# Programmable Flow Injection (pFI) Silicate Underway 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/931760
**Data Type**: Cruise Results
**Version**: 1
**Version Date**: 2024-07-03

**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**
Here we report silicate data (SiOH4) obtained using a programmable Flow Injection (pFI) analyzer connected to the underway seawater system of the RV Investigator during the return transect of the International Nutrient Intercomparison Voyage (INIV). These data were collected in June 2023 at 15-30 min intervals from 52°S, 142°E to 43°S, 147°E in the Australian sector of the Southern Ocean. During this five-day unattended deployment, the pFI instrument operated autonomously for five days, and the resulting surface Si data covered a region spanning from the Polar Frontal Zone (PFZ ~ 52°S) to the vicinity of Hobart Harbor in the Derwent River. The system was calibrated every 24 hours through triplicate runs of a MQ blank and MQ standard (39.7 µmol L-1-Si). Quality control included the analysis of one Kanso RMNS (CR, 14.3 µmol L-1-Si) mid-way through the deployment. These data, obtained using a commercially available pFI analyzer, are used to confirm that pFI is a viable technology for autonomous monitoring of silicate in underway mode.

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## Coverage

**Location**: Australian sector of the Southern Ocean
**Spatial Extent**: **N**:-42.958642 **E**:147.514878 **S**:-52.661337 **W**:142.390989
**Temporal Extent**: 2023-06-12 - 2023-06-17

### Methods & Sampling

Unfiltered seawater samples from the RV Investigator underway lab were aspirated using an auxiliary diaphragm pump (KNF, USA) into a 3 mL sample loop every 15-30 min during the deployment. The stored samples were immediately analyzed for silicate in duplicate 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 660 nm product reached a steady state.

**Data Processing Description**

The FloZF software returns a time stamped mean absorbance at 660 nm calculated from the last 10 seconds of the 60 sec stopped flow time in the pFI flow cell. Corresponding silicate concentrations were calculated using the slopes and intercepts of calibrations obtained every 12 hours during this deployment. All samples were measured in duplicate and the mean silicate concentration is reported here.

Quality flags represented in the primary data file

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

**BCO-DMO Processing Description**

- "Depth" column added to primary data file; all samples were taken at 5 meters depth
- Time column converted from %m/%d/%y %H:%M format to %Y-%M-%DT%H:%DZ format
- Units removed from parameter names
- Special characters removed from parameter names
- Spaces in character names replaced with underscores ("_")
- Latitude and longitude values rounded to 6 degrees of precision

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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

| Parameter | Description | Units |
|---|---|---|
| Time_UTC | Sample date and time in UTC. | unitless |
| Latitude | Sample latitude in decimal degrees; a positive value indicates a Northern coordinate. | decimal degrees |
| Longitude | Sample longitude in decimal degrees; a negative value indicates a Western coordinate. | decimal degrees |
| Mean_pFI_Si_OH_4_concentration | Mean silicate (pFI Si(OH)4) concentration from duplicate sample analysis. | umol/L |
| mean_pFI_flag | Data quality flag for mean silicate value. 1 = good, 2 = bad, 3 = below limit of detection, 9 = not sampled. | unitless |
| Depth | Sample depth. | meters (m) |

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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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