Water column Beryllium-7 from samples collected on the MOSAiC expedition, PS122, on R/V Polarstern in the Central Arctic Ocean during 2019-2020

Website: https://www.bco-dmo.org/dataset/861596
Data Type: Cruise Results
Version: 1
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Project
» Collaborative Research: Defining the Atmospheric Deposition of Trace Elements Into The Arctic Ocean-Ice Ecosystem During The Year-Long MOSAiC Ice Drift (MOSAiC)

Contributors	Affiliation	Role
Kadko, David C.	Florida International University (FIU)	Principal Investigator
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Abstract
This dataset reports Beryllium-7 concentrations from water samples collected on the MOSAiC expedition, PS122, aboard R/V Polarstern in the Central Arctic Ocean during 2019-2020.

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Coverage

Spatial Extent: **N**:88.4963 **E**:115.9663 **S**:83.994 **W**:12.3923
Temporal Extent: 2019-12-21 - 2020-04-29

Methods & Sampling

Methods of ^{7}Be collection and analyses
Pumps were used to collect seawater within the upper 60 m of the ocean during legs 2-3. Typically ~1400-2100 liters were taken from a hydrohole through the ice at 1-2 depths below the mixed layer. Unfiltered seawater was drawn through the sampling hose to the surface where it was passed through iron-oxide impregnated acrylic fiber filters which adsorb the ^{7}Be (Lal et al., 1988; Krishnaswami et al., 1972; Lee et al., 1991). A flow meter attached in-line to the filter compartment recorded the amount of seawater that passed through each filter. To maximize ^{7}Be collection, two fibers filtering approximately 600- 700 L of seawater apiece were collected from each ice station depth and later combined. The efficiency of the fiber for extraction of Be from seawater was determined by adding stable Be atomic absorption standards to a drum containing seawater (bringing the stable Be concentration to ~1 ppm), pumping the water through an iron fiber cartridge, and at every 100 L measuring the Be content of the cartridge effluent. Based on several trials, it was found that for sample volumes in the range 400–700 L, extraction efficiencies are respectively, 82 ± 3% to 76 ± 2%. The uncertainty of the extraction efficiency (4%) and the detector efficiency (2%) was, in all cases, smaller than the statistical counting error and the uncertainty in the blank. For the mixed layer samples, water was collected

from the ship's seawater intake (~8m) and collected in barrels from which the water was passed through the iron-oxide filters as described above. The fibers were dried and shipped to Florida International University. There, the fibers were ashed, placed in a Marinelli beaker and analyzed with a high purity germanium (HPGe) gamma detector (Kadko et al, 2016). The ^{7}Be has a readily identifiable gamma peak at 478 keV. The detector is calibrated by adding a commercially prepared mixed solution of known gamma activities to an ashed fiber and counting it in the Marinelli geometry.

Data Processing Description

BCO-DMO Processing:
- modified parameter names to conform to BCO-DMO naming conventions;
- converted date to YYYY-MM-DD format;
- converted Latitude and Longitude to decimal degrees and rounded to 4 decimal places.

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Data Files

File
Be7.csv (Comma Separated Values (.csv), 1.32 KB) MD5:ae322056fb29b576aa193793b987a0fe Primary data file for dataset ID 861596

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Related Publications

Kadko, D., Galfond, B., Landing, W. M., & Shelley, R. U. (2016). Determining the pathways, fate, and flux of atmospherically derived trace elements in the Arctic ocean/ice system. Marine Chemistry, 182, 38–50. doi:10.1016/j.marchem.2016.04.006
Methods

Krishnaswami, S., Lal, D., Somayajulu, B. L. K., Dixon, F. S., Stonecipher, S. A., & Craig, H. (1972). Silicon, radium, thorium, and lead in seawater: In-situ extraction by synthetic fibre. Earth and Planetary Science Letters, 16(1), 84–90. doi:10.1016/0012-821x(72)90240-3
Methods

Lai, D., Chung, Y., Platt, T., & Lee, T. (1988). Twin cosmogenic radiotracer studies of phosphorus recycling and chemical fluxes in the upper ocean. Limnology and Oceanography, 33(6part2), 1559–1567. doi:10.4319/lo.1988.33.6part2.1559
Methods

Lee, T., Barg, E., & Lal, D. (1991). Studies of vertical mixing in the Southern California Bight with cosmogenic radionuclides 32P and 7Be. Limnology and Oceanography, 36(5), 1044–1052. doi:10.4319/lo.1991.36.5.1044
Methods

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Parameters

Parameter	Description	Units
Sample	Sample identifier	unitless
Depth	Depth	meters (m)
Collection_Date	Collection date; format: YYYY-MM-DD	unitless
Latitude	Latitude	decimal degrees North
Longitude	Longitude	decimal degrees East
Be_7_CONC	Beryllium-7 isotope concentration	becquerels per cubic meter (bq/m3)
Be_7_ERR	Error (+/-) associated with Be_7_CONC	becquerels per cubic meter (bq/m3)

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Flow Meter
Dataset-specific Description	A flow meter attached in-line to the filter compartment recorded the amount of seawater that passed through each filter.
Generic Instrument Description	General term for a sensor that quantifies the rate at which fluids (e.g. water or air) pass through sensor packages, instruments, or sampling devices. A flow meter may be mechanical, optical, electromagnetic, etc.

Dataset-specific Instrument Name	high purity germanium (HPGe) gamma detector
Generic Instrument Name	Gamma Ray Spectrometer
Dataset-specific Description	^{7}Be was analyzed with high purity germanium (HPGe) gamma detectors.
Generic Instrument Description	Instruments measuring the relative levels of electromagnetic radiation of different wavelengths in the gamma-ray waveband.

Dataset-specific Instrument Name	
Generic Instrument Name	Pump
Dataset-specific Description	Pumps were used to collect seawater within the upper 60 m of the ocean during legs 2-3.
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

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Deployments

PS122

Website	https://www.bco-dmo.org/deployment/861601
Platform	R/V Polarstern
Report	https://datadocs.bco-dmo.org/docs/305/MOSAiC/data_docs/Expeditionsprogramm_PS122_leg2.pdf
Start Date	2019-09-20
End Date	2020-10-14
Description	MOSAiC (Multidisciplinary Drifting Observatory of the Study of Arctic Climate) was Polarstern expedition PS122, which started on September 20th 2019 in Tromsø (Norwegian). PS122 was a year-around expedition in the central Arctic Ocean and was divided into six legs (PS122/1 – PS122/6). The expedition finished on October 14th 2020 in Bremerhaven. Additional information can be found at: https://mosaic-expedition.org/ https://epic.awi.de/id/eprint/50082/

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Project Information

Collaborative Research: Defining the Atmospheric Deposition of Trace Elements Into The Arctic Ocean-Ice Ecosystem During The Year-Long MOSAiC Ice Drift (MOSAiC)

Coverage: Central Arctic Ocean

NSF Award Abstract:
This project will use a Beryllium 7 (7-Be) method in a year-long expedition as part of the international Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition to assess the seasonal variability of aerosol deposition. This is the first modern opportunity for such a comprehensive study of the yearly depositional flux of trace elements (TEs) into the Arctic ocean/ice ecosystem. The combination of 7-Be and aerosol TE measurements has been shown to be an effective tool for estimating the atmospheric input of TEs in remote ocean regions where nearby land-based collection sites do not exist. The data generated in this work will be available to allow ground-truthing of models of aerosol deposition and atmospheric input of TEs. Atmospheric deposition is the dominant pathway by which anthropogenically-derived trace elements, especially mercury (Hg), enter the Arctic Ocean, and recent literature suggests that atmospheric deposition of biologically-essential trace elements such as iron (Fe) could play a major role in controlling biological productivity in the Arctic.

Atmospheric transport and deposition of aerosols is an important delivery mechanism of natural and contaminant trace elements (TEs) to the Arctic. Existing data show that atmospheric deposition of contaminant elements like Hg, Pb, and Se may be a major input of these elements to the Arctic, with likely sources being anthropogenic - industrial or power plant emissions associated with fossil fuel combustion in Europe, Russia, and Asia. The atmospheric input of biologically-essential trace elements (e.g. Mn, Fe, Co, Ni, Cu, Zn) plays a key role in controlling biogeochemical processes in the ocean, and recent work suggests this might be true in the Arctic as well. These inputs have strong implications for the ecosystem, and even human health. Assessment of this input is difficult because measurements of deposition rates in remote ocean regions are scarce, and are particularly daunting to take in the Arctic because harsh conditions and limited research platforms make it difficult to obtain quality-controlled precipitation and aerosol chemistry measurements on a routine basis. This research will provide estimates of the yearly atmospheric deposition flux of aerosol TEs (total and soluble), including those of biogeochemical importance as well as pollutant species. The seasonal evolution of partitioning of trace element deposition among the various catchments (ice, water, snow, melt ponds) will also be assessed. The work will involve measurements of 7-Be inventories, 7-Be aerosol activities, and aerosol concentrations of TEs. Field work will be during a year-long ice drift of the MOSAiC expedition through the central Arctic Ocean.

This project will be a component of the MOSAiC expedition, an international initiative motivated by the rapidly evolving Arctic climate system, with thinning sea ice, warming ocean and atmosphere temperatures, strong climate feedbacks, and dramatic implications for society. MOSAiC has broad international support and has been endorsed by international and US institutions as a project that is critically needed to provide foundational information on the changing central Arctic system required to support coupled model development. The ability to provide estimates of the atmospheric input of relevant TEs to the Arctic Ocean will contribute widely to the field of chemical oceanography, including understanding anthropogenic impacts on the region and the role atmospheric input of TEs plays in Arctic Ocean ecology. The lead institution is one of the country's leading minority serving universities, and the lead researcher has undertaken a mentoring program for students involved in its research activities. The team will record short lectures and video logs that can be used in future iterations of his courses to introduce important oceanographic concepts and give his students a first-hand account of life aboard an oceanographic vessel. Other scientists will be asked to grant interviews to add to the breadth of perspectives, and the outreach will emphasize the role of basic scientific research in improving our understanding of natural phenomena and the planet's response to anthropogenic stressors.

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Funding

Funding Source	Award
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1753408
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1753423
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1753418

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