

Supplementary discrete sample measurements of dissolved inorganic carbon and total alkalinity from Ocean Observatories Initiative (OOI) cruises to the Irminger Sea Array 2024 (AR84-01) and 2025 (RR2505)

Website: <https://www.bco-dmo.org/dataset/1009070>

Data Type: Cruise Results

Version: 1

Version Date: 2026-10-06

Project

» [CAREER: Constraining the high-latitude ocean carbon cycle: Leveraging the Ocean Observatories Initiative \(OOI\) Global Arrays as marine biogeochemical time series](#) (OOI Global BGC time series)

Contributors	Affiliation	Role
Palevsky, Hilary I.	Boston College (BC)	Principal Investigator
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Abstract

This dataset contains discrete sample measurements of dissolved inorganic carbon (DIC) and total alkalinity (TA) collected during the June 2024 and July 2025 Ocean Observatories Initiative (OOI) turn-around cruise to maintain the Irminger Sea Array (60.46°N, 38.44°W). Samples in this dataset were collected as part of an ancillary research project that joined the OOI turn-around cruise as part of ongoing efforts to enable OOI biogeochemical sensor data to be used to address scientific questions about ocean carbon cycling and the biological carbon pump. Discrete sample data collected and analyzed by this research team complement data collected by the OOI program as part of routine turn-around cruise activities. We provide the discrete DIC and TA sample measurements alongside temperature and bottle-calibrated salinity and oxygen values from the depths where Niskin bottles were closed for water sample collection.

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Coverage

Location: Irminger Sea (60.46°N, 38.44°W)

Spatial Extent: N:59.97639 E:-38.60874 S:59.65724 W:-41.1177

Temporal Extent: 2024-06-11 - 2025-08-03

Methods & Sampling

The Ocean Observatories Initiative (OOI) is a long-term NSF-funded program that deploys autonomous sensors on both moored and mobile platforms at multiple locations, including the Global Irminger Sea Array (60.46°N, 38.44°W) (Trowbridge et al., 2019). The OOI program conducts yearly turn-around cruises to the Irminger Sea Array to recover and redeploy moorings and gliders deployed year-round at this site. During these cruises the OOI program routinely conducts Conductivity Temperature Depth (CTD) casts and collects water samples from Niskin bottles on the CTD rosette for discrete sample analysis. These turn-around cruise data are critical for validation and calibration of the data from sensors deployed year-round and also provide a valuable dataset in and of themselves (Palevsky et al., 2023).

For this project, our team participated in the 2024 and 2025 turn-around cruises to the OOI Irminger Sea Array (AR84-01, RV Neil Armstrong and RR2505, R/V Roger Revelle). We collected supplementary additional samples for DIC and TA from CTD casts to further support efforts to improve the capacity to produce high-quality data products from OOI's biogeochemical sensors to enable analysis of scientific questions about the ocean's biological carbon pump and other carbon cycling processes (Yoder et al., 2024; Palevsky et al., 2023). Sampling was targeted to add full-depth profiles and increase depth resolution beyond the validation samples routinely collected by the OOI program.

Samples were collected for dissolved inorganic carbon (DIC) and total alkalinity (TA) analysis following standard protocols (Dickson et al., 2007). Samples were collected into 250 mL borosilicate glass bottles and preserved with saturated mercuric chloride (100 µL) for later analysis. For further sample and data processing details, please see the Data Processing section of this metadata landing page.

These supplemental data provided here were collected in coordination with data collected by the OOI program. The complete collection of shipboard data and cruise documentation from these cruises is available on the OOI managed document storage, the OOI Raw Data Repository (https://rawdata.oceanobservatories.org/files/cruise_data/Irminger_Sea/). The discrete water sampling data collected by the OOI program at the Irminger Sea Array is also available from BCO-DMO (see Related Datasets). For more information on recommendations for use of cruise data to calibrate OOI biogeochemical sensors, see the OOI Biogeochemical Sensor Data Best Practices and User Guide (Palevsky et al., 2023).

Full cruise data from the OOI Irminger Sea cruises for which discrete sample data are presented here can be accessed via the Rolling Deck to Repository (R2R).

Data Processing Description

Samples were analyzed at the Boston College Marine Biogeochemistry Laboratory. DIC was analyzed using an Apollo SciTech AS-C6L DIC Analyzer and TA was analyzed using an Apollo SciTech AS-ALK2 TA Analyzer. Both DIC and TA were measured from the same sample bottle. All DIC measurements were made on the day the bottle was opened for analysis, and TA measurements were made within the same week. DIC and TA instruments were calibrated daily and monitored throughout each analysis session by measuring Certified Reference Materials (CRMs) (Andrew Dickson, UCSD).

Analytical replicates were measured for all samples such that after analytical outliers (> 1 standard deviation) were removed, all samples for both DIC and TA retained at least two replicate measurements (median number of replicates for DIC = 3 in both years; median number of replicates for TA = 3 in 2024 and median number of replicates for TA = 4 in 2025). Analytical precision was determined for each sample as the standard deviation of analytical replicates. Mean analytical precision for all DIC samples in this dataset, consistent across samples from both the 2024 and 2025 cruises, is 0.5 µmol/kg. For TA, mean analytical precision is 0.9 µmol/kg for samples from the 2024 cruise and 1.1 µmol/kg for samples from the 2025 cruise. Individual samples are flagged as questionable (QC flag = 3) if the analytical precision is >3 µmol/kg. Individual samples for DIC are also flagged as questionable (QC flag = 3) if CRMs run prior and subsequent to the sample in question differ by >6 µmol/kg.

BCO-DMO Curation Notes

Curation Actions Performed to the Data Files of this Dataset:

- Loaded the original data files (AR84-01_Discrete_Bottle_Samples.csv and RR2505_Discrete_Bottle_Samples.csv), using filenames as resource names, with header row 2, skip row 3, treating "" and "nd" as missing values.
- Concatenated both injected files into single table named 1009070_v1_irminger_dic_ta_and_do_bottle_data in order to publish data from these two separate cruises in one tabular file.
- Converted date column (format %d-%b-%Y %H:%M:%S, UTC) into new ISO_DateTime.UTC datetime column (output format %Y-%m-%dT%H:%M:%SZ, UTC).
- Updated column metadata with BCO-DMO standard names, units, descriptions, and flagged lat, lon, and ISO_DateTime.UTC as primary parameters
- Saved the resulting file as 1009070_v1_irminger_dic_ta_and_do_bottle_data.csv, which is the primary datafile of this dataset.

Problem Description

Quality flags

WOCE quality flags for CTD pressure, temperature and salinity are carried over from corresponding calibrated bottle files.

WOCE quality flags:

- 1 = Not calibrated with water samples
- 2 = Acceptable measurement
- 3 = Questionable measurement
- 4 = Bad measurement
- 9 = Not sampled

Quality flags for DIC, TA and oxygen values follow the recommendations of Jiang et al. 2022. Quality flags for oxygen are carried over from corresponding calibrated bottle files.

Jiang et al. 2022 quality flags:

- 1 = not evaluated/quality unknown
- 2 = acceptable
- 3 = questionable
- 4 = known bad
- 6 = median of replicates
- 9 = Missing value

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Data Files

File	
1009070_v1_irminger_dic_ta_and_do_bottle_data.csv	(Comma Separated Values (.csv), 30.90 KB) MD5:02cdf924285f7e1a8ade2738d1f7db4d
Primary data file for dataset ID 1009070, version 1	
This file contains the discrete DIC and TA sample measurements alongside temperature and bottle-calibrated salinity and oxygen values from the depths where Niskin bottles were closed for water sample collection during cruises AR84-01 in 2024 and RR2505 in 2025.	

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Related Publications

Dickson, A. G., & et. al. (2007). Guide to best practices for ocean CO₂ measurement. North Pacific Marine Science Organization. <https://doi.org/10.25607/OBP-1342>
Methods

Jiang, L.Q., Pierrot, D., Wanninkhof, R., Feely, R. A., Tilbrook, B., Alin, S., Barbero, L., Byrne, R. H., Carter, B. R., Dickson, A. G., Gattuso, J.P., Greeley, D., Hoppema, M., Humphreys, M. P., Karstensen, J., Lange, N., Lauvset, S. K., Lewis, E. R., Olsen, A., et al. (2022). Best Practice Data Standards for Discrete Chemical Oceanographic Observations. *Frontiers in Marine Science*, 8. <https://doi.org/10.3389/fmars.2021.705638>
Methods

Palevsky, H., Clayton, S., Atamanchuk, D., Battisti, R., Batryn, J., Bourbonnais, A., Briggs, E. M., Carvalho, F., Chase, A. P., Eveleth, R., Fatland, R., Fogaren, K. E., Fram, J. P., Hartman, S. E., Le Bras, I., Manning, C. C. M., Needoba, J. A., Neely, M. B., Oliver, H., Wingard, C. (2023). OOI Biogeochemical Sensor Data Best Practices and User Guide. Version 1.1.1. [GOOS ENDORSED PRACTICE]. Ocean Observatories Initiative, Biogeochemical Sensor Data Working Group. <https://doi.org/10.25607/OBP-1865.2>
Methods

Palevsky, H., Clayton, S., Atamanchuk, D., Battisti, R., Batryn, J., Bourbonnais, A., Briggs, E. M., Carvalho, F., Chase, A. P., Eveleth, R., Fatland, R., Fogaren, K. E., Fram, J. P., Hartman, S. E., Le Bras, I., Manning, C. C. M., Needoba, J. A., Neely, M. B., Oliver, H., Wingard, C. (2023). OOI Biogeochemical Sensor Data Best Practices and User Guide. Version 1.1.1. [GOOS ENDORSED PRACTICE]. Ocean Observatories Initiative, Biogeochemical Sensor Data Working Group. <https://doi.org/10.25607/OBP-1865.2>
<https://doi.org/https://doi.org/10.1029/2024JC021027>
Methods

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Related Datasets

IsSupplementTo

NSF Ocean Observatories Initiative (2025) **OOI Global Irminger Sea Array CTD and Discrete Water Sampling Data from Mooring Overturning Cruises in the Irminger Sea from 2014-2023 (OOI Cruise Data project)**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-10-24 doi:10.26008/1912/bco-dmo.911407.1 [[view at BCO-DMO](#)]
Relationship Description: Additional discrete water sample data from the same time series site

IsRelatedTo

Palevsky, H. I., Fogaren, K. E., Nicholson, D. P., Yoder, M. (2023) **Supplementary discrete sample measurements of dissolved oxygen, dissolved inorganic carbon, and total alkalinity from Ocean Observatories Initiative (OOI) cruises to the Irminger Sea Array 2018-2019**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-07-19 doi:10.26008/1912/bco-dmo.904722.1 [[view at BCO-DMO](#)]
Relationship Description: Discrete DIC, TA, and dissolved oxygen samples from previous cruises to the same time series site.

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Parameters

Parameter	Description	Units
cruise	Cruise identification	n.a.
ISO_DateTime_UTC	Date time (UTC)	n.a.

lat	Latitude	degree
lon	Longitude	degree
cast	Cast number	n.a.
NiskinID	Unique Niskin bottle number from the CTD rosette	n.a.
CTDPRES	Hydrostatic pressure recorded from CTD at the depth where the sample was taken	dbar
CTDPRES_flag	WOCE quality control flag for CTDPRES. WOCE quality flags: 1 = Not calibrated with water samples, 2 = Acceptable measurement, 3 = Questionable measurement, 4 = Bad measurement, 9 = Not sampled	n.a.
CTDTEMP_ITS90	In situ temperature recorded from CTD on the ITS-90 scale	degrees C
CTDTEMP_flag	WOCE quality control flag for CTDTEMP. WOCE quality flags: 1 = Not calibrated with water samples, 2 = Acceptable measurement, 3 = Questionable measurement, 4 = Bad measurement, 9 = Not sampled	n.a.
CTDSAL_PSS78	Calibrated salinity (Practical Salinity Scale of 1978) calculated from conductivity recorded with CTD	unitless
CTDSAL_flag	WOCE quality control flag for CTDSAL PSS78. WOCE quality flags: 1 = Not calibrated with water samples, 2 = Acceptable measurement, 3 = Questionable measurement, 4 = Bad measurement, 9 = Not sampled	n.a.
CTDOXY	Calibrated dissolved oxygen content from oxygen sensor mounted on the CTD	umol/kg
CTDOXY_flag	Jiang et al. 2022 quality flag for CTDOXY. Jiang et al. 2022 quality flags: 1 = not evaluated/quality unknown, 2 = acceptable, 3 = questionable, 4 = known bad, 6 = median of replicates, 9 = Missing value	n.a.
Oxygen1	Dissolved oxygen content measured from discrete-bottle-based Winkler titration	umol/kg

Oxygen1_flag	Jiang et al. 2022 quality flag for Oxygen1: Jiang et al. 2022 quality flags: 1 = not evaluated/quality unknown, 2 = acceptable, 3 = questionable, 4 = known bad, 6 = median of replicates, 9 = Missing value	n.a.
Oxygen2	Dissolved oxygen content measured from discrete-bottle-based Winkler titration	umol/kg
Oxygen2_flag	Jiang et al. 2022 quality flag for Oxygen2. Jiang et al. 2022 quality flags: 1 = not evaluated/quality unknown, 2 = acceptable, 3 = questionable, 4 = known bad, 6 = median of replicates, 9 = Missing value	n.a.
DIC	Total dissolved inorganic carbon content	umol/kg
DIC_flag	Jiang et al. 2022 quality flag for DIC. Jiang et al. 2022 quality flags: 1 = not evaluated/quality unknown, 2 = acceptable, 3 = questionable, 4 = known bad, 6 = median of replicates, 9 = Missing value	n.a.
TA	Total alkalinity content	umol/kg
TA_flag	Jiang et al. 2022 quality flag for TA. Jiang et al. 2022 quality flags: 1 = not evaluated/quality unknown, 2 = acceptable, 3 = questionable, 4 = known bad, 6 = median of replicates, 9 = Missing value	n.a.

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Instruments

Dataset-specific Instrument Name	Apollo SciTech AS-ALK2 TA Analyzer
Generic Instrument Name	Apollo SciTech AS-ALK2 total alkalinity titrator
Dataset-specific Description	Samples were analyzed at the Boston College Marine Biogeochemistry Laboratory. DIC was analyzed using an Apollo SciTech AS-C6L DIC Analyzer and TA was analyzed using an Apollo SciTech AS-ALK2 TA Analyzer. Both DIC and TA were measured from the same sample bottle. All DIC measurements were made on the day the bottle was opened for analysis, and TA measurements were made within the same week. DIC and TA instruments were calibrated daily and monitored throughout each analysis session by measuring Certified Reference Materials (CRMs) (Andrew Dickson, UCSD).
Generic Instrument Description	An automated acid-base titrator for use in aquatic carbon dioxide parameter analysis. The titrator provides standardisation and sample analysis, using the Gran titration procedure for alkalinity determination of seawater and brackish waters. It is designed for both shipboard and land based laboratory use. The precision of the instrument is 0.1 percent or higher, and sample volumes may range from 10-25 ml. Titration takes approximately 8 minutes per sample, and the repeatability is within plus or minus 1-2 micromoles per kg.

Dataset-specific Instrument Name	Apollo SciTech AS-C6L DIC Analyzer
Generic Instrument Name	Apollo SciTech AS-C5 dissolved inorganic carbon analyzer
Dataset-specific Description	Samples were analyzed at the Boston College Marine Biogeochemistry Laboratory. DIC was analyzed using an Apollo SciTech AS-C6L DIC Analyzer and TA was analyzed using an Apollo SciTech AS-ALK2 TA Analyzer. Both DIC and TA were measured from the same sample bottle. All DIC measurements were made on the day the bottle was opened for analysis, and TA measurements were made within the same week. DIC and TA instruments were calibrated daily and monitored throughout each analysis session by measuring Certified Reference Materials (CRMs) (Andrew Dickson, UCSD).
Generic Instrument Description	The Apollo SciTech AS-C5 is a compact, automated analyzer for measuring dissolved inorganic carbon (DIC) in fresh and saltwater. This DIC analyzer uses small sample volumes (0.1 to 1.8 mL) with fast analytical rate (~3 mins), making it ideal for both lab and shipboard use in oceanography and climate studies. The AS-C5 DIC analyzer is comprised of a solid state infrared CO2 detector (LI-850, by LI-COR, USA), a digital syringe pump for precise delivery of reagent and sample solutions (Kloehn, USA), a mass flow controller to accurately regulate the carrier gas flow rate, a specifically designed CO2 stripping reactor that allows for an efficient and smooth stripping of CO2 from the water sample, an electronic cooling system for removing moisture, and a computer communication assembly to understand the marine carbon cycle. The AS-C5 DIC analyzer has a very large analytical range (0.2 – 20 mM) and therefore is ideal for DIC analysis (and has been tested) in a variety of aquatic conditions such as in river and lake waters, coastal and open ocean waters, sediment porewater, and groundwater. The sample's salt and hydrogen sulfide (H2S) contents have had no effect on DIC analyses.

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Deployments

AR84-01

Website	https://www.bco-dmo.org/deployment/1009059
Platform	R/V Neil Armstrong
Start Date	2024-06-02
End Date	2024-07-02

RR2505

Website	https://www.bco-dmo.org/deployment/1009061
Platform	R/V Roger Revelle
Start Date	2025-07-18
End Date	2025-08-07

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Project Information

CAREER: Constraining the high-latitude ocean carbon cycle: Leveraging the Ocean Observatories Initiative (OOI) Global Arrays as marine biogeochemical time series (OOI Global BGC time series)

NSF Award Abstract:

The ocean absorbs a large fraction of the atmospheric carbon dioxide generated by the burning of fossil fuels. Much of this uptake occurs in high latitude (polar) regions of the ocean. However, current monitoring capabilities in the polar ocean are limited. The Ocean Observatories Initiative (OOI) aims to address this need by providing 25 years of continuous physical and biogeochemical sensor data from autonomous platforms in the high latitude ocean. This CAREER project will improve understanding of the marine carbon cycle in the high latitude ocean using OOI data. The science team will use biogeochemical data collected by the OOI sensors to monitor long term changes in carbon cycling processes. In addition, this CAREER project includes educational activities to broaden participation in oceanographic research. The lead scientist will develop a new research seminar course to provide training and research opportunities for undergraduate students. A series of educational videos will be created to showcase the use and application of OOI data. The videos will be used in college level courses at three universities. This project will provide training opportunities for eight undergraduate students, two doctoral students, and one postdoctoral researcher.

This CAREER project will utilize marine biogeochemical time series data from Ocean Observatories Initiative (OOI) locations in the subpolar North Atlantic and subarctic Northeast Pacific to evaluate the relative roles of biological, chemical, and physical processes driving the ocean's carbon sink. The project seeks to improve the usability of OOI biogeochemical (BGC) sensor data and leverage these marine BGC time series data to determine changes in carbon cycling processes in the subpolar North Atlantic and subarctic Northeast Pacific Oceans. This research is key for predicting long term perturbations due to climate change and for understanding how changes in carbon cycling in these regions will influence carbon sequestration. The objectives of this project are to: 1) quantify the rates and drivers of carbon cycling and long-term carbon sequestration in the subpolar North Atlantic and subarctic Northeast Pacific Oceans and 2) determine the mechanistic controls on the ocean carbon sink due to inter-related biological, chemical, and physical processes over >10 years at each array site. The high temporal resolution BGC data collected by the arrays will improve understanding of the sampling resolution needed to capture key carbon cycling processes and test the hypothesis that short-time scale events during spring phytoplankton blooms and strong winter storms play a significant role in the overall annual carbon cycle. Education activities associated with this CAREER project include a series of educational videos about OOI and use of the data it provides that will be incorporated into undergraduate courses, a new research seminar course for undergraduates, and research opportunities for undergraduate and graduate students as well as a postdoctoral researcher.

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-2338450

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