Total dissolved nitrogen (TDN) and total dissolved phosphorus (TDP) of samples collected on the West Florida Shelf during STING I cruise AE2305 on R/V Atlantic Explorer from Feb 20 to Mar 05, 2023

Website: https://www.bco-dmo.org/dataset/986688
Data Type: Cruise Results
Version: 1
Version Date: 2025-11-20

Project
» Collaborative Research: Linking iron and nitrogen sources in an oligotrophic coastal margin: Nitrogen fixation and the role of boundary fluxes (Gulf of Mexico DON and Fe)

Contributors	Affiliation	Role
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Abstract
The West Florida Shelf (WFS) is oligotrophic, with inorganic N and P concentrations typically at or below detection limits, and yet significant rates of primary productivity, including blooms of the cyanobacterial diazotroph Trichodesmium spp. as well as the harmful algal species Karenia brevis, are observed there. Consequently, dissolved organic nitrogen (DON) and dissolved organic phosphorus (DOP) are thought to be the primary sources of assimilative nutrients on the WFS. Here we report measurements of total dissolved nitrogen (TDN) and total dissolved phosphorus (TDP) concentrations made on samples collected on a cross-shelf cruise in Feb-Mar 2023 aboard the R/V Atlantic Explorer. Elevated concentrations of TDN (>12 µM) and TDP (>0.5 µM) were observed in the shallow, nearshore region, while to the west concentrations of both TDN and TDP decreased to values typically associated with oligotrophic North Atlantic waters (4 to 5 µM TDN and 0.05 to 0.1 µM TDP).

Table of Contents

Coverage

Location: West Florida Shelf
Spatial Extent: **N**:28.497 **E**:-82.581 **S**:26.334 **W**:-86.574
Temporal Extent: 2023-02-20 - 2023-03-05

Methods & Sampling

Water column samples were collected in February and March 2023, on the West Florida Shelf during STING I cruise AE2305 on R/V Atlantic Explorer, using a trace metal clean rosette (SeaBird) outfitted with 12-L Niskin-X samplers (Ocean Test Equipment), a trace metal clean pump, or a custom surface pump “towfish” system

(Mellett and Buck, 2020). Seawater samples for macronutrient analysis were filtered through 0.2 µm Pall Acropak Super membrane filter capsules, collected into 60 mL HDPE bottles and frozen at -20 C until analysis on land.

TDP concentrations were measured using a Shimadzu UV-1800 and a Shimadzu UV-1900i. All reagents were prepared in dedicated labware with high purity Milli-Q (>18.2 MΩ cm) water. Samples were calibrated using a 6 point calibration curve with concentrations that bracketed sample concentrations. Each run included multiple Milli-Q water and reagent blanks, as well as three internal standards including adenosine triphosphate, a polyphosphate compound, glyphosate, a polyphosphonate compound, and 0.2 µm filtered oligotrophic surface water from the Gulf to check the consistency of the TDP concentration analysis over time.

TDN concentrations were measured using a Thermo 42i NOx analyzer and a Teledyne T200 NOx analyzer and were calibrated with standards that bracketed the concentration range of samples. Additionally, as an internal check on the completeness of the persulfate oxidation method, DON standards were included as “unknowns” in each set of persulfate oxidation, in this case USGS 40 (L-glutamic acid) and IAEA600 (caffeine).

The detection limit for TDN concentration analysis is 0.1 µM, and detection limit for TDP concentration analysis is 0.025 µM.

Data Processing Description

Data were flagged using the SeaDataNet quality flag scheme recommended by GEOTRACES (https://www.geotraces.org/geotraces-quality-flag-policy/) and described below. Notes specific to the application of these flags to this dataset are noted in brackets […].

0: No Quality Control: No quality control procedures have been applied to the data value. This is the initial status for all data values entering the working archive. [Not used].

1: Good Value: Good quality data value that is not part of any identified malfunction and has been verified as consistent with real phenomena during the quality control process.

2: Probably Good Value: Data value that is probably consistent with real phenomena, but this is unconfirmed or data value forming part of a malfunction that is considered too small to affect the overall quality of the data object of which it is a part. [Used when no replicate measurements were available to check the quality of the data].

3: Probably Bad Value: Data value recognized as unusual during quality control that forms part of a feature that is probably inconsistent with real phenomena. [Used when all replicate measurements were too high to be consistent with real phenomena].

4: Bad Value: An obviously erroneous data value. [Not used].

5: Changed Value: Data value adjusted during quality control. Best practice strongly recommends that the value before the change be preserved in the data or its accompanying metadata. [Not used].

6: Value Below Detection Limit: The level of the measured phenomenon was less than the limit of detection (LOD) for the method employed to measure it. The accompanying value is the detection limit for the technique or zero if that value is unknown. [Values below detection are reported as 0.00 µM in the data file. Detection limits for each parameter are listed in the “methods and sampling” section].

7: Value in Excess: The level of the measured phenomenon was too large to be quantified by the technique employed to measure it. The accompanying value is the measurement limit for the technique. [Not used].

8: Interpolated Value: This value has been derived by interpolation from other values in the data object. [Not used].

9: Missing Value: The data value is missing. Any accompanying value will be a magic number representing absent data [When sample was not collected the notation ‘na’ for ‘not applicable’ was used; when sample collected but there is no result for this parameter, the notation ‘NDA’ for ‘no data available’ was used].

A: Value Phenomenon Uncertain: There is uncertainty in the description of the measured phenomenon associated with the value such as chemical species or biological entity. [Not used.]

BCO-DMO Processing Description

- Imported "BCO-DMO_STING1_TDN_TDP_Conc_v2.xlsx" into the BCO-DMO system
- Reformatted date in 'DATE_UTC' and 'DATE_GMT' in ISO 8601 format, YYYY-MM-DD
- Exported file as "986688_v1_sting1_tdn_tdp.csv"

[table of contents | back to top]

Related Publications

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

Liang, Z., McCabe, K., Fawcett, S. E., Forrer, H. J., Hashihama, F., Jeandel, C., Marconi, D., Planquette, H., Saito, M. A., Sohm, J. A., Thomas, R. K., Letscher, R. T., & Knapp, A. N. (2022). A global ocean dissolved organic phosphorus concentration database (DOPv2021). Scientific Data, 9(1). https://doi.org/10.1038/s41597-022-01873-7
Methods

Mellett, T., & Buck, K. N. (2020). Spatial and temporal variability of trace metals (Fe, Cu, Mn, Zn, Co, Ni, Cd, Pb), iron and copper speciation, and electroactive Fe-binding humic substances in surface waters of the eastern Gulf of Mexico. Marine Chemistry, 227: 103891. doi:10.1016/j.marchem.2020.103891
Methods

[table of contents | back to top]

Related Datasets

IsRelatedTo

Buck, K. N., Parente, C. E., Caprara, S., Boiteau, R. M., Chappell, P. Dreux, Conway, T. M., Knapp, A. N., Smith, C., Tamborski, J. (2024) **Dissolved Macronutrient Concentrations from Depth Profiles and Incubation Experiments from STING I Cruise AE2305 on R/V Atlantic Explorer in the Gulf of Mexico from February to March 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-06-25 doi:10.26008/1912/bco-dmo.929305.1 [view at BCO-DMO]
Relationship Description: These data are part of the same cruise and project.

Chappell, P. Dreux, Confesor, K. (2024) **Chlorphyll a and pheophytin from two cruises performed as part of the STING project from R/V Atlantic Explorer AE2305 (Sting I cruise) and R/V Endeavor EN704 (Sting II cruise) in the Gulf of Mexico near Florida from February to July 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-05-28 doi:10.26008/1912/bco-dmo.928980.1 [view at BCO-DMO]
Relationship Description: These data are part of the same cruise and project.

Tamborski, J., Lindgren, A., Alorda-Kleinglass, A., Buck, K. N., Boiteau, R. M., Chappell, P. Dreux, Conway, T. M., Smith, C., Knapp, A. N. (2025) **Dissolved radium from STING I Cruise AE2305 on R/V Atlantic Explorer and STING II Cruise EN704 on R/V Endeavor and U.S. Geological Survey small boat surveys in the Gulf of Mexico from Feb to Jul 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-09-18 doi:10.26008/1912/bco-dmo.982223.1 [view at BCO-DMO]
Relationship Description: These data are part of the same cruise and project.

[table of contents | back to top]

Parameters

Parameter	Description	Units
CRUISE_ID	Sampling cruise	unitless
STING_ID	Unique number assigned to each sampling event in STING project	unitless
EVTNBR	Event number; ‘nda’ for ‘no data available’ or missing information; ‘na’ for ‘not applicable’ to that sample	unitless
ISO_DateTime_UTC	UTC datetime when sample was collected in ISO 8601 format	unitless
DATE_UTC	UTC date when sample was collected	unitless
TIME_UTC	UTC time when sample was collected; ‘nda’ for ‘no data available’ or missing information; ‘na’ for ‘not applicable’ to that sample	unitless
DATE_GMT	GMT date when sample was collected	unitless
TIME_GMT	GMT time when sample was collected; ‘nda’ for ‘no data available’ or missing information; ‘na’ for ‘not applicable’ to that sample.	unitless
LATITUDE	Position when sample was collected in decimal degrees; a positive value indicates a Northern coordinate; ‘nda’ for ‘no data available’ or missing information	degrees
LONGITUDE	Position when sample was collected in decimal degrees; a negative value indicates a Western coordinate; ‘nda’ for ‘no data available’ or missing information	degrees
PLATFORM	Sampling system used; TMC CTD = trace metal CTD rosette; FISH = tow fish; TM PUMP = trace metal pump; INC = incubation	unitless
CASTNBR	Cast number	unitless
STNNBR	Station number for cruises; ‘na’ for ‘not applicable’ to that sample	unitless
BTLNBR	CTD rosette bottle number; ‘na’ for ‘not applicable’ to that sample	unitless
DEPTH	Sample collection depth below sea surface; ‘nda’ for ‘no data available’ or missing information; ‘na’ for ‘not applicable’ to that sample	meters (m)
TDP	Concentrations of total dissolved phosphorus	micromoles per liter (μM)

TDP_STDEV	Standard deviation of replication total dissolved phosphorus measurements. If only 2 replicates, the difference about the mean was used to calculate error	micromoles per liter (µM)
TDP_COUNT	Number of TDP analytical replicates performed	replicate
TDP_FLAG	Quality flag for TDP measurements. See the Data Processing Description" section of the BCO-DMO metadata page for this dataset for full data quality flag details"	unitless
TDN	Concentrations of total dissolved nitrogen	micromoles per liter (µM)
TDN_STDEV	Standard deviation of replication total dissolved nitrogen measurements. If only 2 replicates, the difference about the mean was used to calculate error	micromoles per liter (µM)
TDN_COUNT	Number of TDN analytical replicates performed	unitless
TDN_FLAG	Quality flag for TDN measurements. See the Data Processing Description" section of the BCO-DMO metadata page for this dataset for full data quality flag details"	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Thermo 42i NOx analyzer
Generic Instrument Name	Chemiluminescence NOx Analyzer
Dataset-specific Description	TDN concentrations were measured using a Thermo 42i NOx analyzer and a Teledyne T200 NOx analyzer and were calibrated with standards that bracketed the concentration range of samples.
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	Teledyne T200 NOx analyzer
Generic Instrument Name	Chemiluminescence NOx Analyzer
Dataset-specific Description	TDN concentrations were measured using a Thermo 42i NOx analyzer and a Teledyne T200 NOx analyzer and were calibrated with standards that bracketed the concentration range of samples.
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	trace metal clean rosette (SeaBird)
Generic Instrument Name	CTD - profiler
Dataset-specific Description	Water column samples were collected in February and March 2023 aboard the R/V Atlantic Explorer using a trace metal clean rosette (SeaBird) outfitted with 12-L Niskin-X samplers (Ocean Test Equipment), a trace metal clean pump, or a custom surface pump “towfish” system (Mellett and Buck, 2020).
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	Trace metal clean pump
Generic Instrument Name	Pump
Dataset-specific Description	Water column samples were collected in February and March 2023 aboard the R/V Atlantic Explorer using a trace metal clean rosette (SeaBird) outfitted with 12-L Niskin-X samplers (Ocean Test Equipment), a trace metal clean pump, or a custom surface pump “towfish” system (Mellett and Buck, 2020).
Generic Instrument Description	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

Dataset-specific Instrument Name	Custom surface pump “towfish” system
Generic Instrument Name	Pump surface
Dataset-specific Description	Water column samples were collected in February and March 2023 aboard the R/V Atlantic Explorer using a trace metal clean rosette (SeaBird) outfitted with 12-L Niskin-X samplers (Ocean Test Equipment), a trace metal clean pump, or a custom surface pump “towfish” system (Mellett and Buck, 2020).
Generic Instrument Description	A source of uncontaminated near-surface seawater pumped onto the deck of the research vessel that can be sampled and analyzed. This pumped seawater supply is from an over-the-side pumping system, and is therefore different from the vessel underway seawater system.

Dataset-specific Instrument Name	2-L Niskin-X samplers
Generic Instrument Name	Trace Metal Bottle
Dataset-specific Description	Water column samples were collected in February and March 2023 aboard the R/V Atlantic Explorer using a trace metal clean rosette (SeaBird) outfitted with 12-L Niskin-X samplers (Ocean Test Equipment), a trace metal clean pump, or a custom surface pump “towfish” system (Mellett and Buck, 2020).
Generic Instrument Description	Trace metal (TM) clean rosette bottle used for collecting trace metal clean seawater samples.

Dataset-specific Instrument Name	Shimadzu UV-1800
Generic Instrument Name	UV Spectrophotometer-Shimadzu
Dataset-specific Description	TDP concentrations were measured using a Shimadzu UV-1800 and a Shimadzu UV-1900i.
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.

Dataset-specific Instrument Name	Shimadzu UV-1900i
Generic Instrument Name	UV Spectrophotometer-Shimadzu
Dataset-specific Description	TDP concentrations were measured using a Shimadzu UV-1800 and a Shimadzu UV-1900i.
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.

[table of contents | back to top]

Deployments

AE2305

Website	https://www.bco-dmo.org/deployment/929020
Platform	R/V Atlantic Explorer
Start Date	2023-02-18
End Date	2023-03-07
Description	Start and End port: St. Petersburg, Florida

[table of contents | back to top]

Project Information

Collaborative Research: Linking iron and nitrogen sources in an oligotrophic coastal margin: Nitrogen fixation and the role of boundary fluxes (Gulf of Mexico DON and Fe)

Coverage: Gulf of Mexico, West Florida Shelf

NSF Award Abstract:
This project will investigate how groundwater discharge delivers important nutrients to the coastal ecosystems of the West Florida Shelf. Preliminary studies indicate that groundwater may supply both dissolved organic nitrogen (DON) and iron in this region. In coastal ecosystems like the West Florida Shelf that have very low nitrate and ammonium concentrations, DON is the main form of nitrogen available to organisms. Nitrogen cycling is strongly affected by iron availability because iron is essential for both photosynthesis and for nitrogen fixation. This study will investigate the sources and composition of DON and iron, and their influence on the coastal ecosystem. The team will sample offshore groundwater wells, river and estuarine waters, and conduct two expeditions across the West Florida Shelf in winter and summer. Investigators will participate in K-12 and outreach activities to increase awareness of the project and related science. The project will fund the work of six graduate and eight undergraduate students across five institutions, furthering NSF's goals of education and training.

Motivated by preliminary observations of unexplained, tightly-correlated DON and dissolved iron concentrations across the West Florida Shelf (WFS), the proposed work will quantify the flux and isotopic signatures of submarine groundwater discharge (SGD)-derived DON and iron to the WFS, and evaluate the bioavailability of this temporally-variable source using four seasonal near-shore campaigns sampling offshore groundwater wells, estuarine, and riverine endmembers and two cross-shelf cruises. The work will evaluate whether SGD

stimulates nitrogen fixation on the WFS, and the potential for the stimulated nitrogen fixation to further modify the chemistry of DON and dissolved iron in the region. The cross-shelf cruises will investigate hypothesized periods of maximum SGD and Trichodesmium abundance (June), and reduced river discharge and SGD (February), thus comparing two distinct biogeochemical regimes. The concentrations and isotopic compositions of DON and dissolved iron, molecular composition of DON, and the concentration and composition of iron-binding ligands will be characterized. Nitrogen fixation rates and Trichodesmium spp. abundance and expression of iron stress genes will be measured. Fluxes of DON and iron from SGD and rivers will be quantified with radium isotope mass balances. The impacts of SGD on nitrogen fixation and DON/ligand production will be constrained with incubations of natural phytoplankton communities with submarine groundwater amendments. Two hypotheses will be tested: 1) SGD is the dominant source of bioavailable DON and dissolved iron on the WFS, and 2) SGD-alleviation of iron stress changes the dominant Trichodesmium species on the WFS, increases nitrogen fixation rates and modifies DON and iron composition. Overall, the work will establish connections between marine nitrogen and iron cycling and evaluate the potential for coastal inputs to modify water along the WFS before export to the Atlantic Ocean. This study will thus provide a framework to consider these boundary fluxes in oligotrophic coastal systems and the relative importance of rivers and SGD as sources of nitrogen and iron in other analogous locations, such as coastal systems in Australia, India, and Africa, where nitrogen fixation and SGD have also been documented.

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2148989
NSF Division of Ocean Sciences (NSF OCE)	OCE-2506248

[table of contents | back to top]