Noble gas concentrations from water samples collected in August and September 2016 during R/V Neil Armstrong cruise AR7-02 as part of the Overturning in the Subpolar North Atlantic Project (O-SNAP)

Website: https://www.bco-dmo.org/dataset/913904
Data Type: Cruise Results
Version: 1
Version Date: 2023-10-24

Project
» Tracking Greenland Melt in the Ocean Using Noble Gas Fingerprints (Greenland Melt Noble Gases)

Contributors	Affiliation	Role
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Abstract
This noble gas dataset was collected around Southern Greenland in August and September of 2016 aboard the R/V Neil Armstrong as part of the Overturning in the Subpolar North Atlantic Project (O-SNAP). Parameters include the concentrations of Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), along with the co-located temperature, salinity, and pressure data from the CTD at the sample collection point. During the cruise, 391 noble gas water samples were collected, of which funding was available for 86 to be analyzed at Woods Hole Oceanographic Institution's Isotope Geochemistry Facility. Those processed samples are archived in this dataset. The 86 analyzed noble gas samples are concentrated along five sections across the shelfbreak on the east and west sides of Cape Farewell in southern Greenland. Noble gas samples were acquired from 10-liter Niskin bottles using gravity feed-through TYGON tubing to fill lengths of 5/8" copper refrigeration tubing (trapping ~45 grams water in replicate pairs), then each was hydraulically crimp sealed.

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Coverage

Spatial Extent: **N**:61.2882 **E**:-41.4207 **S**:59.39 **W**:-48.5147
Temporal Extent: 2016-08-08 - 2016-09-01

Methods & Sampling

At each station, conductivity-temperature-depth (CTD) casts were made with a SeaBird 911Plus equipped with additional sensors measuring oxygen, beam transmission, fluorescence, and turbidity. Sensors were calibrated by the manufacturer before and after the cruise. The conductivity sensors were further calibrated using water sample salinity measurements. A rosette with twelve 10-liter Niskin bottles was deployed with the CTD to collect water samples. Noble gas samples were acquired from the Niskin bottles using gravity feed-through TYGON tubing to fill lengths of 5/8" copper refrigeration tubing (trapping ~45 grams water in replicate pairs), then each was crimp sealed using a hydraulic press.

The extracted gases are purified, separated, and measured mass spectrometrically using a third-generation, WHOI-constructed, statically operated, helium isotope mass spectrometer of branch tube design for fully simultaneous collection of 3He and 4He with improved ion optics. It employs a high-emission Nier-type ion source. The 4He branch has a Faraday Cup detector with a low-noise FET-input electrometer and precision high-frequency VFC for digital signal integration. The 3He branch uses a Galileo Channeltron operating in pulse counting mode, with high-speed preamplifier and discriminator electronics. The fully automated sample processing line is optimized for processing extracted water samples, and combines a three-stage cryogenics system (Stanley 2009) with a Pd-catalyst and dual SAES-707 getters for the removal of water vapor, the purification of reactive gases, and the quantitatively reproducible separation of the 5 noble gases (He, Ne, Ar, Kr, and Xe). Helium isotopes (3He, 4He) are measured using the magnetic sector dual-collecting mass spectrometer to a reproducibility of 0.1%, and the other noble gases using a quadrupole mass spectrometer (QMS) with a triple mass filter and an electron multiplier operated in pulse counting mode. The lighter noble gases (He, Ne, and Ar) are determined using peak-height manometry while the heavier noble gases (Kr and Xe) are measured using a newly developed, modified ratiometric multi-isotope dilution method. The system achieves reproducibility of gas standards of 0.1% for He, Ne, Ar, Kr, and Xe.

BCO-DMO Processing Description

- Imported original file "osnap2016_noble_gases.csv" into the BCO-DMO system.
- Converted the date/time field to ISO8601 format.
- Renamed fields to comply with BCO-DMO naming conventions.
- Converted the "bottle" column to integer format.
- Rounded He3_sat_anomaly column to 3 decimal places.
- Saved the final file as "913904_v1_osnap_noble_gases_2016.csv".

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Data Files

File
913904_v1_osnap_noble_gases_2016.csv (Comma Separated Values (.csv), 14.33 KB) MD5:f93056c67e8cc83f0942ffa014016e20 Primary data file for dataset ID 913904, version 1.

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Related Publications

Beaird, N., Straneo, F., Le Bras, I., Pickart, R., & Jenkins, W. (in revision JGR Oceans). Glacial Meltwater in the Current System of Southern Greenland.
Results

Jenkins, W. J., Lott, D. E., & Cahill, K. L. (2019). A determination of atmospheric helium, neon, argon, krypton, and xenon solubility concentrations in water and seawater. Marine Chemistry, 211(1), 94–107. doi:10.1016/j.marchem.2019.03.007
Methods

Jenkins, W. J., Lott, D. E., German, C. R., Cahill, K. L., Goudreau, J., & Longworth, B. (2018). The deep distributions of helium isotopes, radiocarbon, and noble gases along the U.S. GEOTRACES East Pacific Zonal Transect (GP16). Marine Chemistry, 201, 167–182. doi:10.1016/j.marchem.2017.03.009
Methods

Stanley, R. H. R., Baschek, B., Lott, D. E., & Jenkins, W. J. (2009). A new automated method for measuring noble gases and their isotopic ratios in water samples. Geochemistry, Geophysics, Geosystems, 10(5), n/a–n/a. doi:10.1029/2009GC002429
Methods

Young, C. and J. E. Lupton (1983). "An ultratight fluid sampling system using cold-welded copper tubing." EOS Transactions AGU 64: 735.
Methods

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Parameters

Parameter	Description	Units
station	station number	unitless
lat	latitude of sample collection; positive values = North	decimal degrees
lon	longitude of sample collection; negative values = West	decimal degrees
ISO_DateTime_UTC	date and time (UTC) of sample collection in ISO 8601 format	unitless
bottle	bottle number	unitless
pressure	pressure	decibars (dbar)
temperature	temperature	degrees Celsius
salinity	salinity	PSU
He3_sat_anomaly	Helium-3 saturation anomoly	percent (%)
Helium_concentration	Helium concentration	moles per kilogram (mol/kg)
Neon_concentration	Neon concentration	moles per kilogram (mol/kg)
Argon_concentration	Argon concentration	moles per kilogram (mol/kg)
Krypton_concentration	Krypton concentration	moles per kilogram (mol/kg)
Xenon_concentration	Xenon concentration	moles per kilogram (mol/kg)

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Instruments

Dataset-specific Instrument Name	SeaBird 911Plus
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	At each station, conductivity-temperature-depth (CTD) casts were made with a SeaBird 911Plus equipped with additional sensors measuring oxygen, beam transmission, fluorescence, and turbidity. Sensors were calibrated by the manufacturer before and after the cruise. The conductivity sensors were further calibrated using water sample salinity measurements. A rosette with twelve 10-liter Niskin bottles was deployed with the CTD to collect water samples.
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Faraday Cup detector
Generic Instrument Name	Faraday cup
Generic Instrument Description	A Faraday cup is a metal (conductive) cup designed to catch charged particles in a vacuum. The resulting current can be measured and used to determine the number of ions or electrons hitting the cup.

Dataset-specific Instrument Name	helium isotope mass spectrometer
Generic Instrument Name	Mass Spectrometer
Dataset-specific Description	Description obtained from the Woods Hole Oceanographic Institution (WHOI) Isotope Geochemistry Facility website (https://www2.whoi.edu/site/igffacility/): Our helium isotope and tritium measurement mass spectrometer system (MS1) was first designed and built in 1975, and has evolved, grown, and been modernized over the years. It is fully automated and runs 24/7. Cryogenic traps are used to transfer and purify Helium (He) and Neon (Ne). The magnetic sector mass spectrometer analyzes the helium isotopes, while the QMS previews samples and measures He and Ne. The automanifold allows the "mounting" of up to 32 samples for measurement and unattended operation.
Generic Instrument Description	General term for instruments used to measure the mass-to-charge ratio of ions; generally used to find the composition of a sample by generating a mass spectrum representing the masses of sample components.

Dataset-specific Instrument Name	Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	A rosette with twelve 10-liter Niskin bottles was deployed with the CTD to collect water samples.
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	quadrupole mass spectrometer (QMS)
Generic Instrument Name	Quadrupole Mass Spectrometer
Generic Instrument Description	A piece of apparatus that consists of an ion source, a mass-to-charge analyser, a detector and a vacuum system and is used to measure mass spectra. The detector is a quadrupole mass-to-charge analyser, which holds the ions in a stable orbit by an electric field generated by four parallel electrodes.

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Deployments

AR7-02

Website	https://www.bco-dmo.org/deployment/913911
Platform	R/V Neil Armstrong
Start Date	2016-08-03
End Date	2016-09-08
Description	See more information from R2R at https://www.rvdata.us/search/cruise/AR7-02 and on the project website at https://www.o-snap.org/

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Project Information

Tracking Greenland Melt in the Ocean Using Noble Gas Fingerprints (Greenland Melt Noble Gases)

Coverage: Sermilik Fjord, East Greenland

NSF Award Abstract:
Rapid land-ice loss from the Greenland Ice Sheet is resulting in increased fresh water discharge into the ocean.

One consequence is a rise in global sea level. Another consequence, that has attracted less attention, is the freshening of ocean waters at Greenland's coastal margins. Locally, this impacts sea-ice formation, air-sea exchange, the marine ecosystems and local communities. On larger scales, it can impact dense water formation and hence the global circulation. Beyond bulk estimates based on ice sheet-wide assessments, however, the limited knowledge of where, when and how fresh water enters the ocean makes it difficult to assess its present and future impact. One consequence of this uncertainty is the large discrepancy in the formulation of the fresh water forcing used in model studies to investigate the oceanic impact of Greenland melt. Greenland's fresh water discharge occurs at the head of fjords in the form of icebergs, submarine melt and discharge of surface melt at base of glaciers often hundreds of meters beneath sea level. This discharge drives a non-trivial transformation of the fjords' waters and forms a new water class, glacially modified waters. It is through the export of these glacially modified waters, much of it occurring below the surface, that Greenland's fresh water reaches the large-scale ocean circulation. Traditional measurements do not provide an unambiguous means of tracking glacially modified waters nor can they be used to quantify the relative fraction of surface and submarine melt. Yet knowing how Greenland's fresh water is exported, and differentiating pathways and rates for submarine or surface melt, which may vary at different rates, is key to the ability to assess present and future local and large-scale impacts. By providing the first measurements of how different melt components spread into Greenland's fjords and onto the continental shelves, this project will contribute to ensuring appropriate representation of the relevant dynamics in climate models, which do not resolve ice-ocean exchanges or fjord dynamics. The cross-disciplinary nature of this project will benefit the training of a post-doc. As part of this project, the scientists have interested a media science program (NOVA) in the largely neglected impact of Greenland's increasing fresh water discharge on the ocean. Pending obtaining separate funding, NOVA will be sending a professional producer in the field with the scientists and use material for this project to produce several media pieces on the problem of melting glaciers. In addition, the material from this research will used to raise public awareness on changes occurring in the oceans near Greenland.

Land-ice loss at both poles is predicted to increase in a warming climate and will further increase the fresh water discharge into the oceans. Understanding the mechanisms that govern the fate of this fresh water is key to the ability to predict both its local and global impacts. This project utilizes the unique signature of noble gases, and other tracers (tritium, oxygen and helium isotopes), in each type of glacial meltwater to identify and track different kinds of Greenland fresh water in a major glacier-fjord system and on the continental shelves. The method builds on work in Antarctica and, more recently, on a pilot study conducted by the project's scientists in a small glacier-fjord system in West Greenland. The field observations will take advantage of two existing cruises, one to a large glacial fjord system in Southeast Greenland and the other to the continental shelves at the southern tip of Greenland, to collect geochemical tracer data in regions influenced by Greenland's meltwater. Synoptic and moored measurements, collected as part of these cruises, will provide context to the geochemical tracer analysis. The first goal of the project is to develop a method that can be used to track glacial melt water both in Greenland and Antarctica and at the margins of other ice caps and glaciers. A second objective is to provide an ocean-based assessment of the glacial melt water transport out of a major fjord, and along Greenland's continental shelves, at the peak of the melt season.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1536856

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