

Aerosol trace element concentrations from the French GEOTRACES GS02 SWINGS cruise aboard R/V Marion-Dufresne (MD229) from January to March 2021

Website: <https://www.bco-dmo.org/dataset/1008364>

Data Type: Cruise Results

Version: 1

Version Date: 2026-09-29

Project

» [Collaborative Research: Quantifying the atmospheric flux of bio-active trace elements to the southwestern Indian Ocean](#) (SWINGS Be-7)

Program

» [U.S. GEOTRACES](#) (U.S. GEOTRACES)

Contributors	Affiliation	Role
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Abstract

This project involved measuring the aerosol trace element concentrations, aerosol fractional solubility, and atmospheric deposition of bio-essential trace elements on a cruise of opportunity, collaborating in a multidisciplinary project studying trace element sources, transformations, and sinks in the Indian Ocean sector of the Southern Ocean, an area that has been relatively under-studied from a biogeochemical perspective. The cruise track crossed the currents and oceanographic fronts that are major pathways of the general circulation in the region and allowed us to quantify the atmospheric deposition of bioactive trace elements in a region with multiple possible aerosol sources, and where aerosol iron (Fe) deposition and rainfall rates are predicted to range over 1-2 orders of magnitude.

Table of Contents

- [Coverage](#)
- [Dataset Description](#)
 - [Methods & Sampling](#)
 - [Data Processing Description](#)
 - [BCO-DMO Curation Notes](#)
- [Data Files](#)
- [Supplemental Files](#)
- [Related Publications](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Program Information](#)
- [Funding](#)

Coverage

Location: Southwestern Indian Ocean

Spatial Extent: N:-25 E:81.481 S:-57.992 W:31.701

Temporal Extent: 2021-01-14 - 2021-03-04

Methods & Sampling

Aerosol samples were collected according to protocols in the GEOTRACES cookbook using a Tisch TE-5170V-BL high-volume aerosol sampler modified to collect 12 replicate samples on 47-millimeter (mm) diameter Whatman-41 (W-41) filters. In order to minimize filter blanks, the W-41 filters were pre-cleaned inside a HEPA-filtered laminar flow hood using three cycles of leaching with 0.5M HCl (Optima) and then rinsing with ultra-high purity water (UHP water) according to trace element protocols. Sector control, which was accomplished via a Campbell Scientific data logger, was set such that the sampler would only operate during winds of >0.5 meters per second (m/s) and from $\pm 60^\circ$ of the ship's bow to avoid sampling air influenced by the ship's exhaust.

Briefly, a W41 filter aerosol sample was digested and dried down three times in a 15-milliliter (mL) flat-bottom/round-interior Teflon jar (Savillex: 200-015-20 and 600-033-01); first with HNO₃, next with HNO₃ and HF, and finally with HNO₃ only (all acids were Fisher Optima grade). All filter digestions were performed under a continuous flow of HEPA-filtered air within a Class-1000 clean room.

Data Processing Description

ICPMS data (raw counts) for each isotope were drift corrected and converted to element mass using calibration curves generated from high-purity ICPMS standards of known concentrations. Element masses were then divided by the volume of air filtered over each deployment.

Quality Flags:

The dataset includes quality flags applied following the GEOTRACES recommendations found at <https://www.geotraces.org/geotraces-quality-flag-policy/>, where 2 = probably good value, and 9 = missing value.

BCO-DMO Curation Notes

This section documents curation actions performed prior to publication review with the submitter, and additional information relevant to understanding and reusing this dataset. It distinguishes changes made to the submitted (meta)data from unresolved issues and/or enhancements that improve future reuse and interoperability.

CURATION ACTIONS PERFORMED ON DATA

- Imported original file "template_MD229 SWINGS aerosol data.xlsx" (sheet 4) into the BCO-DMO processing system.
- Treated "-999.000" as a missing data value (missing data are empty/blank in the final CSV file).
- Renamed data columns to comply with BCO-DMO naming conventions.
- Converted Start_Date_UTC + Start_Time_UTC into Start_ISO_DateTime_UTC (ISO 8601, UTC) and End_Date_UTC + End_Time_UTC into End_ISO_DateTime_UTC (ISO 8601, UTC).
- Deleted the following empty/unused columns: Station_ID, Rosette_Position, Sample_ID, Sample_Depth.
- Saved the final file as "1008364_v1_gs02_swings_aerosols.csv".

CURATION ACTIONS PERFORMED ON METADATA

- BCO-DMO's standard metadata entry and text formatting steps were performed. See: <https://www.bco-dmo.org/how-to/standard-curation-edits>

ISSUES POTENTIALLY IMPACTING REUSE

- N/A

[[table of contents](#) | [back to top](#)]

Data Files

File
1008364_v1_gs02_swings_aerosols.csv (Comma Separated Values (.csv), 6.75 KB) MD5:5545bccbe43a9de9998637a37ee862d6
Primary data file for dataset ID 1008364, version 1

[[table of contents](#) | [back to top](#)]

Supplemental Files

File
GEOTRACES DOoR template for GS02 SWINGS aerosols filename: template_MD229 SWINGS aerosol data.xlsx (Microsoft Excel, 36.16 KB) MD5:1460ebdd7114a37ad7622fd1c536f0bb
Supplemental file for dataset ID 1008364, version 1. This file contains the data and sample metadata in the template the PI generated through the GEOTRACES DOoR portal. This format is provided for greater interoperability and use with the global GEOTRACES program. The "Sample Metadata" sheet of this file contains important metadata including number of samples collected per measurement, number of analytical replicates run per sample, analytical instruments, and other information about each parameter reported in the dataset. This file is presented here in its original format without modification by BCO-DMO.

[[table of contents](#) | [back to top](#)]

Related Publications

Aguilar-Islas, A., Bridgestock, L., Bundy, R., Conway, T., Hayes, C., Heimbürger, L., Planquette, H., & Shaked, Y. (2024). Sampling and Sample-handling Protocols for GEOTRACES Cruises (Cookbook). Version 4.0, August 2024. <https://www.geotraces.org/wp-content/uploads/2024/10/GEOTRACES-cookbook-v4-2024.pdf>
Methods

[[table of contents](#) | [back to top](#)]

Parameters

Parameter	Description	Units
Event_ID	Aerosol event number	unitless
BODC_Event_ID	BODC event ID number	unitless
Gear_ID	Sampling instrument	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) at start of deployment in ISO 8601 format	unitless
Start_Date_UTC	Start date	unitless
Start_Time_UTC	Start time	unitless
End_ISO_DateTime_UTC	Date and time (UTC) at end of deployment in ISO 8601 format	unitless

End_Date_UTC	End date	unitless
End_Time_UTC	End time	unitless
Start_Latitude	Latitude at start of deployment	decimal degrees
Start_Longitude	Longitude at start of deployment	decimal degrees
End_Latitude	Latitude at end of deployment	decimal degrees
End_Longitude	Longitude at end of deployment	decimal degrees
Mn_A_T_CONC_HIVOL_89eynk	Total aerosol concentration of Mn	picomoles per cubic meter (pmol/m3)
SD1_Mn_A_T_CONC_HIVOL_89eynk	One standard deviation	picomoles per cubic meter (pmol/m3)
Flag_Mn_A_T_CONC_HIVOL_89eynk	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless
Al_A_T_CONC_HIVOL_6nucza	Total aerosol concentration of Al	picomoles per cubic meter (pmol/m3)
SD1_Al_A_T_CONC_HIVOL_6nucza	One standard deviation	picomoles per cubic meter (pmol/m3)
Flag_Al_A_T_CONC_HIVOL_6nucza	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless
Zn_A_T_CONC_HIVOL_v2ye95	Total aerosol concentration of Zn	picomoles per cubic meter (pmol/m3)
SD1_Zn_A_T_CONC_HIVOL_v2ye95	One standard deviation	picomoles per cubic meter (pmol/m3)
Flag_Zn_A_T_CONC_HIVOL_v2ye95	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless
Pb_A_T_CONC_HIVOL_wzhatx	Total aerosol concentration of Pb	picomoles per cubic meter (pmol/m3)
SD1_Pb_A_T_CONC_HIVOL_wzhatx	One standard deviation	picomoles per cubic meter (pmol/m3)
Flag_Pb_A_T_CONC_HIVOL_wzhatx	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless

Ti_A_T_CONC_HIVOL_oujufj	Total aerosol concentration of Ti	picomoles per cubic meter (pmol/m3)
SD1_Ti_A_T_CONC_HIVOL_oujufj	One standard deviation	picomoles per cubic meter (pmol/m3)
Flag_Ti_A_T_CONC_HIVOL_oujufj	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless
Co_A_T_CONC_HIVOL_3dsiii	Total aerosol concentration of Co	picomoles per cubic meter (pmol/m3)
SD1_Co_A_T_CONC_HIVOL_3dsiii	One standard deviation	picomoles per cubic meter (pmol/m3)
Flag_Co_A_T_CONC_HIVOL_3dsiii	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless
Cd_A_T_CONC_HIVOL_qqt27d	Total aerosol concentration of Cd	picomoles per cubic meter (pmol/m3)
SD1_Cd_A_T_CONC_HIVOL_qqt27d	One standard deviation	picomoles per cubic meter (pmol/m3)
Flag_Cd_A_T_CONC_HIVOL_qqt27d	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless
Fe_A_T_CONC_HIVOL_mqpk25	Total aerosol concentration of Fe	picomoles per cubic meter (pmol/m3)
SD1_Fe_A_T_CONC_HIVOL_mqpk25	One standard deviation	picomoles per cubic meter (pmol/m3)
Flag_Fe_A_T_CONC_HIVOL_mqpk25	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless
P_A_T_CONC_HIVOL_ioj65j	Total aerosol concentration of P	picomoles per cubic meter (pmol/m3)
SD1_P_A_T_CONC_HIVOL_ioj65j	One standard deviation	picomoles per cubic meter (pmol/m3)
Flag_P_A_T_CONC_HIVOL_ioj65j	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless
Cu_A_T_CONC_HIVOL_jwki2u	Total aerosol concentration of Cu	picomoles per cubic meter (pmol/m3)
SD1_Cu_A_T_CONC_HIVOL_jwki2u	One standard deviation	picomoles per cubic meter (pmol/m3)
Flag_Cu_A_T_CONC_HIVOL_jwki2u	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless

Ni_A_T_CONC_HIVOL_4dneay	Total aerosol concentration of Ni	picomoles per cubic meter (pmol/m ³)
SD1_Ni_A_T_CONC_HIVOL_4dneay	One standard deviation	picomoles per cubic meter (pmol/m ³)
Flag_Ni_A_T_CONC_HIVOL_4dneay	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless
V_A_T_CONC_HIVOL_diymwj	Total aerosol concentration of V	picomoles per cubic meter (pmol/m ³)
SD1_V_A_T_CONC_HIVOL_diymwj	One standard deviation	picomoles per cubic meter (pmol/m ³)
Flag_V_A_T_CONC_HIVOL_diymwj	SeaDataNet Quality flag, where 2 = probably good value, and 9 = missing value	unitless

[[table of contents](#) | [back to top](#)]

Instruments

Dataset-specific Instrument Name	Tisch TE-5170V-BL high-volume aerosol sampler
Generic Instrument Name	Aerosol Sampler
Dataset-specific Description	Aerosol samples were collected according to protocols in the GEOTRACES cookbook using a Tisch TE-5170V-BL high-volume aerosol sampler.
Generic Instrument Description	A device that collects a sample of aerosol (dry particles or liquid droplets) from the atmosphere.

Dataset-specific Instrument Name	Campbell Scientific data logger
Generic Instrument Name	Data Logger
Dataset-specific Description	Sector control was accomplished via a Campbell Scientific 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	Thermo-Scientific Element II ICPMS
Generic Instrument Name	Thermo Fisher Scientific ELEMENT 2 inductively coupled plasma mass spectrometer
Generic Instrument Description	The Thermo Scientific Element 2 ICP-MS is a double-focussing magnetic-sector-field Inductively Coupled Plasma Mass Spectrometer equipped with a discrete dynode detector system, linear over nine orders of magnitude - from ppq to ppm concentrations. Other features include: Sensitivity (Concentric Nebuliser) greater than 1×10^9 counts per second (cps)/ppm In; Dark noise less than 0.2 cps; Mass resolution 300, 4,000, 10,000 (10 percent valley, equivalent to 5 percent height), 600, 8,000, 2,000 (FWHM); Signal stability better than 1 percent RSD over 10 minutes or 2 percent RSD over 1 hour; Mass stability: 25 ppm / 8 hours; Magnetic scan speed: m/z 7 to 240 to 7 in less than 150 ms, Electronic scan speed: 1 ms/jump, independent of mass range.

[[table of contents](#) | [back to top](#)]

Deployments

MD229

Website	https://www.bco-dmo.org/deployment/927581
Platform	R/V Marion-Dufresne
Report	http://doi.org/10.13155/83989
Start Date	2021-01-11
End Date	2021-03-08
Description	French GEOTRACES section GS02 SWINGS Cruise on R/V Marion-Dufresne (cruise ID MD229). For more information, see the following: https://swings.geotraces.org/en/homepage-english/ The French GEOTRACES SWINGS GS02 cruise started from La Réunion island (France) on January 13th, 2021 and ended at the same place on March 8th, 2021. During 54 days, many stations have been sampled with various pieces of equipment on board the Marion Dufresne II research vessel in order to elucidate trace element sources, transformations, and sinks in key areas of the Indian sector of the Southern Ocean contributing to the global effort of the GEOTRACES programme.

[[table of contents](#) | [back to top](#)]

Project Information

Collaborative Research: Quantifying the atmospheric flux of bio-active trace elements to the southwestern Indian Ocean (SWINGS Be-7)

Coverage: Southwest Indian Ocean

NSF Award Abstract:

Marine phytoplankton (microscopic photosynthetic algae) produce about half of the oxygen we breath and remove billions of tons of carbon dioxide from the atmosphere each year. This primary productivity plays a central role in controlling atmospheric carbon dioxide (pCO₂) levels and the global climate. Yet, phytoplankton productivity is limited by lack of iron (an essential trace element) in about 40% of the global ocean. While phytoplankton productivity helps remove carbon dioxide from the atmosphere, it also removes iron and other essential trace elements (like manganese, cobalt, copper, and zinc) from the upper ocean. One critical issue is,

"What are the sources for these essential trace elements that are needed to replace those removed by phytoplankton to keep the annual productivity cycles going?" This is especially important in the waters of the Southern Ocean around Antarctica, where ocean circulation brings deep water to the surface; water that is enriched in nutrients like nitrate and phosphate but depleted in essential trace elements. The main source for iron in the open ocean is from desert dust deposition. In this project, scientists will collect aerosols (fine particles in the air) and rain samples over the Southern Ocean to measure how much iron (and the other essential trace elements) is depositing to surface waters. Other scientists will be measuring how fast phytoplankton are growing, and together we will learn how the input of trace elements from dust helps to remove carbon dioxide from the atmosphere. This information can then be used to help predict the future of Earth's climate. The scientists will communicate results of their study to the public via open house events at their respective campuses, as well as through online forums. One undergraduate student from Florida International University, a leading minority serving university, would be supported and trained as part of this project.

The project will measure the aerosol fractional solubility and atmospheric deposition of bio-essential trace elements as part of a multidisciplinary project studying trace element sources, transformations and sinks in the Indian Ocean sector of the Southern Ocean. The research cruise track will cross the currents and oceanographic fronts that are major pathways of the general circulation in the region where we expect to find multiple possible aerosol sources, and where aerosol Fe deposition and rainfall rates are predicted to range over 1-2 orders of magnitude. Aerosol samples (bulk and size-fractionated) will be collected on a daily basis and event-based rain samples to be analyzed for total and soluble major and trace elements including nitrate, phosphate, silicate, chloride, sulfate, Na, Mg, Al, V, Mn, Fe, Co, Ni, Cu, Zn, and Cd. In addition, scientists will analyze the water-soluble organic compounds in aerosols, focusing on compounds such as oxalate and methane-sulfonic acid (MSA) that enhance aerosol trace element solubility. Scientists will use Be-7 concentrations in aerosols and the upper water column to calculate aerosol bulk deposition velocities and test whether the relationship between rainfall rate and bulk deposition velocity that we have previously published can be applied on a more global basis. Further, scientists will use the trace element concentration data along with air-mass back trajectory analysis to apportion the aerosols between anthropogenic and natural sources, and study how aerosol sources affect the fractional solubility. Aerosol and rain subsamples will be provided to collaborators on the cruise for the analysis of additional important parameters.

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.

[[table of contents](#) | [back to top](#)]

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.

[[table of contents](#) | [back to top](#)]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2022984

[[table of contents](#) | [back to top](#)]