Water column nitrate plus nitrite d15N measurements from seawater collected in November 2019 and November 2020 in the Western Tropical South Pacific

Website: https://www.bco-dmo.org/dataset/869963
Data Type: Cruise Results
Version: 2
Version Date: 2023-04-03

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

Contributors	Affiliation	Role
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Abstract
Here we present nitrate plus nitrite isotopic data from the TONGA research cruises to the Western Tropical South Pacific in 2019 and a reoccupation in 2020. These data were collected along a transect focusing on the impacts on biological productivity and the biological carbon pump from shallow hydrothermal sources of trace elements. Notably, these data show that the subsurface nitrate plus nitrite isotopes were low, 2 to 3 per mil, in the vicinity of the hydrothermal vents. While subsurface nitrate plus nitrite isotopes were low higher, 4 to 7 per mil, at stations further from the vents.

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Coverage

Spatial Extent: **N**:-19.43 **E**:-179.52 **S**:-21.16 **W**:175.81
Temporal Extent: 2019-11-05 - 2020-11-04

Methods & Sampling

Sampling and Analytical Procedures:
Duplicate water column samples were collected by Niskin or GoFlo rosette on one of the following types of casts:

'CTD',
'TMC' (Trace Metal Clean), or

'TWO' (small classical CTD with 12 x Niskin bottles) cast.

Nitrogen isotopic analysis (d15N of NO3-+NO2-) was by the "denitrifier method" and followed the methods described by Sigman et al. (2001), Casciotti et al. (2002), McIlvin and Casciotti (2011), and Weigand et al. (2016).

Briefly, NO3-+NO2- was quantitatively reduced to N2O by *Pseudomonas aureofaciens*, which was then cryogenically focused and analyzed on an isotope ratio mass spectrometer. A volume of sample was added to each bacterial vial to achieve a final quantity of 10 or 20 nanomoles N2O, which was then purged from the vial using a helium carrier gas. The d15N of N2O in samples was calibrated with international isotopic reference materials.

Calibration:
NO3-+NO2- d15N analyses were calibrated with IAEA N3 and USGS 34 NO3- d15N isotopic reference materials as described in McIlvin and Casciotti, 2011.

Precision:
The average precision of NO3-+NO2- d15N measurements was $\leq$0.2 per mil.

Data Processing Description

BCO-DMO Processing:
Version 1:
- Added a column for Vessel
- Combined date and time columns to format of yyyy-mm-dd hh:mm:ss
- Modified parameter (column) names to conform with BCO-DMO naming conventions. The only allowed characters are A-Z,a-z,0-9, and underscores. No spaces, hyphens, commas, parentheses, or Greek letters.

Version 2:
- Created ISO 8601 date-time field;
- Renamed fields to comply with BCO-DMO naming conventions.

Version History:
- version 1 (date 2022-02-24) - contains only data from 2019 cruise.
- version 2 (date 2023-04-03) - contains data from 2019 and 2020 cruises.

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Data Files

File
tonga_no3_d15n.csv (Comma Separated Values (.csv), 12.72 KB) MD5:aad6b02f852e5c359e52318b91dda63b Primary data file for dataset ID 869963; version 2.

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Related Publications

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

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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Parameters

Parameter	Description	Units
CruiseID	Cruise name	unitless
ISO_DateTime_UTC	Date and time (UTC) of sampling in ISO 8601 format	unitless
Latitude	Latitude of sample collection	degrees North
Longitude	Longitude of sample collection	degrees East
Cast	Cast number and type (CTD=standard CTD, TMC=Trace Metal Clean, TWO=small classical CTD with 12 Niskin)	unitless
PotentialDensity	Density of water parcel at the surface	kilograms per cubic meter (kg/m^3)
Depth	Sample depth	meters (m)
NO3_NO2_d15N	Nitrogen isotopic composition of nitrate plus nitrite with respect to nitrogen in air (NO3- + NO2- d15N vs. N2 in air)	per mil vs. N2 in air

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Instruments

Dataset-specific Instrument Name	CTD
Generic Instrument Name	CTD - profiler
Dataset-specific Description	water column samples were collected on a CTD cast
Generic Instrument Description	The Conductivity, Temperature, Depth (CTD) unit is an integrated instrument package designed to measure the conductivity, temperature, and pressure (depth) of the water column. The instrument is lowered via cable through the water column. It permits scientists to observe the physical properties in real-time via a conducting cable, which is typically connected to a CTD to a deck unit and computer on a ship. The CTD is often configured with additional optional sensors including fluorometers, transmissometers and/or radiometers. It is often combined with a Rosette of water sampling bottles (e.g. Niskin, GO-FLO) for collecting discrete water samples during the cast. This term applies to profiling CTDs. For fixed CTDs, see https://www.bco-dmo.org/instrument/869934.

Dataset-specific Instrument Name	GoFlo rosette
Generic Instrument Name	GO-FLO Bottle
Dataset-specific Description	water column samples were collected by Niskin or GoFlo rosette
Generic Instrument Description	GO-FLO bottle cast used to collect water samples for pigment, nutrient, plankton, etc. The GO-FLO sampling bottle is specially designed to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

Dataset-specific Instrument Name	Thermo Finnigan Delta V isotope ratio mass spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	NO3-+NO2- d15N was measured using a Thermo Finnigan Delta V isotope ratio mass spectrometer
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	Niskin
Generic Instrument Name	Niskin bottle
Dataset-specific Description	water column samples were collected by Niskin
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	Trace Metal Clean (TMC) bottle
Generic Instrument Name	Trace Metal Bottle
Dataset-specific Description	water column samples were collected on a TMC (Trace Metal Clean) cast
Generic Instrument Description	Trace metal (TM) clean rosette bottle used for collecting trace metal clean seawater samples.

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Deployments

TONGA2019

Website	https://www.bco-dmo.org/deployment/869973
Platform	R/V L'Atalante
Report	https://campagnes.flotteoceanographique.fr/campagnes/18000884/
Start Date	2019-10-31
End Date	2019-12-06
Description	Project TONGA: shallow hydroThermal sOurces of trace elemeNts: potential impacts on biological productivity and the bioloGicAl carbon pump The objectives of the cruise were to investigate at least two active volcanoes where shallow (less than 500 meters) hydrothermal sites could release chemical elements both able to fertilize and/or bring toxicity to the planktonic food web. Task 1: Characterize chemically and optically the hydrothermal fluids and compare the source from below (shallow hydrothermal fluids) with the source from above (atmospheric deposition); Task 2: Related to the dynamical dispersion of the fluids at small and regional scales; Task 3: Investigate the impact of the shallow hydrothermal sources on the biological activity and diversity, and the feedback to the atmosphere via the oceanic emissions of primary and secondary aerosols. More information can be found on the project website: http://tonga-project.org/web/

TONGA RECUP

Website	https://www.bco-dmo.org/deployment/893063
Platform	R/V Alis
Report	https://campagnes.flotteoceanographique.fr/campagnes/18001357/
Start Date	2020-10-24
End Date	2020-11-07
Description	The first objective of the TONGA RECUP campaign was to recover the fixed mooring launched on 1/12/2019 during the TONGA campaign, (position: 20°42.408 S / 177°52.128). The 4 instruments on the mooring line closed automatically once the last sample collected on 1/11/2020. The recovery date was conditioned by this. The 2nd objective of the TONGA RECUP campaign was to reoccupy 3 stations that were sampled one year earlier (TONGA campaign) in order to refine the delta 15N budget necessary for the interpretation of some mooring results: 2 stations in the Lau basin, close to the mooring and under the expected influence of shallow hydrothermal fluids and a more distant station that will be able to serve as a reference that will be little or not influenced by the emissions of the shallow underwater volcanoes of the TONGA Arc. More information can be found on the project website: http://tonga-project.org/web/

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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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