Snow and frost flower Be7 concentrations from the MOSAIC expedition on the R/V Polarstern in the Central Arctic Ocean from October 2019 to May 2020

Website: https://www.bco-dmo.org/dataset/875902
Data Type: Cruise Results
Version: 1
Version Date: 2022-06-21

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
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Abstract
This is a dataset of snow and frost flower Be7 concentrations from MOSAIC expedition on the R/V Polarstern in the Central Arctic Ocean from October 2019 to May 2020.

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Coverage

Spatial Extent: **N**:88.4888 **E**:128.929 **S**:83.771 **W**:12.8438
Temporal Extent: 2019-10-24 - 2020-05-09

Methods & Sampling

Bulk Snow Sampling: For bulk snow samples, we collected the full snow column (snow surface to ice surface). First, the depth of snow was measured with a ruler. Next, a measured area of the snow surface was outlined with a stick or shovel. Then all of the snow (down to the ice surface) within the marked area was removed with a plastic ice scoop and placed in a plastic bucket.

Snow Profile Sampling: For snow profiles, we collected samples at different depth intervals within the snow column. After measuring the depth of snow and marking a measured area on the snow surface, the first layer of snow was carefully removed with a plastic flat bottomed ice scoop and placed in a bucket. The depth of the remaining snow was then measured with a ruler before collecting the next layer of snow. This process was repeated until the ice surface was reached. We sampled two to five layers per profile.

Frost Flower Sampling: On two occasions we collected frost flowers from a recently frozen lead before significant snow accumulation had occurred. After marking a measured area of the ice surface, all of the material was removed with a plastic ice scoop and placed in a plastic bucket.

Lead Snow samples are bulk snow and snow profiles collected from a frozen lead after frost flowers were covered with snow.

Falling Snow Sampling: On five occasions we were able to sample falling snow in buckets deployed on the Polarstern's p-deck. Snow was collected in a plastic bucket (diameter = 26 cm, area = 531 cm2). The buckets were deployed during periods of active snowfall and light winds (minimal interference from blowing snow).

Shipboard Laboratory Procedure: After the snow samples in buckets to the Polarstern, we added the following solutions: 5 ml hydrochloric acid, 2 ml iron chloride solution, and 1 ml of 1000 ppm stable beryllium AA standard (chemical yield tracer). After melting at room temperature, the water volume was measured using a graduated cylinder. Next, the sample was precipitated using ammonium hydroxide. After allowing the precipitate to settle, excess water was removed by decanting and centrifugation. Finally, the precipitate was transferred to petri dishes and placed in an oven for drying.

Gamma Analysis: Dried samples in petri dishes were counted by gamma spectroscopy. Be-7 has a readily identifiable gamma peak at 478 keV. The counting system was calibrated for all samples by preparing a commercial standard in a geometry identical to the samples.

Chemical Yield Determination: After gamma counting, samples were brought up to 1 liter in 1% nitric acid solution. The beryllium concentrations were then determined using a Perkin Elmer Optima 7300 DV ICP-OES. Our chemical yields averaged over 80% (Kadko et al., 2019).

Data Processing Description

BCO-DMO Processing:
- Converted dates to ISO8601 format (YYYY-MM-DD)
- Adjusted field/parameter names to comply with BCO-DMO naming conventions
- Added a conventional header with dataset name, PI names, version date

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Data Files

File
snow_frost_flower.csv (Comma Separated Values (.csv), 13.24 KB) MD5:5222c45935fd3eb0fd64764ea9f85303
Primary data file for dataset ID 875902

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Related Publications

Kadko, D., Aguilar-Islas, A., Bolt, C., Buck, C. S., Fitzsimmons, J. N., Jensen, L. T., Landing, W. M., Marsay, C. M., Rember, R., Shiller, A. M., Whitmore, L. M., & Anderson, R. F. (2019). The residence times of trace elements determined in the surface Arctic Ocean during the 2015 US Arctic GEOTRACES expedition. Marine Chemistry, 208, 56–69. https://doi.org/10.1016/j.marchem.2018.10.011
Methods

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Parameters

Parameter	Description	Units
SAMPLE_ID	Sample Identifier	unitless
SAMPLE_TYPE	Type of sample	unitless
Collection_Date	Sample collection date in format: YYYY-MM-DD	unitless
MOSAIC_EVENTNO	Event Number	unitless
MOSAIC_Site_Name	Site name on the ice floe	unitless
LATITUDE	Latitude North of sample site	decimal degrees
LONGITUDE	Longitude East (West is negative) of sample site	decimal degrees
SNOW_DEPTH	Depth of snow	meters (m)
SAMPLE_DEPTH	Depth from snow surface	meters (m)
AREA_SAMPLED	Horizontal sample area	square meters (m2)
SAMPLE_VOLUME	Volume of melted sample	Liters (L)
Be_7_CONC	Be-7 concentration	Becquerels per cubic meter (Bq/m3)
Be_7_ERR	Error associated w Be-7 concentration	Becquerels per cubic meter (Bq/m3)

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Instruments

Dataset-specific Instrument Name	high purity germanium (HPGe) gamma detectors
Generic Instrument Name	Gamma Ray Spectrometer
Generic Instrument Description	Instruments measuring the relative levels of electromagnetic radiation of different wavelengths in the gamma-ray waveband.

Dataset-specific Instrument Name	Perkin Elmer Optima 7300 DV ICP-OES
Generic Instrument Name	Mass Spectrometer
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.

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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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