Nutrients from CTD casts conducted on R/V Hugh R. Sharp cruise HRS2110 in the Chesapeake Bay during August 2021

Website: https://www.bco-dmo.org/dataset/896158
Data Type: Cruise Results
Version: 1
Version Date: 2023-05-30

Project
» Nitrite Oxidation in Oxygen Minimum Zones (NO2Ox_OMZs)

Contributors	Affiliation	Role
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Abstract
This dataset includes nutrient data from R/V Hugh R. Sharp cruise HRS2110 in the Chesapeake Bay during August 2021.

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Coverage

Spatial Extent: **N**:39.14 **E**:-76.0926 **S**:37.2702 **W**:-76.4398
Temporal Extent: 2021-08-04 - 2021-08-10

Methods & Sampling

Water samples were collected using a 12 x 10-liter Niskin bottle rosette sampler equipped with a conductivity, temperature, and pressure instrument package (SBE9, Sea-Bird Electronics, Bellevue, Washington, U.S.A.), a sensor for dissolved oxygen (SBE43, Sea-Bird), and a sensor for chlorophyll fluorescence (FluoroWetlabECO, AFL FL Sensor). NH4, NO2, and urea were measured on board immediately after sample collection. NO3 was assayed in the home laboratory on samples stored frozen at the time of collection.

Data Processing Description

BCO-DMO Processing:
- renamed fields to comply with BCO-DMO naming conventions.

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Data Files

File	
cb_2021_nutrients.csv	(Octet Stream, 4.25 KB) MD5:7ca1c706723ac1bdcfe2538bac007cb5
Primary data file for dataset ID 896158.	

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Related Publications

Chen, L., Ma, J., Huang, Y., Dai, M., & Li, X. (2015). Optimization of a colorimetric method to determine trace urea in seawater. Limnology and Oceanography: Methods, 13(6), 303–311. Portico. https://doi.org/10.1002/lom3.10026
Methods

Garside, C. (1982). A chemiluminescent technique for the determination of nanomolar concentrations of nitrate and nitrite in seawater. Marine Chemistry, 11(2), 159–167. doi:10.1016/0304-4203(82)90039-1
Methods

Hansen, H. P., & Koroleff, F. (1999). Determination of nutrients. Methods of Seawater Analysis, 159–228. Portico. https://doi.org/10.1002/9783527613984.ch10
Methods

Holmes, R. M., Aminot, A., Kerouel, R., Hooker, B. A., & Peterson, B. J. (1999). A simple and precise method for measuring ammonium in marine and freshwater ecosystems. Canadian Journal of Fisheries and Aquatic Sciences, 56(10), 1801-1808. doi:10.1139/f99-128 https://doi.org/10.1139/cjfas-56-10-1801
Methods

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Parameters

Parameter	Description	Units
Cast	cast number	unitless
Station	station name	unitless
Date	date of cast	unitless
Latitude	Latitude (positive values = North)	decimal degrees
Longitude	Longitude (negative values = West)	decimal degrees
Depth	depth	meters (m)
NH4	ammonium concentration	micromolar (uM)
NH4_stdev	ammonium concentration standard deviation	micromolar (uM)
NO2	nitrite concentration	micromolar (uM)
NO2_stdev	nitrite concentration standard deviation	micromolar (uM)
NO3	nitrate concentration	micromolar (uM)
NO3_stdev	nitrate concentration standard deviation	micromolar (uM)
Urea	urea concentration	micromolar (uM)
Urea_stdv	urea concentration standard deviation	micromolar (uM)

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Instruments

Dataset-specific Instrument Name	Teledyne Chemiluminescence NO/NOx Analyzer (Model 200E)
Generic Instrument Name	Chemiluminescence NOx Analyzer
Dataset-specific Description	Used to measure NO3
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	10-liter Niskin bottle rosette
Generic Instrument Name	Niskin bottle
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	Turner Designs Trilogy Fluorometer
Generic Instrument Name	Turner Designs Trilogy fluorometer
Dataset-specific Description	Used to measure NH4
Generic Instrument Description	The Trilogy Laboratory Fluorometer is a compact laboratory instrument for making fluorescence, absorbance, and turbidity measurements using the appropriate snap-in application module. Fluorescence modules are available for discrete sample measurements of various fluorescent materials including chlorophyll (in vivo and extracted), rhodamine, fluorescein, cyanobacteria pigments, ammonium, CDOM, optical brighteners, and other fluorescent compounds.

Dataset-specific Instrument Name	UV-visible spectrophotometer (UV-2450, Shimadzu, Japan)
Generic Instrument Name	UV Spectrophotometer-Shimadzu
Dataset-specific Description	Used to measure NO2 and urea
Generic Instrument Description	The Shimadzu UV Spectrophotometer is manufactured by Shimadzu Scientific Instruments (ssi.shimadzu.com). Shimadzu manufacturers several models of spectrophotometer; refer to dataset for make/model information.

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Deployments

HRS2110

Website	https://www.bco-dmo.org/deployment/868888
Platform	R/V Hugh R. Sharp
Start Date	2021-08-03
End Date	2021-08-21
Description	See more information about this cruise in Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/HRS2110

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Project Information

Nitrite Oxidation in Oxygen Minimum Zones (NO2Ox_OMZs)

Coverage: Eastern Tropical South Pacific and Chesapeake Bay

NSF Award Abstract:
This research is grounded in the fundamental role of nitrogen in limiting production in the ocean. Nitrite is a pivotal compound in the nitrogen cycle: it can be oxidized to nitrate, and thus retained as an available nutrient, or it can be reduced to dinitrogen gas, and thus lost from the bioavailable nitrogen pool. Oxidation of nitrite by nitrite oxidizing bacteria (NOB) is the only biological pathway by which nitrate is produced, and all known NOB require oxygen for life. The reduction pathway is also carried out by microbes, in this case, bacteria that thrive only in the absence of oxygen. In previous experiments, however, both oxidation and reduction of nitrite were detected in the same samples from ocean waters in the absence of oxygen. We will investigate three explanations for the apparent oxidation of nitrite in the absence of oxygen on a research cruise to the low oxygen waters off the coast of Peru: 1) The presence of unknown kinds of NOB that do not require oxygen; 2) a new reaction called dismutation, which is possible but never detected in nature; 3) an artifact associated with oxygen stress in NOB. This research could lead to discovery of novel mechanisms and or novel organisms that determine the fate of nitrite and the availability of nitrogen to support primary production in the long run. This project will advance discovery and understanding while promoting teaching, training and learning by providing opportunities for Princeton students to get involved in and have hands on experience in research in the lab and potentially at sea. Both undergraduate and graduate students will participate in the research through internships and field experiences. We will also integrate our work at sea into teaching in the classroom via videos and assignments based on data collected during the cruise.

Nitrite oxidation is the only known biological process that produces nitrate, which comprises the largest fixed nitrogen reservoir in the ocean. Nitrite oxidation is carried out by nitrite oxidizing bacteria (NOB), and all known species are obligate aerobes. Nitrite reduction to N2 occurs in multiple microbial pathways, generally under anoxic conditions. Despite their apparent incompatibility regarding oxygen, both processes are detected in the low oxygen or anoxic waters of oxygen minimum zones (OMZs). Thus, the fate of nitrite in OMZs has implications for the global fixed N budget. Nitrite oxidation is detected at high rates in essentially zero oxygen water in the most oxygen depleted depth intervals in OMZ regions, which suggests that some nitrite oxidizers might possess anaerobic metabolic capabilities. Nitrite disproportionation (or dismutation), in which nitrite is simultaneously oxidized to nitrate and reduced to N2, is a thermodynamically favorable reaction, which would link the two processes in one organism – but it has never been observed in nature. The research proposed here will address two big questions about nitrite in the ocean: 1) How does anaerobic nitrite oxidation work? 2) What determines the fate of nitrite? The experimental approach will investigate three possible explanations for anaerobic nitrite oxidation: 1) Nitrite is oxidized to nitrate by different clades of NOB, which exhibit different tolerances/requirements for oxygen; 2) Nitrite dismutation, also performed by NOB, partially explains the cooccurrence of oxidation and reduction of nitrite; 3) Apparently anaerobic nitrite oxidation is indeed biologically mediated but does not always represent net production of nitrate from nitrite; rather it results from isotopic equilibration during enzyme-catalyzed interconversion of nitrite and nitrate. These questions will be addressed by performing a suite of 15N-tracer incubations at stations located within and outside of one of the major OMZs in the ocean, the Eastern Tropical South Pacific. The dependence of the rate processes on oxygen concentrations will be determined, and the composition of the microbial assemblages will be assessed in order to determine whether different microbial components are involved under different environmental conditions. The expression of genes involved in oxidation/reduction/ respiratory metabolisms at low oxygen concentrations will be measured across oxygen gradients and in oxygen manipulations to identify their potential role in supporting “anaerobic” nitrite oxidation. The possibility that the apparently anaerobic nitrite oxidation is due to an enzyme level interconversion between nitrite and nitrate, which does not lead to net nitrate production and is not linked to growth of nitrite oxidizing bacteria, will also be investigated.

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-1946516

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