Programmable Flow Injection (pFI) Silicate Vertical Profile Data from R/V Investigator IN2023_V04 in the Southern Ocean during June 2023 (pFI-SI-LOV project)

Website: https://www.bco-dmo.org/dataset/931849
Data Type: Cruise Results
Version: 1
Version Date: 2024-07-08

Project
» Collaborative Research: Developing Automated Nutrient and Trace Metal Methodology using Programmable Flow Injection (pFI-SI-LOV)

Contributors	Affiliation	Role
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Abstract
To establish the shipboard capabilities of our newly developed programmable Flow Injection (pFI) silicate analyzer, we collected and analyzed a full-depth vertical profile for silicate (Si) at the Southern Ocean Time Series in the Australian sector of the Southern Ocean in June 2023. For maximum accuracy, the pFI instrument was calibrated using working standards prepared in low nutrient seawater (LNSW, 0-119 umol/L). All 35 individual samples were analyzed in triplicate, the Si(OH)4 data lists the mean of these.

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Coverage

Location: Australian Sector of the Southern Ocean
Spatial Extent: **N**:-46.80044 **E**:142.35452 **S**:-46.80094 **W**:142.35282

Methods & Sampling

Unfiltered seawater samples were collected from the Niskin bottles in acid-washed plastic tubes. The stored samples were immediately analyzed for silicate in triplicate using the pFI assay protocol outlined in Hatta et al. (2021). One key modification was adjusting the holding coils' temperatures to 25ºC instead of the originally specified 50ºC. In tandem with this temperature change, the stop flow time in the flow cell was extended to 60 seconds to ensure the absorbance of the silicomolybdenum blue at 810 and 660 nm product reached a steady state.

We used a miniSIA-2 instrument (miniSIA2, GlobalFIA, Fox Island, USA) equipped with a 8-port LOV unit and a 20 cm flow cell furnished with a Tungsten Halogen light source and UV-VIS spectrophotometer (Ocean Insight, USA) and a 14 position auto sampler (GlobalFIA, USA). The entire system was controlled with FloZF software (v

5.2, GlobalFIA). The system was calibrated using silicate working standards prepared in low nutrient seawater (LNSW, (0-119 µmol L-1 Si)).

Data Processing Description

To accommodate the analysis of Si samples from full depth ocean profiles within the constraints of a 20 cm flow cell, a dual measurement wavelength approach was adopted. For low Si samples (< 40 µmol L-1), the difference between the baseline corrected absorbances at 810 nm and the 1050 nm reference was used. For high Si samples (> 40 µmol L-1), a singular, baseline corrected measurement wavelength at 660 nm was employed. Silicate concentrations were calculated using the mean absorbances (660 nm for Si > 40 µmol L-1 and 810-1050 nm for Si < 40 µmol L-1) and the intercept and slope of the corresponding calibrations curves (660 nm calibration curve for Si > 40 µmol L-1 and 810-1050 nm calibration curve for Si < 40 µmol L-1).

BCO-DMO Processing Description

- Units removed from parameter names in primary data file
- Spaces in parameter names replaced with underscores ("_")

Problem Description

Quality flags represented in the primary data file

1 = good
2 = bad
3 = below detection limit
9 = not sampled

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Related Publications

Hatta, M., Ruzicka, J. (Jarda), Measures, C. I., & Davis, M. (2021). Programmable flow injection in batch mode: Determination of nutrients in sea water by using a single, salinity independent calibration line, obtained with standards prepared in distilled water. Talanta, 232, 122354. https://doi.org/10.1016/j.talanta.2021.122354
Methods

Lebrec, M., & Grand, M. M. (2024). Programmable flow injection: a versatile technique for benchtop and autonomous analysis of phosphate and silicate in seawater. Frontiers in Marine Science, 11. https://doi.org/10.3389/fmars.2024.1354780
Results

Truesdale, V. W., & Smith, C. J. (1976). The automatic determination of silicate dissolved in natural fresh water by means of procedures involving the use of either α- or β-molybdosilicic acid. The Analyst, 101(1198), 19. https://doi.org/10.1039/an9760100019 https://doi.org/10.1039/AN9760100019
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	miniSIA-2 (GlobalFIA, Fox Island, USA)
Generic Instrument Name	Flow Injection Analyzer
Dataset-specific Description	We used a miniSIA-2 instrument (miniSIA2, GlobalFIA, Fox Island, USA) equipped with a 8-port LOV unit and a 20 cm flow cell furnished with a Tungsten Halogen light source and UV-VIS spectrophotometer (Ocean Insight, USA) and a 14 position auto sampler (GlobalFIA, USA).
Generic Instrument Description	An instrument that performs flow injection analysis. Flow injection analysis (FIA) is an approach to chemical analysis that is accomplished by injecting a plug of sample into a flowing carrier stream. FIA is an automated method in which a sample is injected into a continuous flow of a carrier solution that mixes with other continuously flowing solutions before reaching a detector. Precision is dramatically increased when FIA is used instead of manual injections and as a result very specific FIA systems have been developed for a wide array of analytical techniques.

Dataset-specific Instrument Name	UV-VIS spectrophotometer (Ocean Insight, USA)
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	We used a miniSIA-2 instrument (miniSIA2, GlobalFIA, Fox Island, USA) equipped with a 8-port LOV unit and a 20 cm flow cell furnished with a Tungsten Halogen light source and UV-VIS spectrophotometer (Ocean Insight, USA) and a 14 position auto sampler (GlobalFIA, USA).
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

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Deployments

IN2023_V04

Website	https://www.bco-dmo.org/deployment/931763
Platform	R/V Investigator
Report	https://data.csiro.au/collection/csiro%3A59491v3
Start Date	2023-06-05
End Date	2023-06-18
Description	Shipboard data products for this cruise are made available through the CSIRO Data Access Portal: The datasets are curated by the CSIRO National Collections and Marine Infrastructure (NCMI) Information and Data Centre (IDC) in Hobart, with a permanent public archive at the CSIRO Data Access Portal (https://data.csiro.au/). All processed data from this voyage are also made publicly available through the MNF Data Trawler (in the related links).

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Project Information

Collaborative Research: Developing Automated Nutrient and Trace Metal Methodology using Programmable Flow Injection (pFI-SI-LOV)

NSF Award Abstract:

Progress and discovery in the understanding of the chemical processes that regulate the growth of phytoplankton in the marine environment is limited by the ability of oceanographers to measure nutrients and trace metals at relevant spatial and temporal scales. This project aims to develop a new generation of autonomous and highly sensitive nutrient and trace metal analyzers for shipboard use and deployment at coastal monitoring stations, with potential for incorporation into existing autonomous observing platforms (e.g., gliders, autonomous underwater vehicles). Such a development will generate new insights into nutrient dynamics at a range of spatial and temporal scales and provide a new capability to obtain high resolution data sets for nutrients and trace metals in remote areas and environments where sample volumes are limited (e.g., brines, pore waters).

This project will develop novel automated methods for nutrients (phosphate and silicate) and trace metals (aluminium, manganese) using a technology called programmable Flow Injection (pFI). pFI is a microfluidic technique, which allows to automate conventional wet chemical analysis using microliter volumes of sample and reagents while significantly reducing the generation waste. In order to bring low levels of trace metals and nutrients that characterize remote ocean regions into the analytical window of pFI, concentration techniques will also be developed and coupled to spectrophotometric and fluorescence detection. The developed methodologies will be intercalibrated with standard oceanographic methods by participating in a GO-SHIP research cruise and a Hawaii Ocean Time-series cruise of opportunity. The long-term, unattended operation of the pFI analyzers will be evaluated at the Central California Ocean Observing System (CenCOOS) Moss Landing Shore station, where autonomous pFI analyzers will be deployed to undertake a year-long, hourly time series of phosphate and silicate. The data obtained from the shore station will be made publicly available and will complement existing monitoring data from this location, illuminating the connection between deep ocean nutrient dynamics and biological activity in coastal upwelling systems. The newly developed pFI analyzers will be assembled using commercially available components and open source software to facilitate uptake of this new methodology by the chemical oceanography community at large. This project will also support the training and exchange of at least two graduate students at the University of Hawaii at Mānoa and the Moss Landing Marine Laboratories, who will represent the next generation of specialists in the development and application of pFI methodologies to chemical oceanography.

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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1924539

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