

Bulk suspended PON d15N from several cruises conducted in the Southern Ocean south of Africa from 2012-2019

Website: <https://www.bco-dmo.org/dataset/805324>

Data Type: Cruise Results

Version: 1

Version Date: 2020-03-04

Project

» [High-resolution, Assemblage-specific Records of Diatom-bound N Isotopes from the Indian Sector of the Antarctic Ocean](#) (Diatom-bound_N_Isotopes)

» [Understanding the nitrogen isotopes of planktonic foraminifera: A modern Sargasso Sea study](#) (N Isotopes Foraminifera)

» [MRI: Acquisition of Stable Isotope Instrumentation for the Biogeosciences at Princeton University](#) (stable isotope instrumentation)

Contributors	Affiliation	Role
Sigman, Daniel M.	Princeton University	Principal Investigator
Smart, Sandi M.	Stellenbosch University	Contact
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract

Compilation of surface measurements of bulk suspended particulate organic nitrogen (PON) collected from the Southern Ocean south of Africa (spanning 0-42°E). Date, time, latitude, and longitude are the averages of the start and end values of each underway collection.

Table of Contents

- [Coverage](#)
- [Dataset Description](#)
 - [Methods & Sampling](#)
 - [Data Processing Description](#)
- [Data Files](#)
- [Related Publications](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Funding](#)

Coverage

Spatial Extent: N:-34.4835 E:41.9621 S:-56.0768 W:0.0003

Temporal Extent: 2012-07-20 - 2019-04-16

Dataset Description

Compilation of surface measurements of bulk suspended particulate organic nitrogen (PON) collected from the Southern Ocean south of Africa (spanning 0-42°E). Date, time, latitude, and longitude are the averages of the start and end values of each underway collection.

Methods & Sampling

Bulk (>0.3 μ m) suspended PON samples were collected from the underway intake (at 7 m depth) and frozen at -80°C until isotope analysis. The N isotope composition of bulk PON was measured by elemental analyser-

isotope ratio mass spectrometry at the University of Cape Town. See methods section of Smart et al. (2020) for more detail.

Data Processing Description

N isotope measurements were referenced to atmospheric N₂ using three in-house organic standards: Choc, Merck Gel, and Valine. Samples containing GF/F material were additionally corrected for the contribution of the N blank associated with the filter paper.

BCO-DMO Processing:
- added ISO_DateTime field.

[[table of contents](#) | [back to top](#)]

Data Files

File
bulk_suspended_PON.csv (Comma Separated Values (.csv), 13.18 KB) MD5:159e66bc12fc751bda5beb1ca992c191
Primary data file for dataset ID 805324

[[table of contents](#) | [back to top](#)]

Related Publications

Smart, S. M., Fawcett, S. E., Ren, H., Schiebel, R., Tompkins, E. M., Martínez-García, A., ... Sigman, D. M. (2020). The Nitrogen Isotopic Composition of Tissue and Shell-Bound Organic Matter of Planktic Foraminifera in Southern Ocean Surface Waters. *Geochemistry, Geophysics, Geosystems*, 21(2). doi:10.1029/2019gc008440 <https://doi.org/10.1029/2019GC008440>

Results

Smart, S. M., Ren, H., Fawcett, S. E., Schiebel, R., Conte, M., Rafter, P. A., ... Sigman, D. M. (2018). Ground-truthing the planktic foraminifer-bound nitrogen isotope paleo-proxy in the Sargasso Sea. *Geochimica et Cosmochimica Acta*, 235, 463–482. doi:[10.1016/j.gca.2018.05.023](https://doi.org/10.1016/j.gca.2018.05.023)

General

[[table of contents](#) | [back to top](#)]

Parameters

Parameter	Description	Units
cruise	Cruise identifier	unitless
leg	Cruise leg	unitless
ship	Ship name	unitless
date	Date; format: yyyy-mm-dd	unitless
time	Time; format: HH:MM	unitless
latitude	Latitude; positive values = North	decimal degrees
longitude	Longitude; positive values = East	decimal degrees
PONconc_avg	Mean PON concentration. PON is the bulk (> 0.3 µm) particulate organic nitrogen in surface waters filtered from the ship's underway intake) concentration.	micrometers (µm)
PONconc_sd	Standard deviation of PONconc_avg	micrometers (µm)
PONconc_n	Number of replicate measurements of PON	unitless
PONd15N_avg	Mean PON d15N. d15N is the nitrogen isotopic composition of a sample expressed in delta notation (d15N in units of per mil, ‰) relative to atmospheric N ₂ , where $d15N = \{[(15N/14N)_{sample}/(15N/14N)_{atmN2}] - 1\} \times 1000$.	per mil vs AIR
PONd15N_sd	Standard deviation of PONd15N_avg	per mil vs AIR
PONd15N_n	Number of replicate measurements of PONd15N	unitless
ISO_DateTime_UTC	Date and time formatted to the ISO 8601 standard; format: yyyy-mm-ddTHH:MM	yyyy-MM-ddT'HH:mm

[[table of contents](#) | [back to top](#)]

Instruments

Dataset-specific Instrument Name	Thermo Scientific FLASH 2000 elemental analyzer
Generic Instrument Name	Elemental Analyzer
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	Thermo Scientific Delta V Plus mass spectrometer
Generic Instrument Name	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).

[[table of contents](#) | [back to top](#)]

Deployments

VOY03

Website	https://www.bco-dmo.org/deployment/557788
Platform	R/V S.A. Agulhas II
Start Date	2012-07-10
End Date	2012-08-06
Description	R/V S.A. Agulhas II, VOY03 (July 2012): The winter "shake-down" cruise, part of the GoodHope monitoring programme. Transect extends from the subtropics (offshore of Cape Town, South Africa; 33.9°S, 18.4°E) to just beyond the winter sea-ice edge (encountered at 56.7°S, 0.0°E), covering a 0-2000 m depth range.

SOSCEX1

Website	https://www.bco-dmo.org/deployment/805401
Platform	R/V S.A. Agulhas I
Start Date	2013-02-15
End Date	2013-03-11
Description	SOSCEX1 = Southern Ocean Seasonal Cycle Experiment 1. Subantarctic Atlantic, between South Africa and the Greenwich meridian (Good Hope Line, 0°E).

VOY016

Website	https://www.bco-dmo.org/deployment/805402
Platform	R/V S.A. Agulhas II
Start Date	2015-07-22
End Date	2015-08-15
Description	VOY016: Winter Cruise 2015, Good Hope Line. Subantarctic Atlantic, between South Africa and Antarctic winter sea-ice edge (at 56.4°S, 0.3°E).

VOY019

Website	https://www.bco-dmo.org/deployment/805403
Platform	R/V S.A. Agulhas II
Start Date	2016-04-07
Description	VOY019: Marion Cruise 2016. Subantarctic Indian, between South Africa and Marion/Prince Edward Islands (at 46.9°S, 37.7°E).

ACE_Leg1

Website	https://www.bco-dmo.org/deployment/805465
Platform	R/V Akademik Tryoshnikov
Start Date	2016-12-20
End Date	2017-01-19
Description	ACE: Antarctic Circumnavigation Expedition. The 0-42°E section of the Antarctic Circumnavigation Expedition, Leg 1 (Cape Town to Hobart) and Leg 3 (Punta Arenas to Cape Town).

ACE_Leg3

Website	https://www.bco-dmo.org/deployment/805466
Platform	R/V Akademik Tryoshnikov
Start Date	2017-02-26
End Date	2017-03-19
Description	ACE: Antarctic Circumnavigation Expedition. The 0-42°E section of the Antarctic Circumnavigation Expedition, Leg 1 (Cape Town to Hobart) and Leg 3 (Punta Arenas to Cape Town).

[[table of contents](#) | [back to top](#)]

Project Information

High-resolution, Assemblage-specific Records of Diatom-bound N Isotopes from the Indian Sector of the Antarctic Ocean (Diatom-bound_N_Isotopes)

Coverage: Kerguelen Plateau

Description from NSF award abstract:

The high concentration of the major nutrients nitrate and phosphate is a fundamental characteristic of the Antarctic Zone in the Southern Ocean and is central to its role in global ocean fertility and the global carbon cycle. The isotopic composition of diatom-bound organic nitrogen is one of the best hopes for reconstructing the nutrient status of polar surface waters over glacial cycles, which in turn may hold the explanation for the decline in atmospheric carbon dioxide during ice ages. The PIs propose to generate detailed diatom-bound nitrogen isotope ($\delta^{15}\text{N}_{\text{db}}$) records from high sedimentation rate cores from the Kerguelen Plateau. Because the cores were collected at relatively shallow seafloor depths, they have adequate planktonic and benthic foraminifera to develop accurate age models. The resulting data could be compared with climate records from Antarctic ice cores and other archives to investigate climate-related changes, including the major steps into and out of ice ages and the millennial-scale events that occur during ice ages and at their ends. The records generated in this project will provide a critical test of hypotheses for the cause of lower ice age CO₂.

This study will contribute to the goal of understanding ice ages and past CO₂ changes, which both have broad implications for future climate. Undergraduates will undertake summer internships, with the possibility of extending their work into junior year projects and senior theses. In addition, the PI will lead modules for two Princeton programs for middle school teachers and will host a teacher for a six-week summer research project.

Understanding the nitrogen isotopes of planktonic foraminifera: A modern Sargasso Sea study (N Isotopes Foraminifera)

Coverage: Sargasso Sea

NSF Award Abstract:

Nitrogen (N) and phosphorus are the two nutrients required in large quantity by phytoplankton in the ocean, and together they limit productivity throughout most of the tropical, subtropical, and temperate ocean. Both the cycling of N and its input/output budget have been argued to control the fertility of the ocean and the ocean's role in setting atmospheric CO₂. The CaCO₃ tests of foraminifera can represent a substantial fraction of marine sediments and have been used extensively in paleoceanography; they are an obvious target for isotopic analysis of microfossil-bound organic matter.

In recent years, researchers at Princeton have developed a protocol for the isotopic analysis of foraminiferal shell-bound N. The current protocol is at least 100 times more sensitive than typical on-line combustion, allowing for rapid progress with a N isotope archive that was previously not feasible to measure. Measurements on surface sediments and a downcore record from the Caribbean show the promise of foraminifera-bound $\delta^{15}\text{N}$ (fb- $\delta^{15}\text{N}$) to provide both a robust N isotope archive for paleoceanography, and one with a unique potential of richness, given the existence of multiple foraminiferal species with different depth habitats and behaviors. Moreover, the finding from the Caribbean Sea record -- reduced N fixation in ice age Atlantic -- has changed the scientific conversation about the nature of the input/output budget of oceanic fixed N and its potential to change ocean fertility and atmospheric CO₂. However, the controls on fb- $\delta^{15}\text{N}$ have not yet been adequately studied.

In this project, as a first major step in developing a foundation for the paleoceanographic application of fb- $\delta^{15}\text{N}$, the same Princeton University team will study its genesis in the water column, transport to the seafloor, and early diagenesis. They will undertake this study in the Sargasso Sea south of Bermuda. This is one of the best studied regions of the ocean, in general and with respect to foraminifera, and a region that has been a focus of the N isotope research of the PI for the last decade and others previously. Moreover, its significant seasonality -- in physical oceanography, biogeochemistry, and foraminiferal species abundance -- will facilitate the effort to understand the controls on fb- $\delta^{15}\text{N}$ at a mechanistic level. The research team will participate in six Bermuda Atlantic Time-series Study (BATS) cruises over two years, collecting foraminifera and other N forms likely to provide insight into the controls on fb- $\delta^{15}\text{N}$. From the nearby Oceanic Flux Program (OFP) moored sediment traps and from shallow sediments collected in the region, they will pick foraminifera shells and again make relevant ancillary measurements. This work will establish the relationship of foraminiferal biomass to shell-bound $\delta^{15}\text{N}$ for different species, and comparison of the foraminiferal isotope data with the upper ocean N pools will yield empirical isotopic relationships and work toward a mechanistic insight of fb- $\delta^{15}\text{N}$ (e.g., the importance of different N pools to the diets of different foraminifera; the role of algal symbionts). The sediment trap and surface sediment data will support the plankton tow data by integrating over longer time scales and will also address questions regarding late stage (e.g., gametogenic) calcification and the early diagenesis of fb- $\delta^{15}\text{N}$ and fb-N content.

Broader Impacts: This study will yield an improved understanding of the nutrient dynamics of foraminifera, a class of organisms whose shells are a central tool in micropaleontology and paleoclimatology. The project will also build on the principal investigator's involvement in the Bermuda Institute of Ocean Sciences as an asset for integrating ocean-related education and research at both the undergraduate and graduate levels.

MRI: Acquisition of Stable Isotope Instrumentation for the Biogeosciences at Princeton University (stable isotope instrumentation)

NSF Award Abstract:

Intellectual Merit:

The PIs are requesting funds to acquire a suite of instruments for stable isotope (N) research, including a denitrifier-based, natural abundance isotope system, a tracer isotope system, and general purpose natural abundance peripherals for an existing mass spectrometer. Specific instruments requested include a Thermo Electron MAT 253 stable isotope mass spectrometer, a Thermo DeltaV Advantage stable isotope mass spectrometer with peripherals, an EA peripheral for combustion-based isotope analysis, and a GasBench II carbon dioxide preparation and purification system. The proposed instrumentation would enable research efforts examining natural stable isotope abundances that include ocean biogeochemistry and paleoceanography, terrestrial biogeochemistry, carbon isotopes in Precambrian Earth history. Stable isotope tracer research would include nitrification, nitrogen fixation, and carbon partitioning during biostimulation.

Broader Impacts:

The PIs state that the proposed instrumentation would expand the research capabilities of the institution and specifically the Departments of Geosciences and Ecology and Evolutionary Biology. The improvements to the denitrifier method will also serve to expand the capabilities of the ocean research community at large. Additionally, the proposed instrumentation will enable method development and provide training for undergraduate students at the institution and those participating in a collaborative effort with the University of Cape Town.

[[table of contents](#) | [back to top](#)]

Funding

Funding Source	Award
NSF Division of Polar Programs (NSF PLR)	PLR-1401489
NSF Division of Ocean Sciences (NSF OCE)	OCE-1060947
NSF Division of Ocean Sciences (NSF OCE)	OCE-0922345

[[table of contents](#) | [back to top](#)]