IAEA N3 and USGS 34 NO3- d15N isotopic reference materials as described in McIlvin and Casciotti, 2011.
Generic Instrument Description	The Thermo Scientific DELTA V Advantage is an isotope ratio mass spectrometer designed to measure isotopic, elemental, and molecular ratios of organic and inorganic compounds. The DELTA V Advantage is the standard model of the DELTA V series of isotope ratio mass spectrometers, which can be upgraded to the DELTA V Plus. The DELTA V Advantage can be operated in Continuous Flow or Dual Inlet mode. The standard collector configuration is the Universal Triple Collector. H2 collectors with online hydrogen capability are optional. The DELTA V Advantage is controlled by an automated, integrated Isodat software suite. A magnet, whose pole faces determine the free flight space for the ions, eliminates the traditional flight tube. The magnet is designed for fast mass switching which is further supported by a fast jump control between consecutive measurements of multiple gases within one run. The sample gas is introduced at ground potential, eliminating the need for insulation of the flow path, ensuring 100 percent transfer into the ion source. The amplifiers register ion beams up to 50 V. The DELTA V Advantage has a sensitivity of 1200 molecules per ion (M/I) in Dual Inlet mode and 1500 M/I in Continuous Flow mode. It has a system stability of < 10 ppm and an effective magnetic detection radius of 191 nm. It has a mass range of 1 - 80 Dalton at 3 kV.

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Deployments

NBP1706

Website	https://www.bco-dmo.org/deployment/988445
Platform	RVIB Nathaniel B. Palmer
Start Date	2017-07-03
End Date	2017-08-17
Description	Project: Collaborative Research: Global Ocean Repeat Hydrography, Carbon, and Tracer Measurements, 2015-2020 (US GO-SHIP Leg I)

NBP1707

Website	https://www.bco-dmo.org/deployment/855113
Platform	RVIB Nathaniel B. Palmer
Start Date	2017-08-20
End Date	2017-09-30
Description	Project: Collaborative Research: Global Ocean Repeat Hydrography, Carbon, and Tracer Measurements, 2015-2020 (US GO-SHIP Leg II)

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Project Information

Collaborative Research: Dissolved organic phosphorus controls on marine nitrogen fixation and export production (DOP N2 fixation and export production)

Coverage: Global scope (see Description box for details)

This study was global in nature, but included significant numbers of analyses from: GO-SHIP cruises (P06-2017, P18-2016, I08S-2016, I09N-2016); Eastern Tropical South Pacific; Atlantic, Pacific, and Indian Ocean sectors of the Southern Ocean; Gulf of Alaska; and the western Pacific.

NSF Award Abstract:
Phytoplankton play an important role in the Earth's elemental cycles of carbon and nitrogen. In addition to sunlight, phytoplankton living in the surface waters of the oceans require the elements nitrogen and phosphorus for growth. Much of these nutrients are supplied in their inorganic forms from mixing of deep waters towards the surface during the winter months when vertical stability of the water column breaks down. However much of the low latitude oceans, 45degS45degN, suffer from limited nutrient input to sunlit surface waters due to strong thermal stratification (vertical stability) of the upper water column. As a consequence, tropical and subtropical phytoplankton have devised alternative ways of acquiring nitrogen and phosphorus. Marine nitrogen fixation is a process by which specialized microbes utilize the abundant nitrogen gas from the atmosphere to convert elemental nitrogen into the bioavailable form ammonia. These nitrogen fixing phytoplankton and many others also use organic forms of phosphorus in the low latitude ocean where inorganic nutrients are often scarce. This project will significantly increase the number of dissolved organic nitrogen and dissolved organic phosphorus concentration measurements, especially from the currently under-sampled Pacific and Indian Oceans. Changes in the concentration of organic nutrients across the surface ocean will be used to infer rates of organic nutrient use by phytoplankton in numerical models. Specifically, the role for the biological uptake of dissolved organic phosphorus to stimulate the processes of marine nitrogen fixation and photosynthesis in the low latitude ocean will be quantified from the combined data and model output. The project will train one graduate student and several undergraduate students in both laboratory chemical analysis techniques and numerical simulation of ocean biological and chemical processes. New scientific knowledge will be shared with the public via a social media campaign and will inform the development of the next generation of global climate models.

The marine biogeochemical modeling community has identified the lack of dissolved organic nitrogen (DON) and especially dissolved organic phosphorus (DOP) concentration measurements from the upper 300 m of the global ocean as crucial gaps in our ability to accurately model export production and N2 fixation rates in the subtropics. The proposed work will significantly increase global data coverage of marine DON and DOP concentration measurements, in particular from under-sampled ocean regions in the Indian Ocean, western, central, and eastern tropical South Pacific, Gulf of Alaska, eastern subtropical and subpolar South Pacific, Southern Ocean, subtropical North Atlantic, and tropical South Atlantic Ocean basins. These new measurements will be assimilated in state-of-the-art biogeochemical models to constrain the relative cycling rates of DOP and DON and to quantify the role of preferential DOP consumption as a P source supporting export production and N2 fixation in the low latitude ocean. Model output will solve for the regionally-resolved fraction of new production that accumulates as DON and DOP, autotrophic DOP uptake rates, as well as the remineralization rates for DON and DOP. The model output will also include the first regionally variable rate estimates of euphotic zone DOP consumption sustaining export production and N2 fixation to be constrained by observations from the Pacific and Indian Oceans. Thus, the new concentration measurements and diagnostic modeling will allow us to evaluate the quantitative role for regional variability in DOP consumption and recycling that supports export production and N2 fixation in the low latitude ocean.

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-1829797

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