Fine aerosol iron (Fe) collected on the US GEOTRACES Arctic cruise (HLY1502, GN01) from August to October 2015

Website: https://www.bco-dmo.org/dataset/779649
Data Type: Cruise Results
Version: 1
Version Date: 2019-10-24

Project
» U.S. Arctic GEOTRACES Study (GN01) (U.S. GEOTRACES Arctic)
» Collaborative Research: GEOTRACES Arctic Section: Sampling and Analysis of Atmospheric Deposition (GEOTRACES Arctic Atmospheric Deposition)

Program
» U.S. GEOTRACES (U.S. GEOTRACES)

Contributors	Affiliation	Role
Gao, Yuan	Rutgers University	Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Coverage

Spatial Extent: **N**:88.4088 **E**:176.7522 **S**:56.0743 **W**:-170.7498
Temporal Extent: 2015-08-10 - 2015-10-09

Dataset Description

These data are associated with the following publication:
Gao, Y., Marsay, C., Yu, S., Fan, S., Mukherjee, P., Buck, C.S., & Landing, W.M. (in press). Particle-Size Variability of Aerosol Iron and Impact on Iron Solubility and Dry Deposition Fluxes to the Arctic Ocean. Scientific Reports.

Methods & Sampling

Sampling:
Aerosol samples were collected by a MICRO ORIFIFICE UNIFORM DEPOSIT IMPACTOR (MOUDI) (MSP Corporation, MN, USA) which was installed on the forward rail of Healy's flying bridge, ~23 m above sea level, to minimize the influence of sea spray. To minimize the potential for contamination from the stack exhaust, samplers were forward of the ship's stack and sampling was controlled by wind speed and direction, through a Campbell Scientific CR800 data-logger interfaced with an anemometer and wind vane set up near the samplers. Aerosol sampling was restricted to periods when in-sector conditions (defined as a relative wind direction from

within ±60° of the ship's bow and a relative wind speed of >0.5 m s-1) persisted for at least five continuous minutes. The MOUDI impactor used Teflon filters for particle collection (Pall Corp., 47 mm diameter, 1 µm pore size), with a sampling flowrate of 30 L min-1. Both the MOUDI impactor and its pump were housed in enclosures to protect them from rain and sea-spray with an extension tube connected to the MOUDI inlet and extending from the enclosure. A rain shield was installed above the inlet. Due to the anticipated low dust conditions during GN01, and the relatively low frequency of in-sector wind conditions, sample collections lasted for an average of seven days.

Clean polyethylene gloves were worn for loading and unloading of sample filters, which were carried out underneath a high-efficiency particulate air (HEPA) filter blower within a plastic "bubble" clean area constructed in the ship's main laboratory. Filters were loaded onto the MOUDI impactor from labeled petri dishes using pre-cleaned Teflon tweezers and were transferred back to the same petri dishes after sample recovery. Filter holders were double-bagged for transfer between the ship's laboratory and the samplers. Deployment blanks were carried out using the same protocols, but with the pumps turned off. All sample and field blank filters were subsequently double-bagged and stored frozen until analysis.

Sampler Location: Flying deck, forward railings
Sampler Type: MICRO ORIFIFICE UNIFORM DEPOSIT IMPACTOR (MOUDI) (MSP CORP.,MN, USA)
Sampler Flow: 0.030 m3/min
Substrate Type: Pall corp. Teflon Filter, 47 mm discs (Teflon, 1um pore size)
Size Segregation Method: Size-segregated sample; 1um is used as a cut off size for COARSE and FINE particle sizes

Aerosol Sample Analyses:
Total aerosol Fe in this study was measured following the detailed procedures in Morton et al. (2013) and Gao et al. (2013).

Total Fe: Aerosol samples were analyzed for the total concentrations of atmospheric Fe by a sector field inductively coupled plasma-mass spectrometer (SF-ICPMS) in Rutgers Inorganic Analytical Laboratory, following a previously described digestion protocol (Gao et al., 2013). Briefly, a portion of each sample filter was placed in a 15 mL Teflon vial with a mixture of concentrated HNO3 (0.8 ml) and HF (0.1 ml) (Optima, Fisher Sci.) and digested for 4 hours on a hot plate at 160°C. Each digestion solution was evaporated to dryness, followed by the addition of 2 ml 3% HNO3 and 1 ppb Indium (In) for ICP-MS drift correction. Both field blanks and procedure blanks were treated in the same way as samples. All Teflon vials were acid-cleaned, and all procedures were carried out in a class-100 clean-room hood in the lab. The sample digestion procedures were assessed using Standard Reference Material (SRM) 1648a (National Institute of Standards and Technology, NIST, Gaithersburg, MD), subsamples of which were treated under the same conditions as for samples. The digest recoveries based on SRM1648a ranged between 89-99% for Fe (n=7) which was close enough to the measured quantities that no yield correction needed to be applied, and the precision determined from sample splits and duplicate digest aliquots ranged between 93-106% for Fe (n=10). The method detection limits were 0.691 pmol m-3 for Fe, which was obtained based on three times the standard deviation of a total of 14 filter blanks and a nominal 100 m3 sampling volume. A series of external calibration standards were run at the beginning and then at the end of the analyses. More details on the ICP-MS instrument settings can be found in Annett et al. (2017).

Dissolvable Fe: The concentrations of dissolvable Fe in aerosol samples were obtained using UV/Visible spectroscopy with a modified Ferrozine method (Gao et al., 2013). The leaching solution for samples was 0.5 mM ammonium acetate that was filtered through a Nuclepore® track-etch membrane filter (47 mm, 0.2 µm) and adjusted to ~pH 5.3. The leaching conditions were chosen to simulate cloud water conditions for marine aerosols. A brief description of the procedures is as follows: a portion of each sample filter was first placed into a leaching solution of ammonium acetate (0.5 mM) for 1 h, and then the leachate was split into two parts, one for Fe(II) determination and the other for total dissolvable Fe. A solution of 0.01 M hydroxylamine hydrochloride solution (1%) was added to the total dissolvable Fe filtrate portion to reduce Fe(III) to Fe(II), and the sample solution was set aside for 1 h to ensure complete reduction before adding the same ferrozine solution as for the Fe(II) filtrate portion. The Fe(II) measured in this way was considered as total dissolvable Fe. After these procedures, each sample leaching solution was filtered through a 13 mm polytetrafluorethylene syringe filter of 0.2 µm pore size. All field blanks were treated in the same way as samples. The concentrations of Fe(II) in sample solutions were determined at 562 nm using a TIDAS-1 spectrometer module with a 200 cm liquid waveguide capillary flow cell (World Precision Instruments Inc., FL, USA). The detection limit of the method for Fe(II) was 0.30 nM, calculated as three times the standard deviation of the measured blank values (n=5). A total of 8 sets of size-segregated aerosol samples were analyzed with this procedure.

Data Processing Description

Data processing followed standard protocols that was included in sample analyses section; no specific software was used.

BCO-DMO Processing:
- modified parameter names (replaced spaces w/ underscores);
- formatted time to HH:MM;
- formatted months and days to two-digits;
- added ISO Date/Time fields.

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Data Files

File
Fe_Fine.csv (Comma Separated Values (.csv), 1.57 KB) MD5:e86bcf9eca3e46e089458f2ab5411bb4 Primary data file for dataset ID 779649

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Related Publications

Annett, A. L., Fitzsimmons, J. N., Séguret, M. J. M., Lagerström, M., Meredith, M. P., Schofield, O., & Sherrell, R. M. (2017). Controls on dissolved and particulate iron distributions in surface waters of the Western Antarctic Peninsula shelf. Marine Chemistry, 196, 81–97. doi:10.1016/j.marchem.2017.06.004
Methods

Gao, Y., Marsay, C. M., Yu, S., Fan, S., Mukherjee, P., Buck, C. S., & Landing, W. M. (2019). Particle-Size Variability of Aerosol Iron and Impact on Iron Solubility and Dry Deposition Fluxes to the Arctic Ocean. Scientific Reports, 9(1). https://doi.org/10.1038/s41598-019-52468-z
Results

Gao, Y., Xu, G., Zhan, J., Zhang, J., Li, W., Lin, Q., … Lin, H. (2013). Spatial and particle size distributions of atmospheric dissolvable iron in aerosols and its input to the Southern Ocean and coastal East Antarctica. Journal of Geophysical Research: Atmospheres, 118(22), 12,634–12,648. doi:10.1002/2013jd020367
Methods

Morton, P. L., Landing, W. M., Hsu, S.-C., Milne, A., Aguilar-Islas, A. M., Baker, A. R., … Zamora, L. M. (2013). Methods for the sampling and analysis of marine aerosols: results from the 2008 GEOTRACES aerosol intercalibration experiment. Limnology and Oceanography: Methods, 11(2), 62–78. doi:10.4319/lom.2013.11.62
Methods

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Parameters

Parameter	Description	Units
Cruise_id	Cruise identifier	unitless
GEOTRC_EVENTNO	GEOTRACES Event Number	unitless
SAMPLE_ID	GEOTRACES Sample Number	unitless
Julian_Day	Sampling start Julian day	unitless
Start_Day	Sampling start day	unitless
Start_Month	Sampling start month	unitless
Start_Year	Sampling start year; format: yyyy	unitless
Start_Time_UTC	Sampling start time; format: HH:MM	unitless
Start_Lat	Sampling start Latitude	decimal degrees N
Start_Long	Sampling start Longitude	decimal degrees E
End_Day	Sampling end day	unitless
End_Month	Sampling end month	unitless
End_Year	Sampling end year; format: yyyy	unitless
End_Time	Sampling end time; format: HH:MM	unitless
End_Lat	Sampling end Latitude	decimal degrees N
End_Long	Sampling end Longitude	decimal degrees E
Air_Vol_Total	Total volume of air sampled	cubic meters (m^3)
Fe_A_T_CONC_FINE_IMPACTOR	smaller size fraction of total Fe concentration in aerosols (no preliminary leaching) collected with size fractionation	pmol/m^3
Fe_A_SSLNH4AC_CONC_FINE_IMPACTOR	?	pmol/m^3
Fe_II_A_SSLNH4AC_CONC_FINE_IMPACTOR	?	pmol/m^3

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Instruments

Dataset-specific Instrument Name	Micro-orifice uniform deposit impactor (MOUDI)
Generic Instrument Name	Aerosol Sampler
Dataset-specific Description	Aerosol samples were collected by a MICRO ORIFiCE UNIFORM DEPOSIT IMPACTOR (MOUDI) (MSP Corporation, MN, USA) which was installed on the forward rail of Healy's flying bridge.
Generic Instrument Description	A device that collects a sample of aerosol (dry particles or liquid droplets) from the atmosphere.

Dataset-specific Instrument Name	anemometer
Generic Instrument Name	Anemometer
Generic Instrument Description	An anemometer is a device for measuring the velocity or the pressure of the wind. It is commonly used to measure wind speed. Aboard research vessels, it is often mounted with other meteorological instruments and sensors.

Dataset-specific Instrument Name	Campbell Scientific CR800 data-logger
Generic Instrument Name	Data Logger
Generic Instrument Description	Electronic devices that record data over time or in relation to location either with a built-in instrument or sensor or via external instruments and sensors.

Dataset-specific Instrument Name	Element-1 sector field ICP-MS
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Element-1 sector field ICP-MS (Thermo-Finnigan, Bremen, Germany) for total aerosol Fe
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	TIDAS-1 spectrometer
Generic Instrument Name	Spectrometer
Dataset-specific Description	TIDAS-1 spectrometer module with a 200 cm liquid waveguide capillary flow cell (World Precision Instruments Inc., FL, USA) for dissolvable Fe.
Generic Instrument Description	A spectrometer is an optical instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.

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Deployments

HLY1502

Website	https://www.bco-dmo.org/deployment/638807
Platform	USCGC Healy
Report	https://datadocs.bco-dmo.org/docs/302/geotraces/GEOTRACES_ARCTIC/data_docs/cruise_reports/healy1502.pdf
Start Date	2015-08-09
End Date	2015-10-12
Description	Arctic transect encompassing Bering and Chukchi Shelves and the Canadian, Makarov and Amundsen sub-basins of the Arctic Ocean. The transect started in the Bering Sea (60°N) and traveled northward across the Bering Shelf, through the Bering Strait and across the Chukchi shelf, then traversing along 170-180°W across the Alpha-Mendeleev and Lomonosov Ridges to the North Pole (Amundsen basin, 90°N), and then back southward along ~150°W to terminate on the Chukchi Shelf (72°N). Additional cruise information is available in the GO-SHIP Cruise Report (PDF) and from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/HLY1502

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Project Information

U.S. Arctic GEOTRACES Study (GN01) (U.S. GEOTRACES Arctic)

Website: https://www.geotraces.org/

Coverage: Arctic Ocean; Sailing from Dutch Harbor to Dutch Harbor (GN01)

Description from NSF award abstract:
In pursuit of its goal "to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions", in 2015 the International GEOTRACES Program will embark on several years of research in the Arctic Ocean. In a region where climate warming and general environmental change are occurring at amazing speed, research such as this is important for understanding the current state of Arctic Ocean geochemistry and for developing predictive capability as the regional ecosystem continues to warm and influence global oceanic and climatic conditions. The three investigators funded on this award, will manage a large team of U.S.scientists who will compete through the regular NSF proposal process to contribute their own unique expertise in marine trace metal, isotopic, and carbon cycle geochemistry to the U.S. effort. The three managers will be responsible for arranging and overseeing at-sea technical services such as hydrographic measurements, nutrient analyses, and around-the-clock management of on-deck sampling activites upon which all participants depend, and for organizing all pre- and post-cruise technical support and scientific meetings. The management team will also lead educational outreach activities for the general public in Nome and Barrow, Alaska, to explain the significance of the study to these communities and to learn from residents' insights on observed changes in the marine system. The project itself will provide for the support and training of a number of pre-doctoral students and post-doctoral researchers. Inasmuch as the Arctic Ocean is an epicenter of global climate change, findings of this study are expected to advance present capability to forecast changes in regional and globlal ecosystem and climate system functioning.

As the United States' contribution to the International GEOTRACES Arctic Ocean initiative, this project will be part of an ongoing multi-national effort to further scientific knowledge about trace elements and isotopes in the world ocean. This U.S. expedition will focus on the western Arctic Ocean in the boreal summer of 2015. The scientific team will consist of the management team funded through this award plus a team of scientists from U.S. academic institutions who will have successfully competed for and received NSF funds for specific science projects in time to participate in the final stages of cruise planning. The cruise track segments will include the Bering Strait, Chukchi shelf, and the deep Canada Basin. Several stations will be designated as so-called super stations for intense study of atmospheric aerosols, sea ice, and sediment chemistry as well as water-column processes. In total, the set of coordinated international expeditions will involve the deployment of ice-capable research ships from 6 nations (US, Canada, Germany, Sweden, UK, and Russia) across different parts of the

Arctic Ocean, and application of state-of-the-art methods to unravel the complex dynamics of trace metals and isotopes that are important as oceanographic and biogeochemical tracers in the sea.

Collaborative Research: GEOTRACES Arctic Section: Sampling and Analysis of Atmospheric Deposition (GEOTRACES Arctic Atmospheric Deposition)

NSF Award Abstract:
In this project, a group of investigators participating in the 2015 U.S. GEOTRACES Arctic Ocean expedition will study the distribution of a variety of trace elements in seawater, sea ice, and marine air. It is important to understand where they are and how they move in the Arctic because some trace elements are essential to life, others are known biological toxins, and still others are important because they can be used as tracers of a variety of physical, chemical, and biological processes in the sea. In common with other multinational initiatives in the International GEOTRACES Program, the goals of the U.S. Arctic expedition are to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions. This multi-institutional team of ocean trace element experts will focus its attention on the importance of aerosol, precipitation, and sea ice melt water in trace element cycling. Results from this work will be disseminated through public educational initiatives, such as web communications and outreach to members of the public, including indigenous populations in Alaska. The project will also provide training for graduate and undergraduate students in biology and chemistry.

Atmospheric deposition is an important pathway and transport mechanism of both natural aerosols and contaminants to the ocean. Relative to other regions, atmospheric deposition rates in the Arctic are low and aerosols and dissolved chemicals in precipitation may be deposited directly to the sea surface or, unique to polar regions, onto sea ice. Given the unique biogeochemical processes of the region and its rapid changes in response to global climate change, quantifying the current atmospheric deposition of trace elements and isotopes to differing catchments (ocean, sea ice, and melt ponds) in the Arctic is critical to our ability to predict how their distribution may evolve over time. In this study, aerosol, precipitation, and melt water samples will be collected and analyzed for trace elements and isotopes in order to evaluate the impacts on the surface ocean and sea ice chemistry from natural and anthropogenic aerosols. Through this project, collected atmospheric samples from the Arctic will also be made available for distribution to the broader scientific community.

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Program Information

U.S. GEOTRACES (U.S. GEOTRACES)

Website: http://www.geotraces.org/

Coverage: Global

GEOTRACES is a SCOR sponsored program; and funding for program infrastructure development is provided by the U.S. National Science Foundation.

GEOTRACES gained momentum following a special symposium, S02: Biogeochemical cycling of trace elements and isotopes in the ocean and applications to constrain contemporary marine processes (GEOSECS II), at a 2003 Goldschmidt meeting convened in Japan. The GEOSECS II acronym referred to the Geochemical Ocean Section Studies To determine full water column distributions of selected trace elements and isotopes, including their concentration, chemical speciation, and physical form, along a sufficient number of sections in each ocean basin to establish the principal relationships between these distributions and with more traditional hydrographic parameters;

* To evaluate the sources, sinks, and internal cycling of these species and thereby characterize more completely the physical, chemical and biological processes regulating their distributions, and the sensitivity of these processes to global change; and

* To understand the processes that control the concentrations of geochemical species used for proxies of the past environment, both in the water column and in the substrates that reflect the water column.

GEOTRACES will be global in scope, consisting of ocean sections complemented by regional process studies. Sections and process studies will combine fieldwork, laboratory experiments and modelling. Beyond realizing the scientific objectives identified above, a natural outcome of this work will be to build a community of marine scientists who understand the processes regulating trace element cycles sufficiently well to exploit this knowledge reliably in future interdisciplinary studies.

Expand "Projects" below for information about and data resulting from individual US GEOTRACES research projects.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1438047
NSF Division of Ocean Sciences (NSF OCE)	OCE-1435871
NSF Division of Ocean Sciences (NSF OCE)	OCE-1437266

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