

Southern Ocean deep-sea fossil coral (*Desmophyllum dianthus*) nitrogen isotope records generated using Monte Carlo and Kalman Filters generated using Monte Carlo and Kalman Filters (DeepSeaCoralNitrogen project)

Website: <https://www.bco-dmo.org/dataset/692791>

Data Type: experimental

Version:

Version Date: 2017-04-28

Project

» [Nitrogen isotopic \(d15N\) composition of carbonate-bound organic nitrogen in Deep Sea Corals: A new, high resolution proxy for N cycle studies](#) (DeepSeaCoralNitrogen)

Contributors	Affiliation	Role
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Table of Contents

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

Dataset Description

[Note: 28 Apr 2017] The metadata description of this dataset is still in progress. The metadata have not yet been reviewed by the data contributor.

This dataset contains average scleractinian coral (*Desmophyllum dianthus*) nitrogen isotope records over the past 40,000 years generated using Monte Carlo and Kalman Filters approaches.

These data were published in:

Wang, X. T., Sigman, D. M., Prokopenko, M. G., Adkins, J. F., Robinson, L. F., Hines, S. K., ... & Haug, G. H. (2017). Deep-sea coral evidence for lower Southern Ocean surface nitrate concentrations during the last ice age. *Proceedings of the National Academy of Sciences*, 201615718. doi: [10.1073/pnas.1615718114](https://doi.org/10.1073/pnas.1615718114)

Related dataset also from this publication:

[Southern Ocean deep-sea coral nitrogen isotopes](#)

Methods & Sampling

A synthetic time series of d15N and age were generated using observed measurements in Tasmania and the Drake Passage. Monte Carlo simulation and a Kalman smoother were combined to obtain the best estimate of the average d15N time series on a regular time grid and its corresponding confidence interval.

For a more detailed methodology description see:

Wang, X. T., Sigman, D. M., Prokopenko, M. G., Adkins, J. F., Robinson, L. F., Hines, S. K., ... & Haug, G. H. (2017). Deep-sea coral evidence for lower Southern Ocean surface nitrate concentrations during the last ice age. Proceedings of the National Academy of Sciences, 201615718. doi: [10.1073/pnas.1615718114](https://doi.org/10.1073/pnas.1615718114)

Data Processing Description

BCO-DMO Data Manager Processing Notes:

- * added a conventional header with dataset name, PI name, version date
- * modified parameter names to conform with BCO-DMO naming conventions
- * blank values replaced with no data value 'nd'
- * combined Excel sheets in original .xlsx file into one tabular dataset. Created column "source_location" to capture region information which was why the sheets were originally separated.

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

Data Files

File
MonteCarlo.csv (Comma Separated Values (.csv), 40.73 KB) MD5:b6a3715d8afc26b588df432787315a3d Primary data file for dataset ID 692791

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

Parameters

Parameter	Description	Units
source_location	Location of sample collection	unitless
age	Monte Carlo Age (year) in format yyyy	unitless
d15N	d15N (ratio of stable isotopes 15N:14N);Generated using Monte Carlo and Kalman Filter statistical techniques	permil vs. air (0/00 vs air)
d15N_sd1	One sigma errors of d15N	permil vs. air (0/00 vs air)
d15N_sd2	Two sigma errors of d15N	permil vs. air (0/00 vs air)

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

Instruments

Dataset-specific Instrument Name	Gas chromatography
Generic Instrument Name	Gas Chromatograph
Generic Instrument Description	Instrument separating gases, volatile substances, or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay. (from SeaDataNet, BODC)

Dataset-specific Instrument Name	isotope ratio mass spectrometry
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](#)]

Project Information

Nitrogen isotopic ($\delta^{15}\text{N}$) composition of carbonate-bound organic nitrogen in Deep Sea Corals: A new, high resolution proxy for N cycle studies (DeepSeaCoralNitrogen)

Coverage: Sub-Antarctic waters and Antarctic waters

PI supplied project description:

Intellectual Merit

The history of the nitrogen (N) cycle provides insight into the links between past climate and marine biogeochemical cycles. Interpretations of the history of the N cycle rely on the nitrogen isotopic composition ($\delta^{15}\text{N}$) of Particulate Organic Nitrogen ($\delta^{15}\text{N}$ -PON) preserved in sedimentary archives such as: bulk organic nitrogen (ON) buried in anoxic/suboxic sediments, skeletal-bound ON in diatom frustules and foraminiferal tests, and organic skeletons of deep-sea proteinaceous corals. As is often is the case with paleo-proxies, these archives have advantages, as well as limitations, the latter arising from temporal and/or spatial restrictions in distribution. Therefore, multiple archives are needed for better understanding the patterns and causes of N cycle variability in the past.

To improve upon the geographic and temporal resolution of $\delta^{15}\text{N}$ paleo-records, this projects evaluates a new proxy for the history of the marine N cycle-- $\delta^{15}\text{N}$ of ON bound within the mineral lattice of deep-sea corals (DSC). The project included two parts: 1) a modern calibration study; 2) a survey of $\delta^{15}\text{N}$ in the fossil corals from the Southern Ocean and comparison with previously published records of the diatom- and foraminifera-bound $\delta^{15}\text{N}$.

Summary of findings

A survey of modern coral specimens (*Desmophyllum dianthus*) from disparate oceanographic environments, each chosen to represent a distinct $\delta^{15}\text{N}$ signature of PON exported from the euphotic zone showed strong statistical correlation between the coral-bound ON (CB- $\delta^{15}\text{N}$) and $\delta^{15}\text{N}$ of regional export PON (Wang et al., 2014), establishing the fidelity of CB- $\delta^{15}\text{N}$ proxy.

In the second phase, the research group generated a set of time-resolved records of $\delta^{15}\text{N}$ in fossil *D. dianthus* from the Subantarctic (south of Tasmania and northern Drake Passage) and Antarctic (southern Drake Passage) regions of the Southern Ocean, spanning 40Ka through the present (Wang et al., 2017). In the modern Southern Ocean, the surface nutrients (including nitrate) are not fully consumed, resulting in leakage of deeply sequestered CO_2 to the atmosphere. Incomplete nitrate consumption is manifested in low $\delta^{15}\text{N}$ of the exported modern PON. Wang et al. (2017) found that in both Southern Ocean regions the average CB- $\delta^{15}\text{N}$ during Last Glacial Maximum (LGM) was 4 to 5 permil higher than today. This finding provided a strong proof for the previously proposed hypothesis of the more efficient biological pump in the Southern Ocean, driving lower pCO_2 during the ice ages. Stronger vertical stratification in the Antarctic and higher iron supply in the Subantarctic zones are the two likely reasons for the more efficient surface nitrate uptake during the LGM than occurs in the modern Southern Ocean.

The trends defined by the CB- $\delta^{15}\text{N}$ in the Southern Ocean corals were comparable to the previously published $\delta^{15}\text{N}$ records of diatom- and foraminifera-bound ON from both the Antarctic and Subantarctic zones, validating the reliability of the fossil deep-sea corals as paleo-archives. However, higher temporal resolution afforded by the DSC revealed a previously unnoticed feature: the CB- $\delta^{15}\text{N}$ in the Antarctic Zone continued to decrease through the Holocene, pointing to the ongoing decline in the nitrate uptake efficiency. One possible mechanism driving this change is the intensifying overturning of the Southern Ocean, which might have contributed to the rise in atmospheric pCO_2 since 8 kyr.

For more information see the [NSF award page](#)

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

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1234664

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