

Joint Ocean Ice Study (JOIS) Beaufort Gyre Observing System (BGOS)

2025 Cruise Report



Report on the oceanographic research conducted aboard the *Canadian Coast Guard Ship Louis S. St-Laurent*

Dates: September 18th to October 23rd, 2025*
IOS Cruise ID: 2025-010

Co-Chief Scientists:

Paul Macoun, Sarah Zimmermann

Fisheries and Oceans Canada, Institute of Ocean Sciences, Sidney, BC

Principle Investigators:

Bill Williams, Fisheries and Oceans Canada

Isabela Le Bras, Andrey Proshutinsky and Richard Krishfield, Woods Hole Oceanographic Institution, USA

Mary-Louise Timmermans, Yale University, USA

* The science program had 25 days within this date range

Contents

1	Overview	5
2	Cruise Summary	7
2.1	Program Components	10
2.2	Comments on Operations	13
3	Program Component Descriptions	19
3.1	Rosette/CTD Casts	19
3.2	Chemistry Sampling	27
3.2.1	Dissolved Oxygen	30
3.2.2	Dissolved Inorganic Carbon	35
3.2.3	Analysis for Alkalinity	37
3.2.4	Stable Isotope of Dissolved Inorganic Carbon ($\delta^{13}\text{C-DIC}$)	38
3.2.5	Colored and Fluorescent Dissolved Organic Matter Sampling	40
3.2.6	Barium	42
3.2.7	Chlorophyll-a	43
3.2.8	Bacteria Sample Collection	46
3.2.9	Oxygen Isotope Ratio ($\delta^{18}\text{O}$)	47
3.2.10	Nutrients	48
3.2.11	Ammonium	51
3.2.12	Biotoxins	55
3.2.13	Microbial communities in the Western Arctic Ocean	57
3.2.14	Salinity	61
3.2.15	Transient Tracers Iodine-129, Uranium-236, CFCs & SF6	63
3.2.16	Biogeochemistry sampling at ice station	65
3.3	Moorings and Buoys (BGOS)	70
3.3.1	Moorings	71
3.3.2	Ice Buoys	75
3.3.3	Buoy Recoveries	80
3.3.4	Sea surface pCO ₂ , pH, and dissolved O ₂	84
3.4	XCTD Cruise Report	87
3.5	Zooplankton Vertical Net Tows	90
3.6	Phytoplankton Vertical SCOR Net Tows	92
3.7	Underway Surface Sea-water Measurements	93

3.8	Underway data logging using SCS	96
3.9	Ice Observations	97
3.9.1	Ice Observations on the ship	97
3.9.2	Observations from the Bridge	98
3.9.3	Ice Camera	100
3.9.4	EM Observation	101
3.9.5	Passive Microwave Radiometer observation	103
3.10	Ice Observations at Ice Stations	106
3.10.1	Overview of ice stations	106
3.10.2	Ice Transects	108
3.10.3	Ice cores	109
3.10.4	Snow Pits	111
3.10.5	Data Descriptions	113
3.11	Ship Performance and Operation in Ice	114
3.11.1	Ship performance monitoring	114
3.11.2	Ship-borne and satellite radar monitoring	117
3.11.3	Future work: Ice breaking monitoring, bubbler	119
3.12	Infrared camera observation	120
3.12.1	Camera system	120
3.12.2	Recorded images (snippets)	122
3.12.3	Sample images	123
3.12.4	Suggestions for improvement	124
3.13	Wave buoys	125
3.13.1	Wave sensor array on ice floe	126
3.13.2	Wave buoy with a floater	127
3.13.3	Suggestions for improvement	128
3.14	Meteorological Buoys (ECCC)	130
3.15	ARGO floats	132
4	APPENDIX	136
4.1	Science Participants	136
4.2	Location of Science Stations	139
4.2.1	CTD/Rosette	140
4.2.2	XCTD	144
4.2.3	Zooplankton – Vertical Bongo Net Hauls	147
4.2.4	Phytoplankton – Vertical SCOR Net Hauls	150
4.2.5	Mooring and Buoy Operations	153

4.3	CTD/Rosette Sensor Configuration	156
4.4	Seawater Loop Measurements	161
4.4.1	Seawater Loop	161
4.4.2	Issues, Settings, Instruments	165
4.4.3	TSG Configuration	168
4.5	Logging of Underway measurements with SCS	169
4.5.1	Issues with the underway system and data	169
4.5.2	SCS Data Strings Defined	172

1 Overview

The Joint Ocean Ice Study (JOIS) is an important contribution from Fisheries and Oceans Canada to international Arctic climate research programs, and is jointly supported by Fisheries and Oceans Canada and the National Science Foundation.

It is a collaboration between researchers from Fisheries and Oceans Canada (Bill Williams) and, in the USA, from Woods Hole Oceanographic Institution (Isabela Le Bras) and Yale University (Mary-Louise Timmermans). The scientists from WHOI and Yale lead the Beaufort Gyre Exploration Project, which maintains the Arctic Observing Network's Beaufort Gyre Observing System (AON-BGOS), funded by the National Science Foundation (NSF).

The 2025 program includes collaborations with researchers from the following nations and institutions:

USA:

- Woods Hole Oceanographic Institution, Woods Hole, Massachusetts
- Yale University, New Haven, Connecticut
- University of Montana, Missoula, Montana
- Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire
- Oregon State University, Corvallis, Oregon
- University of Delaware, Newark, Delaware

Japan:

- Japan Agency for Marine-Earth Science and Technology (JAMSTEC), as part of the Pan-Arctic Climate Investigation (PACI)
- Tokyo University of Marine Science and Technology (TUMSAT), Tokyo
- Kitami Institute of Technology, Kitami, Hokkaido
- Tohoku University, Sendai

Switzerland:

- ETH Zurich, Zurich

Canada:

- Fisheries and Oceans Canada, Institute of Ocean Sciences (DFO-IOS), Sidney, British Columbia
- Fisheries and Oceans Canada, Bedford Institute of Oceanography (DFO-BIO), Dartmouth, Nova Scotia
- Université de Sherbrooke, Sherbrooke, Québec
- Université Concordia, Montreal, Québec

- Environment and Climate Change Canada (ECCC), Meteorological Service of Canada, Toronto, Ontario

Research questions seek to understand the impacts of global change on the physical and geochemical environment of the Canada Basin of the Arctic Ocean and the corresponding biological response. We thus collect data to link decadal and inter-annual variation in the Arctic atmosphere and ocean to basin-scale changes in the Beaufort Gyre Region, including the freshwater content of the Beaufort Gyre, freshwater sources, ice properties and distribution, water mass properties and distribution, ocean circulation, ocean acidification and biota distribution.

Table 1-1. Project Websites

Project	Website Address
Beaufort Exploration Project	https://www2.who.edu/site/beaufortgyre/
Beaufort Gyre Observing System dispatches	https://www2.who.edu/site/beaufortgyre/expeditions/2025-expedition/
Ice-Tethered Profiler buoys	https://www2.who.edu/site/itp/
Ice Mass Balance buoys	https://www.cryosphereinnovation.com/ http://imb-crrel-dartmouth.org/
ARGO buoys	https://argo.ucsd.edu/ https://www.aoml.noaa.gov/argo/
Phytoplankton (we performed ship of opportunity sampling)	https://www.planktoscope.org

2 Cruise Summary

The JOIS/BGOS science program onboard the *CCGS Louis S. St-Laurent* began and ended in Cambridge Bay, Nunavut, from September 18th to October 23rd. In 2025, alterations were made to the Coast Guard crewing schedule to accommodate a 6-week UNCLOS program, which produced a 5-week JOIS trip, instead of the typical 4 weeks. Within this 5-week window, 25 days were allocated to science for completion of the JOIS program. Also, because of the UNCLOS program timing, JOIS was a week later in the season than the previous few years.

The program included 26 scientists and technicians from 12 institutions in Japan, the US, Switzerland and Canada, including 8 students (undergraduate and graduate). One individual was a representative from the operations team (MOL Maritex) tasked with managing the new Japanese Icebreaker *Mirai II*.

There was significantly more ice in the Beaufort Sea this year than in 2024, and the “freeze up” was rapid. Good weather windows in certain regions instigated changes in the normal routing to ensure the more complex mooring operations could be carried out in calmer seas. These three full ocean depth moorings (3.9 km), which collect year-round time-series data, were recovered and redeployed by the Woods Hole Oceanographic Institution (WHOI) team in support of US scientific objectives (Yale, WHOI).

Three “ice stations” were carried out on ice floes. On site work included ice thickness transects, ice coring, water sampling, and the installation of ice tethered buoy systems (WHOI), including three TOPs (Tethered Ocean Profilers), two SIMBs (Seasonal Ice Mass Balance buoys) and one IMB (Ice Mass Balance buoy). Identifying appropriate floes for ice stations was time consuming as the majority of ice floes in the western and central Beaufort consisted of smaller old ice floes “glued” together by new ice. This combination of ice types produced floes that crumbled easily when the ship pressed into them.

Full ocean depth CTD/Rosette casts with water samples were carried out at each station. These casts measured biological, geochemical and physical properties of the seawater. In all, 65 JOIS CTD/Rosette casts for geochemistry analysis were completed, equating to > 300 vertical kilometers of travel in the water column. These casts produced 1,385 Niskin bottles of seawater from various depths for analyses, equivalent to 13,850 L.

Over 50 expendable XCTD probes (temperature, salinity) were deployed in between stations during transits. Data from these probes are used to increase the spatial resolution of CTD measurements taken at stations.

Zooplankton net tows, phytoplankton and bacteria measurements were collected to examine distributions of the lower trophic levels. The ability to carry out net tows was somewhat hindered this year by cold temperatures and stronger winds, with -10 °C and 20 knots of wind being the typical limits for this activity.

Five meteorological buoys were deployed in the northwest Beaufort Sea for Environment and Climate Change Canada (ECCC), providing in-situ real-time data for ground truthing weather models.

Underway measurements were made of the near surface water (~9m) via a pipe in the hull which provided a stream of seawater to a host of instruments onboard. The underway system was periodically impacted by the buildup of ice (slush) at the seawater pump interface.

Continuous measurements of sea ice thickness were made using an over-the-side electromagnetic sensor. In concert, cameras mounted at windows on the bridge recorded ice images in front and at the side of the ship. A bow mounted infra-red camera was installed to continuously measure floe surface temperatures whilst periodic ice measurements were also made using a handheld radar and separate passive microwave system.

Daily dispatches were generated by Jennifer Kosty from Yale University and posted to the following URL: <https://www2.who.edu/site/beaufortgyre/expeditions/2025-expedition/>

Seven ice tethered buoy systems with depleted batteries from previous years were recovered. The five TOP buoys had all lost their 300-800 m tethers and profilers. One of the two recovered Ice Tethered Profilers (ITPs) still had its cable and profiler attached.

The ship travelled 4,451 nautical miles from September 18th to October 23rd, which is approximately the same distance as traveling across Canada from coast to coast.

The location of science stations, the primary sampling at each station, and the total number of each type of station are shown below.

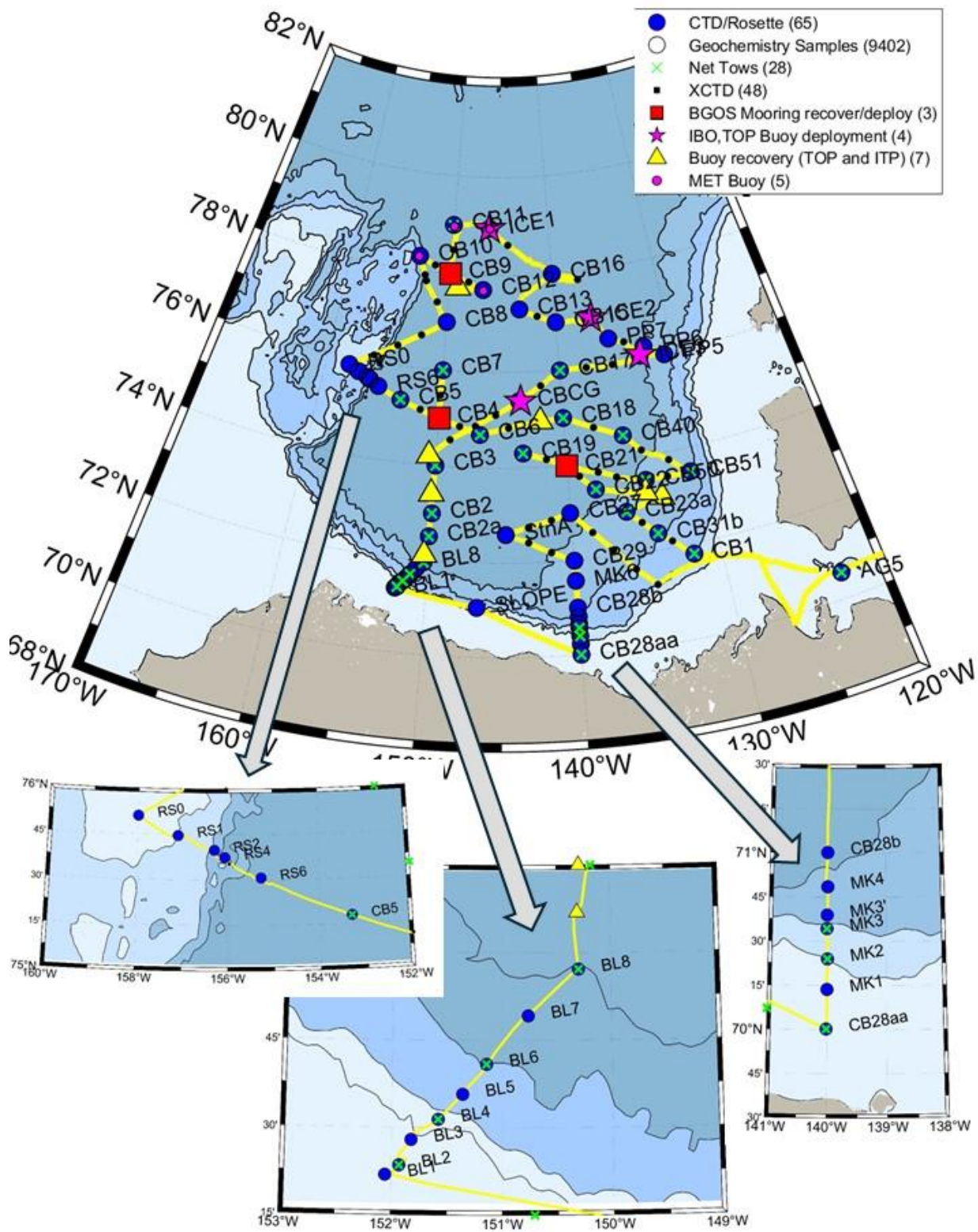


Figure 2-1. The JOIS/BGOS-2025 cruise track showing the location of science stations with station names.

2.1 Program Components

Measurements:

- At CTD/Rosette Stations:
 - 65 CTD/Rosette Casts at 60 Stations (DFO) with 9402 Niskin bottle water samples collected for hydrography, geochemistry and pelagic biology (bacteria, microbial diversity, phytoplankton and biotoxin) analysis (DFO, U. Sherbrooke, TUMSAT, WHOI, Yale, U. Concordia, JAMSTEC, ETH Zurich, U. Delaware).
 - Water samples taken:
 - At all full depth stations: Salinity, dissolved O₂ gas, Nutrients (NO₃+NO₂, PO₄, SiO₄), ¹⁸O isotope in H₂O, Bacteria, Alkalinity, Dissolved Inorganic Carbon (DIC), Fluorescent Dissolved Organic Matter (FDOM), Chlorophyll-a, ¹³C isotope in DIC
 - At selected stations: microbial diversity, transient tracers (radio-nuclides ¹²⁹I and ²³⁶U and gas tracers CFC₁₂ and SF₆), Barium, Dissolved Organic Matter (DOM), Ammonium and BioToxins
 - 29 Zooplankton Vertical Net (“Bongo”) Casts at 29 CTD/Rosette stations. One 100 m cast per station using two nets with mesh size of 150 μm. One set of samples for genetic testing preserved in ethanol and the second set of samples for identification preserved in formalin (DFO).
 - 57 Phytoplankton Vertical Net (“SCOR”) Casts at 26 CTD/Rosette stations. Typically two 20m cast per station using a small SCOR net, mesh size of 20μm. Two casts compared different processing methods. In addition, 5 stations had additional net cast to 80m. Samples were preserved with lugols (ETH Zurich and planktoscope.org).
- 47 XCTD (expendable temperature, salinity and depth profiler) casts to depths over 500m, typically to 1000 m. (DFO, JAMSTEC)
- Mooring operations at 3 sites (WHOI-lead, U. Montana, U. Sherbrooke)
 - 3 Mooring Recoveries and re-deployments in the deep basin (BGOS-A,B,D; WHOI)
- Buoy operations at 11 sites (WHOI, Yale, CRREL, U Montana, NPS)
 - Ice Based Observatory (IBO) #1 Ice Station with:

- Tethered Ocean Profiler (TOP 19 w/ T-chain, WHOI)
- ECCC MetOcean Buoy
- Ice Based Observatory (IBO) #2 Ice Station with:
 - Tethered Ocean Profiler (TOP 21, WHOI)
 - Seasonal Ice Mass Balance Buoy (SIMB3-2025G, CRREL)
 - Ice Mass Balance Buoy (IMB ##, UW)
 - Wave Buoy Array (4 units) (UTokyo)
- Ice Based Observatory (IBO) #3 Ice Station with:
 - Tethered Ocean Profiler (TOP 18, WHOI)
 - Seasonal Ice Mass Balance Buoy (SIMB3-2025H, CRREL)
- Open Water Deployment (OW #1)
 - Tethered Ocean Profiler (TOP 17 with T-chain, WHOI)
- Open Water Recoveries of instruments no longer profiling
 - Recovery 1 Tethered Ocean Profiler (TOP-V12, WHOI)
 - Recovery 2 Ice Tethered Profiler (ITP142, WHOI)
 - Recovery 3 Tethered Ocean Profiler (TOP15, WHOI)
 - Recovery 4 Tethered Ocean Profiler (TOP-V13, WHOI)
 - Recovery 5 Tethered Ocean Profiler (TOP14, WHOI)
 - Recovery 6 Tethered Ocean Profiler (TOP11, WHOI)
 - Recovery 7 Tethered Ocean Profiler (ITP138, WHOI)

Ice Observations (KIT/OSU)

- Visual ice observations were made hourly from the bridge while in ice.
- Automated photographs were taken of the sea-ice from the bridge
 - A camera system (Shipborne Sea Ice Condition Recorder (SSICR)) was mounted in the starboard side of the bridge. It had both forward and downward views, a GPS receiver and inertial sensor. Photographs were taken at 3 minute intervals. (KIT)
 - A forward facing GoPro camera was mounted on the port side of the bridge, recording at 1 minute intervals (DFO).

- Underway ice thickness measurements from and electromagnetic inductive sensor (EM31-ICE) and laser altimeter (LD90-3100HS).
- Ship Performance looking at speed, motor power (kW), and open water and sea-ice conditions
- Passive Microwave Radiation measurements taken at select stations in sea-ice and open water to validate and improve algorithm for estimation of the Arctic snow/sea-ice total thickness from the AMSR2 satellite data[Krishfield et al., 2014].
- Measurements of surface temperature using a thermal camera (Opatrix XI 640) with the goal of estimating sea-ice presence and thickness using the temperature difference between sea-ice, open-water and air temperature.
- On-ice measurements at the ice-stations including:
 - Drill-hole ice thickness transects
 - Snow structure observations
 - Ice-cores for temperature, salinity and structure profiles
 - Ice-cores and water samples for biological sampling.
 - New this year was the installation of a wave buoy array at IBO#2. The purpose of the buoys is to measure waves propagating under the sea-ice. Data were transmitted back to shore via iridium satellite.
- A floating wave buoy was deployed just inside the ice edge with the goal of showing wave dampening during freezeup.
- Underway collection of meteorological, bottom depth, and navigation data, and near-surface seawater measurements of salinity, temperature, chlorophyll-a fluorescence, FDOM fluorescence, and pCO₂. (DFO-IOS, U. Sherbrooke, and U. Montana).
 - Water samples (431) were collected from the underway seawater loop at 238 locations for salinity, nutrients, chlorophyll, DIC, alkalinity (DFO), alkalinity and 18O (TUMSAT), and FDOM (U. Sherbrooke).
- Daily dispatches to the web (WHOI/Yale)

2.2 Comments on Operations

Due to the anticipated ice conditions associated with the timing of the cruise, and the weather patterns encountered along the way, the ship followed an atypical ‘figure-8’ pattern around the Beaufort Gyre. This routing allowed us to perform the mooring operations earlier into the program, ensuring we had good overall conditions for this heavy work. The routing choice also situated the ship in the northern most areas of the gyre where on ice work could be carried out with adequate daylight.

The three full ocean-depth moorings deployed in 2024 were recovered successfully during the first two weeks of the program. The transponders and acoustic releases worked as planned. Two of the three recoveries took place in open water. One mooring (B) was covered by ice, which meant the ship had to take additional time to allow the technicians to confirm the mooring location before then proceeding with breaking up the ice directly above the float. Redeployments of all 3 moorings went well and took place in reasonable conditions (< 2m seas).

There was an ice specialist from the Canadian Ice Service on board. He prepared daily briefings for the ship regarding weather, sea-state and ice-conditions. A significant amount of his time was spent trying to identify suitable ice for this year’s ice-stations. The make up of the larger floes identified via RADARSAT imagery were a conglomeration of small old ice floes “glued together” by new ice. As a result, it proved to be very difficult for the ship to pass through the larger floes (> 2-3 nm across) without rupturing the new ice (20 – 50 cm thick) in between the old ice floes (<50 m across). After much searching, three suitable floes were identified in the NE region of the Beaufort Gyre for the ice-stations.

The three ice-stations started with the “parking” of the ship within the floe. Once the Captain was satisfied the ship was secure in the ice, the gangway was lowered to provide the science team with direct access to the ice, while the ship’s crane transferred the required science equipment from the deck to the ice. The science team was organized into groups with different objectives, which included 1) the installation of buoy systems, 2) survey/transect and coring work, and 3) water sampling.

In general, all of the science activities were conducted successfully. Individual reports on each activity are provided below.

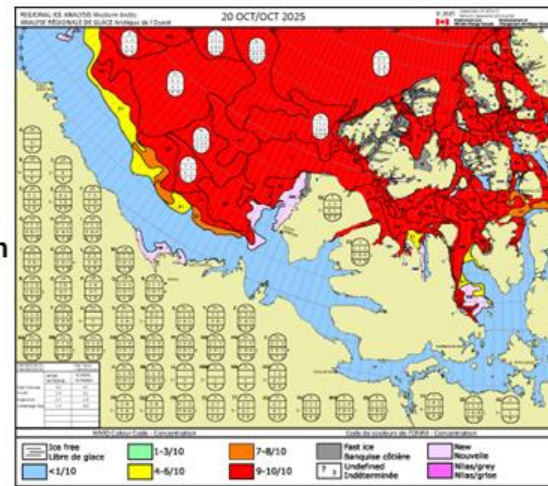
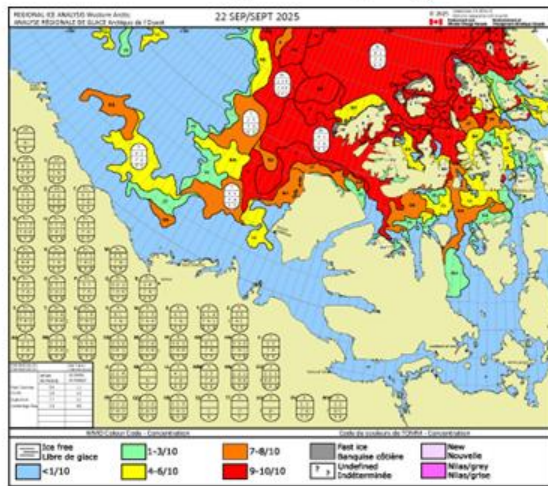
Completion of planned activities

Our primary goals were met during this successful program due to efficient use of time by science and the ship, and the outstanding support from the officers and crew.

Start of Program Sep 22, 2025

End of Program Oct 20, 2025

Concentration



Stage

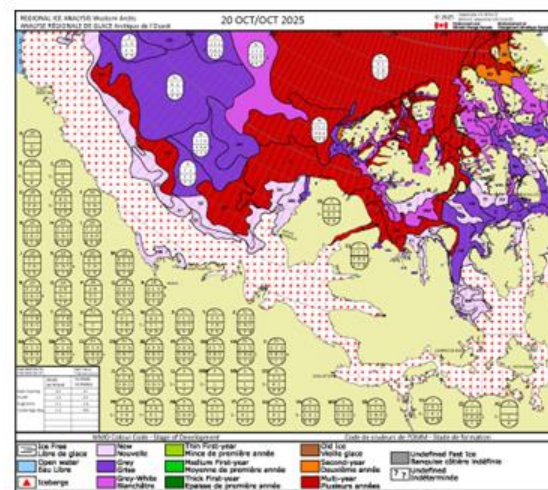
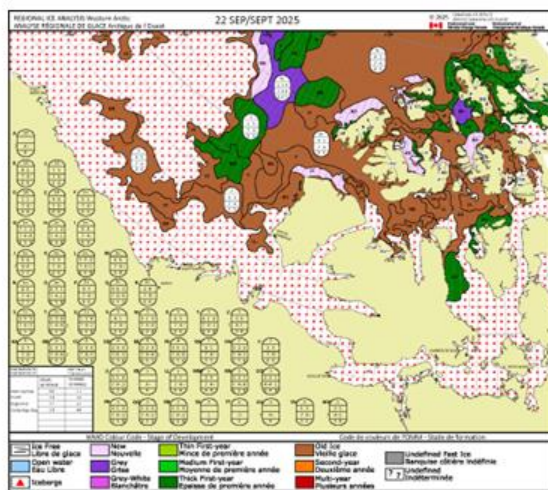


Figure 2.2-1 Ice conditions at the start and end of the program (source: <https://iceweb1.cis.ec.gc.ca/Archive/page1.xhtml>).

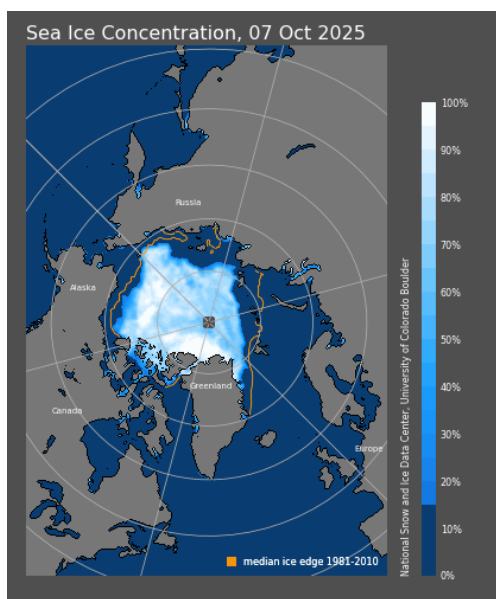
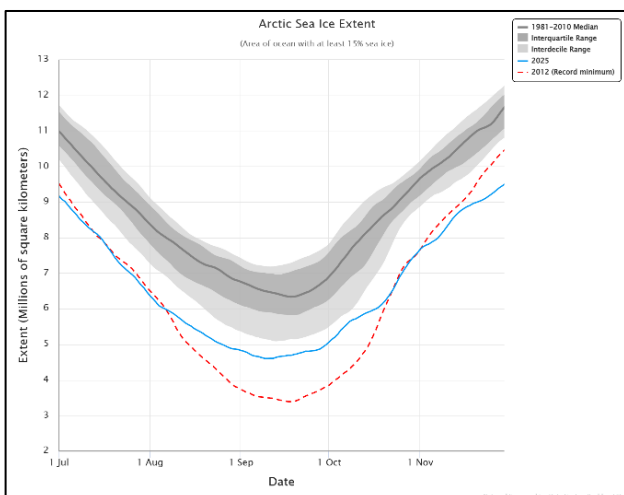


Figure 2.2-2. Sea Ice Concentration from the midpoint of this year’s cruise (7 Oct 2025). Image from the National Snow and Ice Data Center (NSCIDC.org):
https://masie_web.apps.nsidc.org/pub/DATASETS/NOAA/G02135/north/daily/images/2025/10_Oct/



Figures 2.2-3. Sea Ice Extent for all years and a comparison of 2012 (lowest on record) and 2025, from National Snow & Ice Data Center (source: <http://nsidc.org/arcticseaicenews/>)

Graph: <https://nsidc.org/sea-ice-today/sea-ice-tools/charctic-interactive-sea-ice-graph#anchor-working-with-the-images>

Map: [Sea Ice Spatial Comparison Tool | National Snow and Ice Data Center](#) (Not available this year but kept as place holder).

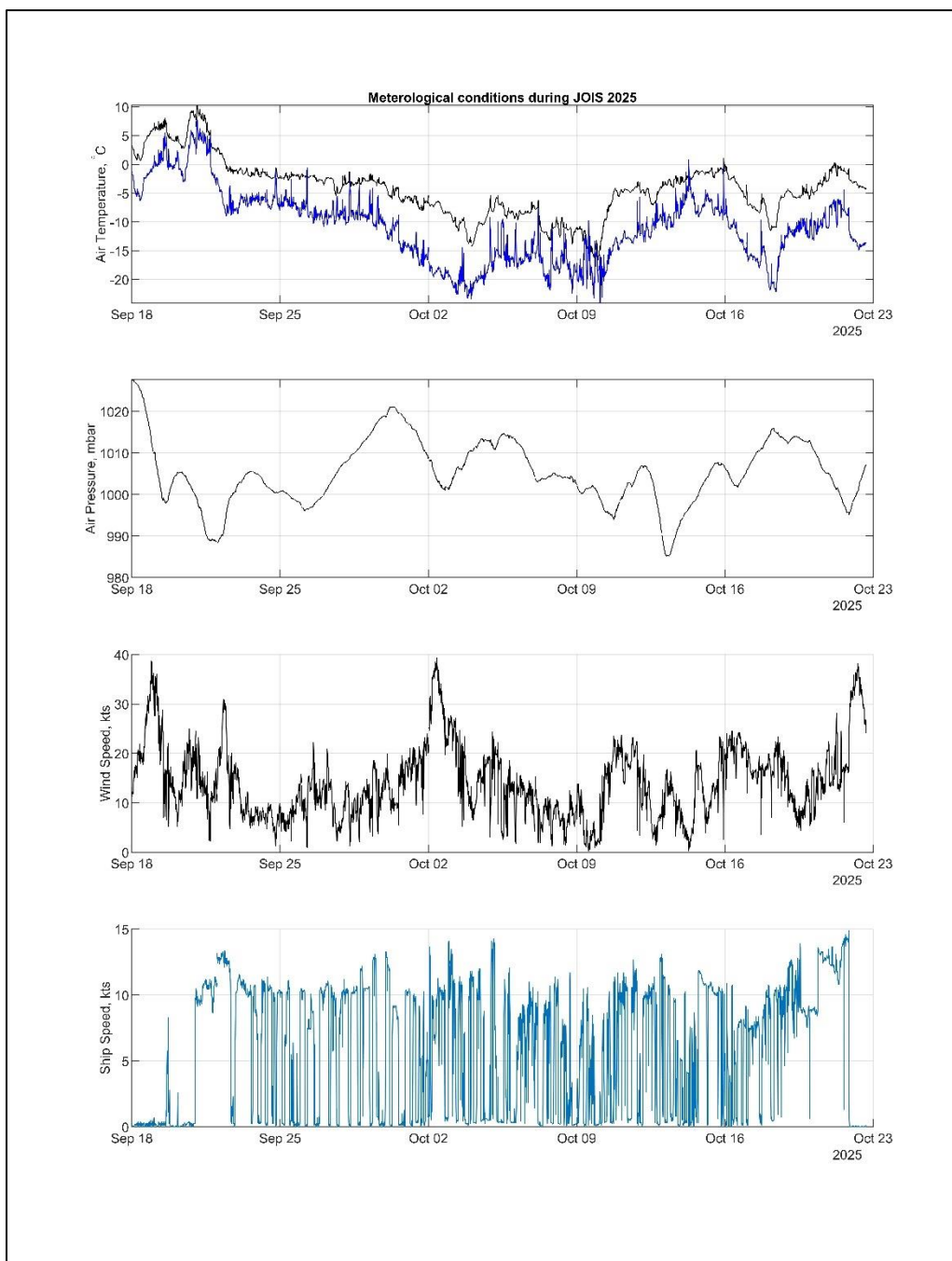


Figure 2.2-4. Temperature (black) and wind chill temperature (blue) in top plot, air pressure (second plot), wind speed (third plot), and ship speed (bottom plot) during the expedition from the ship's AVOS weather station above the bridge of the CCGS Louis S. St-Laurent.

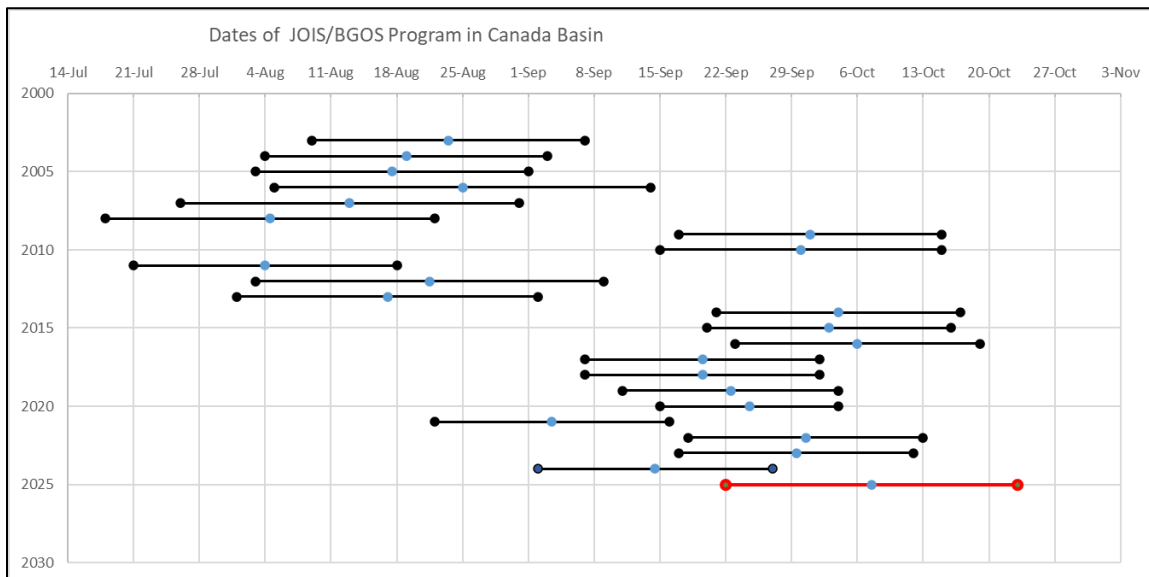


Figure 2.2-5. Start and end dates for all program years. This year is plotted in red. The middle of each program is shown with a blue dot. This year was the latest, but similar to the other years that shared the ship season with the UNCLOS program, 2014 to 2016.



Acknowledgements

The science team would like to thank Captain Byron Briggs, the crew of the *CCGS Louis S. St-Laurent* and the Canadian Coast Guard for their support. We are very grateful for everyone’s hard work and dedication to the delivery of the JOIS program in 2025.

The specialist from the Canadian Ice Service gave daily briefings that were extremely helpful for operational decision making. The Health Officer onboard provided excellent care to the science team. The helicopter pilot and engineer provided great time-savings on crew change days. We’d also like to acknowledge Fisheries and Oceans Canada, the National Science Foundation (USA), the Wood’s Hole Oceanographic Institute (USA), the National Institute for Polar Research (Japan) and the Japan Agency for Marine Earth Science and Technology for their continued support of this program.

This was the JOIS Program’s 23rd consecutive year in the Beaufort Sea, and the exciting and valuable scientific results now in hand are a direct result of the experienced, well trained and professional crews of the *CCGS Louis S. St-Laurent*.

Figure 2.2-6. All crew and science on board.

3 Program Component Descriptions

Descriptions of the programs are given below with event locations listed in the Appendix. Please contact program principle investigators for complete reports.

3.1 Rosette/CTD Casts

Chris Clarke, Paige Hagel, Paul Macoun, Sarah Zimmermann (DFO-IOS)

PI: Bill Williams (DFO-IOS)

Overview

A Seabird 9/11+ CTD system was used with SBE9+ s/n 756 CTD the entire cruise. The CTD was mounted on an ice-strengthened rosette frame configured with a 24-position SBE-32 pylon s/n 1231 with 10L Niskin bottles fitted with internal stainless steel springs. The rosette has been modified to accommodate extra instrumentation by adding an extension on the bottom of the frame.

The data were collected real-time using the SBE 11+ deck unit (s/n 1281) and computer running Seasave version 7.26.7.107 acquisition software. The CTD was set up with two temperature sensors (SBE03), two conductivity sensors (SBE04), dissolved oxygen sensor (SBE43), and chlorophyll fluorometer (Seapoint SCF), all with pumped flow. Also on the CTD was a transmissometer (WetLABS CSTAR-DR), CDOM fluorometer (WetLabs EcoCDOM), cosine PAR (Satlantic) and altimeter (Valeport). In addition, an Alec RINKO III dissolved oxygen sensor was used for comparison and sensor testing purposes for all casts.

Similar to previous years, WHOI added an experimental “D2” CTD sensor and logger battery pack to the rosette frame. The temperature and salinity sensor was mounted as close as possible to the sensors of the SBE9+ in order to be able to reasonably compare data.

A surface PAR sensor (Biospherical QSR2200) connected to the CTD deck unit was integrated into the CTD data for all casts. In addition, a serial communicating surface PAR sensor (Biospherical QSR2150) providing continuous 1hz data was mounted beside the other SPAR unit. Continuous PAR data was collected for the whole cruise. These 1-minute averaged data are reported with the underway suite of sensors.

A typical station started with a CTD cast down to 10 m off the seafloor. While the CTD rosette was in the water, at most stations where weather allowed, a zooplankton vertical net haul (bongo nets) to 100m took place from the foredeck. At 5 stations, both a shallow and full depth CTD cast were performed to capture enough water for additional microbial

diversity sampling (“RNA/DNA”). Extra casts were also sometimes needed at mooring and buoy deployment and recovery sites for calibration purposes. During JOIS 2025, there were a total of 65 CTD/Rosette casts.

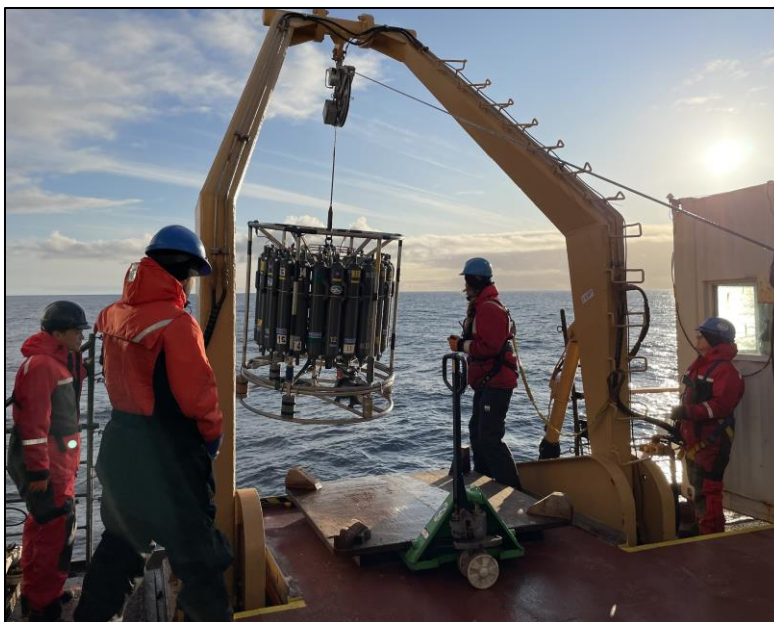


Figure 3.1-1. Typical rosette deployment (photo 2023 but similar for 2025).



Figure 3.1-2. Rosette operation on deck with Hawboldt winch and Brooks Ocean Instrumented Sheave display box mounted on the right.



Figure 3.1-3. CTD operator and acquisition display in the CTD lab.

Typical deployment

On deck, the transmissometer and CDOM sensor windows were sprayed with deionised water with a small amount of Dawn dish soap and wiped with a Kimwipe prior to each deployment. The CTD/Rosette was lowered to 10m and the pumps turned on. This soak cools the sensors to ambient sea water temperature and removes bubbles from the sensor plumbing. After 3 minutes, the package was brought up to just below the surface to begin a clean cast, and lowered at 30m/min to 300m, then at 60m/min to within 10m of the bottom. Routinely, the winch was switched from low to high gear and vice versa at 900m to make operations smoother.

Niskin bottles were closed during the upcast, normally without a stop. For surface bottles, and where multiple bottles were closed at the same depth, the rosette was “yo-yo’d” to mechanically flush the bottle, meaning it was stopped for 30sec, raised 1m, lowered 2m, raised 1m, and stopped again for 30 seconds before bottle closure. The bottles closed using this method are indicated in the rosette log and water sample data spreadsheet (“chemistry spreadsheet”).

For 2025, “yo-yo” Niskin closures were increased to five standard depths to reduce the chance of bottle flushing issues. In addition to the surface (5m), the yo-yo’d depths were at the chlorophyll maximum, and where salinity was 32.3, 33.1 and 34.4 PSU. Due to the ship’s minimal ship-rock due to working in ice and being a large ship, the yo-yo stop of +/- 1m is much more effective at matching bottle to CTD value than a common

alternative used on other ships of a 30second wait. Given the Niskins are 1m long, this artificial mixing is within the same range as the sampling equipment.

The instrumented sheave (Brooke Ocean Technology) provided a read out to the winch operator, CTD operator, main lab and bridge, allowing all to monitor cable out, wire angle, tension and CTD depth during the cast. After the cast the rosette was brought back on deck and rolled using a pallet jack into the heated rosette sampling room.

Performance Notes

CTD

We used the SBE9plus s/n 756 with s/n 1493 as backup. The temperature, conductivity and dissolved oxygen sensors will have pre and post cruise calibrations to compare and decide on best options for data processing. Salinity, Oxygen and Chlorophyll water samples will be used for further sensor calibration. As in 2024, jellies were seen more than just around the BL stations.

All stations:

- Cast 9 (CB19) – jelly caught on rosette frame
- Cast 27 (CB12) – jelly caught on rosette frame
- Cast 21 (RS4) – jelly caught on rosette frame
- Cast 51 (BL3) – jelly caught on rosette frame
- Cast 53 (BL1) – jelly caught on rosette frame

Assembly – Sensors

The CDOM, cosine PAR, altimeter and transmissometer were mounted in roughly the same positions as the last few years. The altimeter was repositioned closer to the bottom of frame on Sept 26, after a “spiky” looking few casts. It was observed that the altimeter cable was also a bit pinched by hoseclamps used to install the D2 temperature sensor.

Pylon/ Water Sampler

We used the SBE32 Pylon s/n 1231 for the entirety of the 2025 cruise. Generally the system performed well, with only one known misfire throughout the whole cruise. In the last few years, we have had issues due to excess lubrication of our conducting cable falling into the trigger mechanisms, but it finally seems the lubricant has washed out to a more reasonable level at this point. We did not require any trigger mechanism swaps this year.



Figure 3.1-4. Water sampling around 24 bottle rosette (photo from 2024 but similar for 2025).

Niskin Bottles

At the beginning of the cruise, in preparation for CFC and SF₆ sampling this year, all niskin bottles were washed with isopropanol, and all o-rings were changed with freshly baked o-rings on the 24 Niskin bottles on the rosette. Silicon rubber o-rings were used on the spigots to reduce sticking in cold conditions. The lanyards were also checked, modified and replaced as needed during the cruise. There were a few integrity problems due to endcap seating with the 24 Niskins. We tracked any pattern issues, and replaced o-rings, spigots, and vent screws, or adjusted spring tension as needed.

Per usual, due to the instrumentation on the rosette, we had to cock some of the Niskins bottom end caps slightly to the side rather than straight back.

Seasave and CTD data

Seasave worked reasonably well throughout. There are still issues when zooming in/out and replotting the display plots with the profile becoming corrupted (graphics only, not the actual data). More computer memory was added prior to the 2022 cruise, however the same problem persisted. We suspect this is a limitation of the Seasave program itself, but again are unsure.

SBE11 Deck Unit

We used one SBE11 deck unit for the duration of the cruise without issue.

GPS feed

The GPS feed managed with GPSgate software worked well this year. No observed dropouts on the CTD computer.

Instrumented Sheave (BOT)

The Instrumented Measurement System (IMS) and the Brooke Ocean Technology (BOT) block bridge display feed worked well throughout the cruise. We used the IMS display on the Knudsen computer and had it distribute the data to the local network.

Temperature and Conductivity Sensors

To test performance issues the temperature and conductivity sensors were swapped during the cruise with different configurations for groups Cast 1 to 41, Casts 41 to 43 and Casts 43 to 65. See the configuration information in the appendix (4.3) for what sensors were in place when.

Transmissometer

Our primary WetLabs CSTAR transmissometer s/n 1052 was swapped with s/n 993 prior to Cast 15 (CB6), due to some anomalous spikyness from 400-600m on the downcast only. At CB6, s/n 993 was found to be spiky throughout the cast, and offset between down and up casts. The fluorometer/transmissometer y-cable was swapped prior to Cast 16. This seemed to resolve the issues, but unfortunately we did not then re-test s/n 1052 with the new cable. So, we are unsure of the status of s/n 1052, and whether the issues seen prior to CB6 were sensor or cable caused.

Altimeter

The Valeport VA500 s/n 80262 mostly worked well, kicking in at full range (99m) without much spiking. We experienced a larger than normal amount of spikes during the casts leading up to Sept 26, so the sensor and cable were inspected and it was found that the cable had been pinched when the D2 temperature sensor was installed. Once rerouted, the altimeter and cable performed without issue. While inspecting the sensor, it was decided to move the altimeter mounting pipe closer to the bottom of the rosette. This leaves even less obstruction, and a more secure mounting arrangement for the sensor.

FDOM fluorometer

The WetLabs FLCDRTD (s/n 8362) fluorometer did not work well, and was noisy at depth. This sensor is new, and never used, so pursuing warranty service is recommended. The WetLabs FLCDRTD (s/n 6677) was swapped in on Sept 24, prior to Cast 7, and performed well.

Surface PAR

Initially, the two sensors (CTD reference PAR and the continuous serial PAR) were mounted in the typical position above the CTD operation area (mid-ship, starboard side), on the railing two decks above the CTD (boat) deck with an unobstructed view over approximately 220deg. The blocked area is due mostly to the ship's crane and smoke stack which are approximately 50 feet inboard, aft and forward of the sensor.

Starting 22 Sep 2025 0046 UTC (entering Amundsen Gulf at start of program, before first cast), this was changed to a higher position, aft on the same deck, mounted on top of the wood dock which was on top of the back portside container.

Cast 13, CB40. SPAR removed to check connection though realized problem was only in the configuration file. No data, but dark out so measurements would be zero.

Cast 14, CB18. SPAR mounted temporarily above the CTD shack during cast.

Cast 15, CB6. SPAR remounted aft above wood dock before station.

Cast 36, ICE-2. SPARs cleaned.

Rinko III dissolved oxygen sensor

An Alec Rinko III s/n 0259 dissolved oxygen sensor was mounted on the rosette next to the SBE43 oxygen sensor for all CTD casts. The RINKO was configured on a splitter Y cable with the Satlantic cosine PAR sensor. Raw voltage measurements were recorded in the Seasave data file using the User Poly option. The Rinko has a fast 2 s response time but is thought to drift between casts. It is hoped that the drift found in this sensor can be corrected for, and the Rinko can be used to provide accurate dissolved oxygen profile data when an oxygen analyst cannot be present on board cruises (programs C30, CBS-

MEA, CROW etc). Analysis of the data collected will be used to prepare a method for independent oxygen measurements. A 2-point calibration was performed on the sensor twice during the cruise, between casts and once shortly after the last station.

The Rinko sensor worked well throughout the cruise, and a 2-point calibration was performed on Sept 22, Oct 18, and Oct 19.

CTD Rosette frame

No issues.

CTD wire issues and re-termination

The CTD wire was new Dec 2021. Wire was cut back ~400m(?) and re-terminated in the spring of 2025 during mobilization.

The wire was heavily lubricated in 2022, and we're still having some issues with excess lubricant in 2025 although much less than the last few years. This excess lubricant was still coming off the wire over the course of the cruise, mostly via the BOT block and level wind rollers. Luckily, we did not experience too much issue with lubricant dripping into the rosette trigger mechanism this year.

Sea cable and communications worked well without issue.

CTD Winch

The CTD winch, the Hawboldt model SRO 75, with 75hp, has been a part of JOIS since 2005. In Dec 2021, 7000 m of new 0.322" 3 conductor UNOLS wire was installed.

Some issues were observed with spooling of the wire on the forward side of the winch drum, where the wire will cross over itself and lay incorrectly when changing direction against the cheek of the drum. This is a persistent issue from previous years. It is possible that the fairlead levelwind rollers are not quite adjusted correctly. This only happened once over the course of the trip, but can otherwise be mitigated by paying close attention and/or slowing down slightly when spooling the forward cheek of the drum.

As in previous years, there was an occasional issue in which the winch hydraulics began surging/pulsing in high gear. The winch can be stopped and slowly restarted to sort out the issue.

Notes from 2023 for reference:

Surging/pulsing in high gear @ ~ 3200m – 3500m wire out. Senior engineer was consulted but there was no obvious issues identified. Issue is resolved by stopping the winch and slowly engaging the valve on the control stick. If the control stick is moved

too quickly (i.e. valve opened too quickly), the winch will surge again. It is possible the valve is faulty, but it is also possible that it is just the limitation of the winch's acceleration with so much wire/weight out. It is suspected that the issue presents itself if the winch operator unintentionally moves the control stick too quickly/erratically at >3000m.

Maintenance suggestions for next year

1. Calibrate T,C&O sensors on SBE 9plus s/n 756
2. Inspect Niskin o-rings and lanyards for replacement of worn items
3. Inspect BOT block cabling; clean off wire lubricant and Loctite retaining screws
4. Make new mounting location for altimeter permanent
5. Consider replacing rosette with different style to alleviate bottle closing issues.

See appendix for CTD sensor configuration and calibration information.

3.2 Chemistry Sampling

The table on the following pages list the sampled properties.

Please see the Rosette Sample Log for the full list of each sample drawn.

Table 3.2-1. Water Sample Summary from CTD/Rosette – JOIS 2025 program

Parameter	Canada Basin Casts	Depths (m) or properties	n (duplicates)	Analyzed	Investigator
Dissolved Oxygen	All casts (geochemistry)	Full depth	1172 (145)	Onboard	Bill Williams (DFO-IOS)
DIC	All casts (geochemistry)	Typically to S=34.7 (5 to 400m)	796 (68)	Onboard	Bill Williams (DFO-IOS), Michiyo Yamamoto-Kawai (TUMSAT)
	Mooring sites and a few on 140W: AG5, CB21, CB4, CB9, CB15, Stn-A, CB27	Full depth			
Alkalinity	Same as DIC, analyzed from same bottle.	Same as DIC	796 (68)	Onboard	Bill Williams (DFO-IOS), Michiyo Yamamoto-Kawai (TUMSAT)
FDOM	All casts (geochemistry)	5, Chl Max, S=33.1, S=34.4, AtlW Tmax, 1000, 2000, DeepTmin, Bot-100	563	Onboard	Celine Gueguen (U Sherbrooke)
	In addition, on all 140W stations and BL-Line sample to match Barium	5 to S=33.1			
Chl- <i>a</i>	All casts (geochemistry)	5-200 (select)	373 (236)	Onboard	Bill Williams (DFO-IOS)
Bacteria	All casts (geochemistry)	5, 20, Chlmax, S=32.3, S= 33.1, 34.4, Tmax, 1000, Bottom	544	Shore lab	Celine Gueguen (U Sherbrooke) David Walsh (Concordia)
Nutrients (NO ₃ +NO ₂ , SiO ₄ , PO ₄)	All casts (geochemistry)	Full depth	1228 (146)	Onboard	Bill Williams (DFO-IOS)
Salinity	All	Full depth	1382 (120)	Onboard	Bill Williams (DFO-IOS)
δ ¹⁸ O	All casts (geochemistry).	5-400 (typically to S=34.7 or 34.8)	813 (66)	Shore lab	Bill Williams (DFO-IOS) Michiyo Yamamoto-

	Mooring sites and some extra stations along 140W: AG5, CB21, CB4, CB9, CB15, Stn-A, CB27	Full depth		Not all collected samples will be analyzed.	Kawai(TUMSAT)
Barium	All 140W stations and BL-Line	5m to S=33.1	192	Shore lab	Celine Gueguen (USherbrooke)
DOM	Along 150W: CB11 to CB-2, and CB-10	A mix: ChlMax and S=34.4 for most and 5m for a few.	24	Shore lab	Celine Gueguen (USherbrooke)
Microbial Diversity (DNA/RNA)	AG5, CB21, CB4, CB9, CB16 (Farthest North)	5, 20, Chlmax, S=32.3, S=33.1, Atl Tmax, 1000, Bot-100	119 (depths, not Niskins)	Shore lab	David Walsh (Concordia)
	StnA, CB31b, CB50, CB40, CB17, PP7, CB15, CB11, CB10, CB8, CB7, CB3, CB2, BL8, CB27, CB28b, RS4, IBO2	5, ChlMax, then "spare" water from above depths			
Ammonium (NH ₄)	150W all stns from shelf to CB2, Slope Stn, 140W all stns from shelf to CB29	5m to S=34.4 (AH)	214 (214)	Onboard	Bill Williams (DFO-IOS)
¹²⁹ I, ²³⁶ U	AG5 (testing), CB1, CB51, CB4, CB7, RS6, RS2, RS1, RS0, CB8, CB9, On-Ice 5m, CB11, CB16, CB13, PP7, CBCG, CB3, CB2, BL4, MK4, MK6, StnA	5m to 1500m (10 select depths)	176	Shore lab	Nuria Casacuberta (ETH Zurich), John Smith (DFO-BIO)
CFC-12, SF6	CB1, CB51, CB4, CB7, CB8, CB9, CB11, CB16, CB13, PP7, CB3, CB2, BL4, MK6, StnA	5m to 1500m (10 select depths)	154	Shore lab	Nuria Casacuberta (ETH Zurich), John Smith (DFO-BIO)
BioToxin	AG5, CB1, CB51, PP7, CB16, CB9, CB4, BL-1, -2, -3, -4, -6, CB28aa, MK-1, -2, -3, CB27, RS4, RS1, RS0, Onice-1	5m, ChlMax, Bottom (sometimes not all 3)	50 (4)	Shore lab	Mackenzie Mueller, Andrew Ross (DFO-IOS)
DIC ¹³ C	Most geochemistry casts.	Typically to S=34.7 (5 to 400m)	536 (44)	Shore lab	Wei-Jun Cai (UDelaware)
	CB4, CB9, CB15, CB21, StnA	Full depth			

3.2.1 Dissolved Oxygen

Erinn Raftery (DFO-IOS)

P.I.: Paul Macoun & Sarah Zimmermann (DFO-IOS)

Overview

Dissolved oxygen concentrations were measured on board the CCGS Louis S. St-Laurent (LSSL) from September 17 – October 24, 2025 during the JOIS mission in the Canada Basin – Cruise 2025-010. A total 1172 samples were collected from 61 stations, with 10-15% in duplicate or triplicate. The cruise started and ended in Cambridge Bay, NU. All samples were analyzed on the SIO Winkler oxygen titration kit. Oxygen concentrations ranged from 5.255 to 10.851 ml/L. The pooled standard deviation (s_p) for duplicate samples was 0.004 ml/L after the removal of 5 outliers based on Chauvenet's criterion. Three duplicates were removed from the study due to an analysis problem. The mean deep water (>3000 m) DO value in the Canada Basin was 6.519 ± 0.009 mL/L.

Pre-cruise preparation

Reagents and Standards

All reagents and standards were prepared in soap and acid-washed glassware and plastic ware and were prepared using chemicals of the highest purity available at the time of purchase. Reagents and Thio were made in 2000 ml and 4000 mL glassware and the KIO_3 standards were prepared in 2000 mL or 1000 mL Class A volumetric flasks. All chemical batches were prepared in 2021, 2022, 2023, 2024, or 2025. Some chemicals were left onboard from the previous year.

Equipment Calibrations

Bottle Top Dispensers: Bottle top dispensers were purchased new in April 2019 – February 2025. Before the 2025 field season the bottle top dispensers were thoroughly cleaned in acid baths for a minimum of 1 hour. Gravimetric checks were performed in March – June 2025 prior to the cruise ensuring the accuracy and precision of the volume dispensed. For the most part the bottle top dispensers worked well. On occasion bubbles were drawn in from the dispensing tip on the NaOH/NaI bottle (common problem that typically develops over the course of a cruise). This problem was remedied by a series of quick flushes periodically on recirculation. At one point in time the NaOH/NaI bottle top dispenser stopped working while waiting to sample a rosette, and needed to be disassembled to clean a valve that was blocked.

Oxygen Sample Flasks: A flask file for 2025 was prepared by Erinn Raftery prior to the cruise and loaded into the appropriate LVO2 directories. All flasks were acid-cleaned prior to the 2025 field season. Calibrations and spot-checks were performed on ~20% of flasks between February – May 2025. 2 new flasks were added to replace those that were broken in 2024.

10 mL Exchange Units: Calibrations were performed in May 2025 to determine the exact volume delivered at 20°C using the broad dosing tip. Both 10 mL exchange units were calibrated with the primary and spare Dosimat base for dispensing KIO₃. For each calibration, ten 10 mL aliquots of deionized water were dispensed into a clean 100 mL glass beaker and each weight was recorded. The mean weight of the 10 aliquots was used along with the temperature of the water to determine the exact volume dispensed at 20°C using the SIO program “glasscal.exe”. The appropriate volume for the exchange unit and Dosimat combo in use was entered into the operating parameters at the beginning of the cruise.

Computers

A new computer was used – Lenovo Thinkpad software installed July 2024. It worked well this year and did not need to be swapped. The efforts of the Arctic Group (Paige Hagel) to go through the cables in the oxygen kits prior to the cruise and make sure all of the serial to USB cables were the same, and that the software/drivers were easily located and tested prior to deployment was very much appreciated and made setup smooth.

Sampling

Samples were collected in nominal 125 mL calibrated ground glass stoppered iodine flasks. Seawater temperatures at the time of sampling were measured with a digital probe thermometer (Fisher Scientific) potted into one arm of a Y-connector with sampling tubing attached to the other two arms (one to the Niskin bottle spigot and one into flask). The samples were immediately fixed with 1.0 mL of MnCl₂ and 1.0 mL of NaI/NaOH, stoppered, and shaken to preserve the dissolved oxygen in precipitate form. Samples were re-shaken immediately after all biogeochemical samples were collected, water-sealed and allowed to settle again to ensure that if any expansion occurred, no precipitate would be lost from the sample. The bottles were then moved to the temperature-controlled (22-24°C) oxygen lab. All samples were analyzed onboard within 48 hours of collection.

Analysis at sea

All samples were analyzed by Erinn Raftery (DFO-IOS) on the Scripps Institution of Oceanography (SIO) Winkler-based UV titration kit B. Refer to previous years' reports

for system details.

Blank and Standard Preparation

Blanks and standards were run just prior to sample runs every day. A dedicated Dosimat was used to accurately dispense either 1.00 mL of KIO_3 for blanks or 10.00 mL of KIO_3 for standards. Blanks and standards were always prepared in ultrapure deionized water and were run in sets of 4 with the criteria that 3 out of 4 titers had to agree to within 0.0003 mL. Generally, this was easy to achieve; only occasionally did an additional set of standards or blanks need to be run. Variability in reagent dispensing was likely the primary cause of poor blank replication as the 2nd titers were generally more consistent. Blanks were not always run with every standard set if no reagent changes had occurred in the interim. The temperature of both the standard and the thiosulfate were recorded by the program and used to correct the delivered mass of both reagents to 20°C in order to calculate the Thio titrant normality.

Analytical Procedure

Prior to analysis each day, the UV light source and stir plate were turned on and allowed to warm up and until stable. The water bath, which holds the sample flasks, was drained, cleaned and refilled with fresh deionized water to ensure good light transmission. The Dosimat lines leading from the Thio and KIO_3 bottles were checked thoroughly for bubbles and were purged as needed. The bottle top dispensers connected to the three reagent bottles and the Dosimat burettes were primed prior to dosing. Stirring was optimized to ensure rapid mixing without drawing bubbles into the light path.

Following the standardization procedure described above, the sample run was started. Sample flasks were inspected for bubbles and the water seal was removed from atop the stopper. A 1.0 mL aliquot of sulfuric acid and a stir bar were added to the flask, which was then placed inside the water bath. The Thio burette dose tip was inserted into the flask and the titration initiated until endpoint was reached. The two options at the end of every sample run were either “FINISH SAMPLE”, which displays the dissolved oxygen (DO) value and resets the Thio burette, or “OVER-TITRATE” (OT), which allows one to salvage a bad titration curve (or an over-shot endpoint) by adding 1.0 mL of KIO_3 standard and re-titrating the sample. The amount of Thio needed to titrate 1.0 mL of KIO_3 is then subtracted by the software from the final titer. After every sample, the DO value was noted on the rosette log sheet. All endpoints were inspected for accuracy and either over-titrated, or had corrected titers determined after the fact by the “O2CHECK” function of the LVO2 software. These updated titers were then entered into the “Recalculations” tab of the dissolved oxygen spreadsheet so that new DO values could be calculated using the relevant flask volume and standardization parameters.

Thio normality

Three batches of Thio (#2101, #2501, #2125MIX) and four batch of KIO_3 standard (#2503x2, #2504, #2502) were used during the cruise and the stability of the Thio for both batches had a maximum change of 0.00040 N.

Precision and Accuracy

Of the 1418 unique samples collected during the course of this survey, 123 were collected in duplicate. Of the replicated samples, average was chosen as the Final DO value except when a problem was noted with it during analysis (i.e. sample redrawn due to bubble addition during fixing). The precision of the dissolved oxygen replicate measurements had a pooled standard deviation (s_p) of 0.004 mL/L after the removal of 5 outliers by the Chauvenet's criterion

Accuracy is much harder to assess than precision but the stability of the deep water (>3000m) DO content in the Canada Basin can act as a proxy reference standard. Although this value has been decreasing over the course of the JOIS program, starting in 2003, and can't be assumed to be completely constant, it has generally been stable over the past decade with an average of 6.53 ml/L (Figure 1). The 2025 value was 6.519 +/- 0.009.

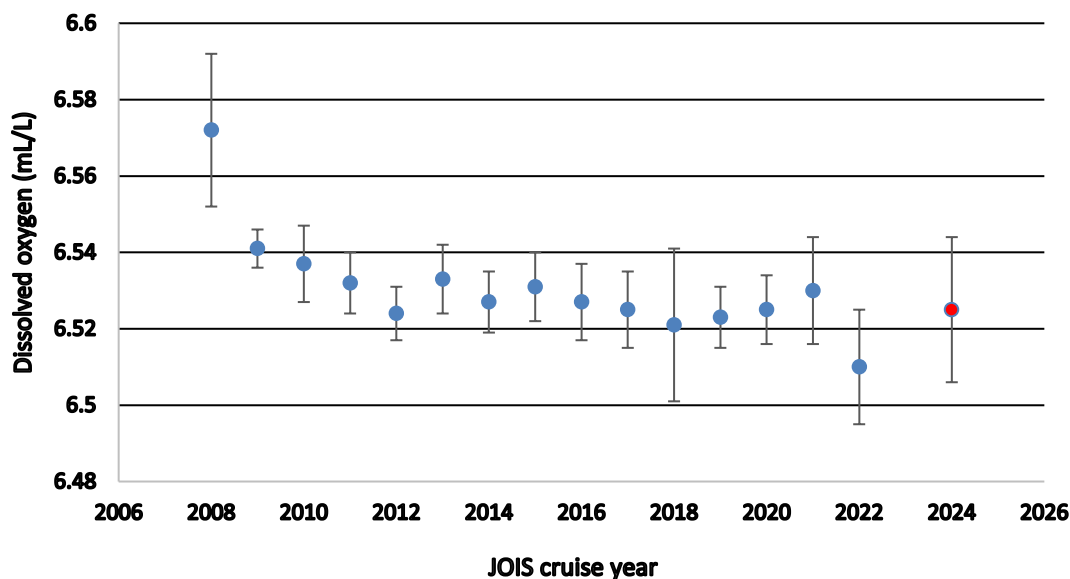


Figure 3.2.1-1. Mean annual dissolved oxygen concentration (mL/L) for the Canada Basin reference stations at all depths below 3000m. Error bars represent standard deviations, 2008 – 2024. (Note: 2023 and 2025 data exist but are not included here).

Issues during sampling and analysis

Occasionally a curve would result with the titration not being displayed until near the end point (e.g. Close to 2.5V). I suspect this may have to do with instability of the UV Detector “0” (e.g. opaque to light). I would like to put a UV film over the Plexiglas that to the water bath to address this.

There were periodically problems with bottle top dispensers (particular NaI-NaOH) getting bubbly. Regular acid-cleaning addressed this for the most part, except for when the aspiration valve was blocked and needed to be disassembled and flushed.

The sink was an ongoing source of frustration – both the drain and hot water line froze about halfway into the cruise. This has been flagged for the ship to address, but I recommend pouring hot water down the drain at least 1x per day, leaving the hot water tap on with a slow drip so that the line doesn’t freeze, and discussing this plan with other lab occupants.

Previous Recommendations & Actions Taken

2024 Recommendations	Action in 2025
Have drivers/software in an easily located place on the desktop for future users.	Completed, all Serial to USB cables & drivers have been updated; there is one type of serial cable per kit, each cable has been tested with the drivers, and the drivers and software have been placed on all computers in an easy-to-locate location on the desktop.
Annually replace the pistons for the exchange units (not sure if the 1mL wears out more often?).	Annual inspection and re-greasing of the pistons has been implemented.
Can something be done to prevent/reduce leaking on the bottle top dispensers?	Use the small tube included to recirculate chemical below the neck of the dispenser.
Replace the UV lamp – gain has to be turned all the way on the last day.	Replaced in May 2025.
There were some issues with dosimat/exchange units not docking easily or not working well together. Are these instruments getting old or require some maintenance to function	I did not experience this problem, but taping them in place can help. I cleaned all the Dosimat connections in the spring which may have helped as well.

more robustly?	
Could or should a fifth bottle of standard be sent out? I feel there is lots of Thio but maybe a little bit limited on standard?	Sent 6 bottles due to UNCLOS and will budget a 5 th bottle when making chemicals for future years.

3.2.2 Dissolved Inorganic Carbon

Marty Davelaar, Yuanxin Zhang (DFO-IOS, Tohoku U)

P.I.: Sarah Zimmermann, Paul Macoun (DFO-IOS)

Sampling

Seawater was transferred to a glass 250 mL reagent bottle following the collection of dissolved oxygen samples. The sampling tube was connected to the spigot of the Niskin bottle and, by holding the tube above the spigot, was rinsed by flowing approximately one tube volume of sea water through the tube. Any trapped air bubbles were removed by tapping or squeezing the tube. The bottle was filled smoothly from the bottom (tubing touching the bottom of the bottle) and the bottle overflowed by two times its volume. The tubing was withdrawn to the neck and the spigot valve closed or the flow in the tubing squeezed off before the tubing was removed from the bottle. One percent of the stoppered sample volume was removed to leave a headspace (about 1 % of the bottle volume - i.e., 2.5 mL for a 250 mL bottle) by inserting a nylon plug into the bottle. All samples were analyzed on the ship using VINDTA 30 and a coulometer 50170. DIC, then alkalinity were measured from the same sample.

From the rosette, 796 samples were analyzed plus 68 replicates. In addition, 25 samples from the TSG system (for pCO₂ calibration) and 2 samples from ice stations were analyzed.

Analysis

Samples were analyzed at sea by Marty Davelaar and Yuanxin Zhang, while on the voyage, using a VINDTA 3D - analysis system to determine the concentration of dissolved inorganic carbon (or total carbon dioxide). The VINDTA (Versatile Instrument for the Determination of Titration Alkalinity) is a sea-going, computer-controlled automated dynamic headspace analysis, constructed in Kiel Germany by Ludger Mintrop of Marianda Instruments. The VINDTA uses a Windows based PC and LabView software along with a coulometric detector (UIC Coulometrics, model 50170). The

VINDTA dispenses and acidifies a known volume of seawater, strips the resultant CO₂ from solution, dries it and delivers it to the coulometric detector.

At the start of each day, seawater was run through the system to condition the cell. Next a system blank was started. If the blank was below 0.50 ug Carbon or approximately 40 counts in a ten minute period a Dickson CRM sample is analyzed to confirm the system is working properly. For each analysis (standard or sample) a peristaltic pump is used to pull the sample out of the bottle and into the water-jacketed calibrated pipette. The water from the pipette is then forced into a scrubber compartment with UHP nitrogen to which approximately 0.5 mL of 8.5 % ortho-phosphoric acid had been added. UHP nitrogen is then pushed through a bottom mounted frit, the nitrogen pushes the CO₂ which has been stripped from the sample by the acid through a Peltier cooler and an Orbo-53 tube which are used to keep water vapor and impurities from entering the cell where the CO₂ is titrated. The coulometer was operated in the counts mode. The software then uses the counts total along with the pipette's temperature, the salinity of the water and other constants to calculate the umol/kg value of each sample. At the start of each sample or standard, the system is rinsed twice with the sample being analyzed and a system clear check is performed to ensure there is no CO₂ in the system. DIC values are not corrected for based on CRM values.

Problems and Solutions

Valves 2 and 3 stopped working part way through the cruise and needed to be replaced. Also the acid pump, valve #1 and the calibrated pipette needed to be replaced as a result of shipping damage.

Some samples from RS1 and RS2 were lost due to possible pipette draining problems.

Precision and Standards

Chemistry Sample	Precision (s_p)	Units	Number of Replicates (n)
DIC	0.95	μmol/kg	65 (after removing 2 outliers)

Table 3.2.2-1. Water Sample Precision

The accuracy of the analysis was assured by daily analysis of certified reference material (batch #219, concentration of S=32.71, DIC=2029.342183.64 μmol/kg; DOE 1994; Dickson 2001; Dickson et al. 2003) supplied by Andrew Dickson (Scripps Institute of Oceanography, San Diego, USA). Precision is given by the pooled standard deviation (s_p) of sample duplicates and was 0.95 μmol/kg, where $n = 65$ pairs.

3.2.3 Analysis for Alkalinity

Michiyo Yamamoto-Kawai, Tsukushi Komura (TUMSAT)

P.I.: Michiyo Yamamoto-Kawai (TUMSAT, michiyo@kaiyodai.ac.jp)

Sampling

During the 2025 JOIS cruise, seawater samples were collected for DIC/alkalinity analysis from 0-400m of the water column at most of CTD/R stations into 250 ml glass bottles. At selected stations, deeper samples (0-bottom) were also taken. Since all the samples on this cruise were analyzed within two days, mercuric chloride was not used to help preserve the samples, instead a Teflon stopper was used to seal the bottle. A total 795 samples were collected from Niskin bottles. Of these, 69 samples were taken in duplicate.

In addition, 190 samples from the TSG system and 2 samples from ice stations were analyzed. Of TSG samples, 25 samples were analyzed for both DIC/alkalinity (for pCO₂ calibration) and 165 samples were analyzed for alkalinity only for the freshwater study.

Analysis

Samples were analyzed for DIC first, and then seawater left in the bottle was analyzed for alkalinity on board. Samples were put in water bath (25 °C) at least 20 minutes before being analyzed. The total alkalinity was determined by potentiometric titration using 0.1N HCl using an open cell system Scripps's alkalinity system (IOS-ID: 876-3) based on DOE (1994). Alkalinity values are reported in units of $\mu\text{mol/kg}$.

At the start of each batch, seawater was run through the system to condition the instruments. Once the system appeared to be working well, certified reference material (CRM) was run to confirm proper operation. The concentration of acid was chosen to give the assigned alkalinity values for CRM. 80 mL of seawater was transferred from the sample bottle to a glass beaker by using a glass syringe equipped with a stopper to take the same volume of sample water every time.

A plot of total alkalinity measurements vs. CTD-salinity was made simultaneously during analysis, and samples that seemed unusual in the plot were re-analyzed. Drift throughout the day was monitored by checking the values of replicate analysis of seawater and/or CRM.

Alkalinity was corrected to the CRM.

Precision and Standards

Chemistry Sample	Precision (s_p)	Units	Number of Replicates (n)
Alkalinity	1.29	$\mu\text{mol/kg}$	66

Table 3.2.3-1. Water Sample Precision

The accuracy of the alkalinity analysis was assured by daily analysis of certified reference material (batch #219, concentration of S=32.71, alkalinity=2183.64 $\mu\text{mol/kg}$; DOE 1994; Dickson 2001; Dickson et al. 2003) supplied by Andrew Dickson (Scripps Institute of Oceanography, San Diego, USA). Precision is given by the pooled standard deviation (s_p) of sample duplicates and was 1.29 $\mu\text{mol/kg}$, where $n = 66$ pairs.

References

- Dickson, A. 2001. Reference materials for oceanic measurements. *Oceanography*. 14(4):21-22.
- Dickson, A. G., Afghan, J. D., Anderson, G. C. 2003. Reference for oceanic CO₂ analysis: a method for the certification of total alkalinity. *Mar. Chem.* 80(2-3):185-197.
- DOE. 1994. *In*: Dickson, A. G. and Goyet, C. (Eds.). Handbook of Methods for the Analysis of the Various Parameters of the Carbon Dioxide System in Sea Water, Version 2. ORNL/CDIAC-74.

3.2.4 Stable Isotope of Dissolved Inorganic Carbon ($\delta^{13}\text{C-DIC}$)

Bo Dong (University of Delaware)

P.I.: Wei-Jun Cai (University of Delaware)

Overview

To better understand how the acidified Pacific Winter Water (PWW) accelerates the subsurface ocean acidification associated with anthropogenic carbon storage, we collected samples for stable isotopes ($\delta^{13}\text{C-DIC}$) analysis. This is the third year of measurements for this new study. Such new observations will serve as a useful tool to distinguish the contributions of dissolved inorganic carbon (DIC) to PWW from air-sea gas exchange and organic matter remineralization. It will also provide more direct evidence that the remineralization of organic matter in the bottom water of the Chukchi/Beaufort Seas mainly contributes high DIC to PWW in the Canada Basin, and

hence strengthens ocean acidification. In addition, we will also gain more insight into seasonal variation of oceanic carbonate chemistry, especially for the late growing season. Finally, observations of $\delta^{13}\text{C}$ -DIC will provide a baseline study for monitoring the long-term trends of anthropogenic carbon storage in the western Arctic Ocean.

Sampling and Analysis

A total of 580 samples were collected from 38 stations, with the sampling procedures following DOE (1994). All samples were collected from Niskin bottles into 250 mL borosilicate glass bottles and preserved with 100 μL HgCl_2 . During sampling, the sampling tube was connected to the spigot of the Niskin bottle and, by holding the tube above the spigot, was rinsed by flowing approximately one tube volume of sea water through the tube. Any trapped air bubbles were removed by tapping or squeezing the tube. The bottle was filled smoothly from the bottom (tubing touching the bottom of the bottle) and the bottle overflowed by two times its volume. The tubing was withdrawn to the neck and the spigot valve was closed or the flow in the tubing squeezed off before the tubing was removed from the bottle. One percent of the stoppered sample volume was removed to leave a headspace (about 1 % of the bottle volume - i.e., 2.5 mL for a 250 mL bottle) by inserting a nylon plug into the bottle. Grease was applied around the ground glass stopper. The stopper was inserted completely and twisted to squeeze the air out of the grease to make a good seal. Finally, a rubber band and a clamp were used to positively reinforce closure, then the bottle was inverted several times to disperse the mercuric chloride solution thoroughly. All samples were stored in a 4°C science fridge and will be shipped back to University of Delaware after the cruise. $\delta^{13}\text{C}$ -DIC will be analyzed using a Picarro-based $\delta^{13}\text{C}$ -DIC analyzer (Su et al., 2019; Deng et al. 2022).

Accuracy

Of the 580 samples collected during this survey, 45 were collected in replicate. The precision of analysis will be evaluated by the results of the duplicated samples. Based on previous practices both in the lab and on board, the analytical precision is better than $\pm 0.05\%$. We will ensure the accuracy of the analysis by calibrating against 2-3 NaHCO_3 internal standard solutions and comparing with selected samples analyzed at the UC Davis Stable Isotope Facility. DIC Certified Reference Materials (CRMs) will also be used for quality control purposes.

References

- DOE. 1994. In: Dickson, A.G. and Goyet, C. (Eds.). Handbook of Methods for the Analysis of the Various Parameters of the Carbon Dioxide System in Sea Water, Version 2. ORNL/CDIAC-74.
- Su, J., Cai, W.J., Hussain, N., Brodeur, J., Chen, B. and Huang, K., 2019. Simultaneous determination of dissolved inorganic carbon (DIC) concentration and stable isotope

($\delta^{13}\text{C-DIC}$) by Cavity Ring-Down Spectroscopy: Application to study carbonate dynamics in the Chesapeake Bay. *Marine Chemistry*, 215, p.103689.

Deng, X., Li, Q., Su, J., Liu, C.Y., Atekwana, E. and Cai, W.J., 2022. Performance evaluations and applications of a $\delta^{13}\text{C-DIC}$ analyzer in seawater

3.2.5 Colored and Fluorescent Dissolved Organic Matter Sampling

Céline Guéguen, Magali Pucet (USherbrooke)

P.I.: Céline Guéguen (USherbrooke)

Summary

Colored and Fluorescent Dissolved Organic Matter (CDOM and FDOM) samples were collected for Céline Guéguen (USherbrooke), following the protocol given below. A total of 559 samples were collected at 56 stations and 87 from the underway seawater loop system between September 23rd and October 21st, 2025 on board the CCGS Louis S. St-Laurent during the Joint Ocean Ice Study-Beaufort Gyre Observational System 2025.

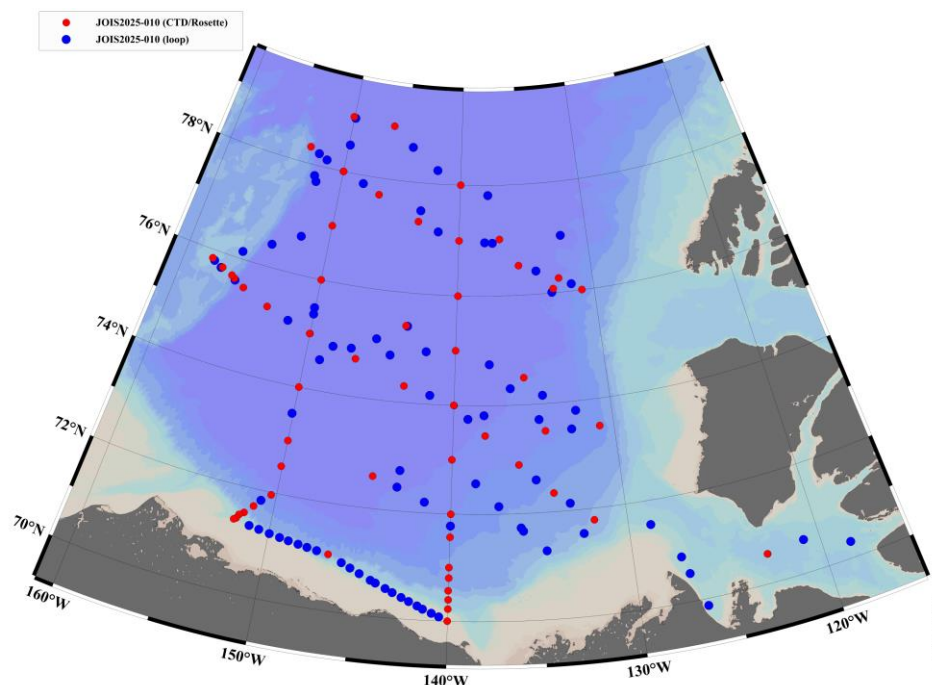


Figure 3.2.5-1: Map of the Canada Basin representing the sampling sites of the CTD/Rosette stations (red) and the loop samples (blue).

Rosette Casts Samples

Samples > 200m

The bottom spigot of Niskin was opened to allow stream of seawater to flush the 40 mL amber glass vial used for FDOM sampling. The vials and caps were rinsed 3X with sample water before collecting the actual sample.

1L water samples were collected for DOM analysis at 1 depth (34.4) at CB04, CB07, RS06, RS04, RS01, CB08, CB10, CB09, CB02 for a total of 9 samples. The samples were acidified and solid phase extracted immediately after collection.

Samples <200m

Samples from depth shallower than 200 m were filtered in line through a pre-combusted GF/F, 47 mm, held in a Swinnex filter holder after the amber glass vials and caps were rinsed three times with the filtered seawater. Approximately 5 mL of seawater was forced through the filter before rinsing and sample collection.

1L water samples were collected for DOM analysis at different depths at different station for a total of 17 samples.

Depths	Stations
33.1	RS06, RS04, RS01, Slope station, BL04
CHL max	CB04, CB07, CB08, CB10, CB09, ICE01, CB02
Surface – 5m	CB08, CB10, CB11, Slope station, ICE01

The samples were acidified and solid phase extracted immediately after collection

Underway Samples and Under Ice Samples

Eighty seven (87) FDOM samples were collected from the underway system while the ship was steaming, generally at XCTD sites. Seawater from the TSG outlet was used to flush the 40 mL amber glass vial used for FDOM sampling. Vials and caps were rinsed 3X with sample before collecting the actual sample. Upon collection of each sample from the underway system, FDOM sensor reading (volts and counts), latitude, longitude, UTC time, sample ID etc. was noted. Samples for nutrients, salinity, and chlorophyll were collected once a day to post-calibrate the sensor.

The USherbrooke real-time FDOM sensor was tested and compared to the old one.

Storage

After collection, FDOM samples were analysed onboard within 12h of collection. The DOM extracts were stored in the -80°C freezer and transferred to the University of Sherbrooke for analysis. A selection of FDOM samples were kept in the fridge (4°C) and will be transferred to the University of Sherbrooke for CDOM analysis.

3.2.6 Barium

Céline Guéguen, Magali Pucet (USherbrooke)

P.I.: Céline Guéguen (USherbrooke)

Background

Barium is naturally released from rocks during the weathering process and is dissolved in river water. The naturally occurring concentration of barium in North America is higher than in Eurasia resulting in different concentrations in rivers from the two continents. When studying the source of fresh water in the Arctic Ocean, the oxygen isotope ratio can identify river water from sea-ice melt, and barium can further distinguish which continent the river water is from (Guay and Falkner, 1998; Guay and Falkner, 1997).

Sampling

189 barium samples were collected along the BL and 140W lines, typically from 5m to salinity 33.1. Barium samples were drawn from the Niskin and filtered at 0.3µm into small (~20 mL) pre-rinsed plastic vials. Once at room temperature the caps were retightened for storage until analysis back onshore.

Analysis

Barium concentrations will be determined at the University of Sherbrooke on an 7800 Agilent inductively coupled quadrupole mass spectrometer using isotope dilution. Briefly, 250 µL aliquots of sample were spiked with an equal volume of a ¹³⁵Ba-enriched solution (Oak Ridge National Laboratories) and diluted with 10 mL of 1% HNO₃.

References

- Falkner, K.K., R.W. MacDonald, E.C. Carmack, and T. Weingartner (1994) The potential of barium as a tracer of Arctic water masses, *in* The Polar Oceans and Their Role in Shaping the Global Environment: The Nansen Centennial Volume, AGU Geophys. Monograph Series, edited by O.M. Johannessen, R.D. Muench, and J.E. Overland, pp. 63-76, AGU Books, Washington, DC (doi: 10.1029/GM085p0063)
- Guay, C.K. and K.K. Falkner (1998). A survey of dissolved barium in the estuaries of major Arctic rivers and adjacent seas. *Cont. Shelf Res.*, 18(8): 859-882 (doi:10.1016/S0278-4343(98)00023-5)
- Guay, C.K. and K.K. Falkner (1997). Barium as a tracer for Arctic halocline and river waters. *Deep-Sea Res. II*, 44(8)1543-1570 (doi: 10.1016/S0967-0645(97)00066-0)

3.2.7 Chlorophyll-a

Erinn Raftery (DFO-IOS), Yuanxin Zhang (TOHOKU).

PI: Sarah Zimmermann & Paul Macoun (DFO-IOS)

Onboard Sampling and Filtering

Chlorophyll-*a* was sampled from the upper ~100m. Samples were taken in single or duplicate (A and B) at all geochemistry stations. All samples were run onboard LSSL within 7 days of collection; no samples are being taken back to IOS for analysis this year.

In addition to the samples at geochemistry stations, 24 loop samples were taken in duplicate (48 total). Samples were drawn from each of the selected Niskins into pre-calibrated 530mL brown Nalgene bottles (calibrated at IOS in 2021-2022). Each bottle and cap was gently rinsed three times with the sample water. The bottle and cap were both filled and the cap was quickly put on resulting in the fullest bottle possible.

The sample water was filtered immediately under low pressure onto ~0.7 μm pore size GF/F 25mm filters. If the samples could not be filtered immediately, they were kept cool and in the dark until filtered, and the time elapsed until filtered was noted. Samples were stored in glass vials and stored in the -80°C freezer until they were analyzed onboard.

Each sample took approximately 10-20 minutes to filter.

Chlorophyll-*a* samples were filtered by Andrew Ross, Collette Leclerc, Marguerite Larriere, Yuanxin Zhang, Erinn Raftery, and Sarah Zimmermann.

Blanks were prepared for each box of filters used throughout the cruise. For each box of filters, two blanks were collected: one in a brown bottle used for sample collection and the graduated cylinder used for spills/etc. Artificial seawater was collected into each. The filters from the blanks were placed in glass vials and stored in the -80°C freezer until analysis. Filtration of the “sample” and handling of the filter with filtered seawater were performed as usual.

Onboard Analysis

Chlorophyll-*a* analysis was performed onboard in Lab B. The Turner Trilogy fluorometer (Arctic Group, Chl Module “A1”) was placed in a fume hood and under green light by Yuanxin Zhang and Erinn Raftery.

The fluorometer was calibrated by Paige Hagel and Erinn Raftery on 23 April, 2025, and the following equations were determined for chl-*a* and phaeopigments:

- Primary stock solution = 4873.02 $\mu\text{g/L}$ chlorophyll-*a*
- Chl-*a* ($\mu\text{g/L}$) = $0.000290 * (1.703 / (1.703 - 1)) * (F_o - F_a) * (v_{\text{ext}} / v_{\text{filt}})$

- Phaeophytin ($\mu\text{g/L}$) = $0.000290 * (1.703 / (1.703 - 1)) * ((1.703 * F_a) - F_o) * (v_{\text{ext}} / v_{\text{filt}})$

where F_o = initial fluorescence, F_a = acidified fluorescence, 0.000290 = slope of calibration curve, $1.703 = F_o/F_a$ = average tau factor from calibration standard curve, v_{ext} = volume extracted and v_{filt} = volume filtered. The calibration was performed using a linear 10 point curve, made from commercially pure chlorophyll a standard (Sigma).

Extraction/Analysis

Samples were extracted in batches of ~ 24. Each sample was extracted in glass scintillation vials with 10.0 mL of 90% Acetone/10% double deionized water for 24 hours at -20°C and in the dark. One hour before sample reading, they were removed from the freezer and placed in the dark to equilibrate to room temperature. Loops and blanks were treated the same as the samples.

Samples were transferred to new borosilicate test tubes before their initial reading (F_o), after which 1 drop of 1N HCl (Reagent grade) were added to the cuvette while sitting in the Trilogy fluorometer. The second readings (F_a) were recorded after one minute.

New borosilicate test tubes were used for each sample to eliminate possible contamination with acid to the next sample. Cleaned scintillation vials were used once at sea and will be returned to IOS for re-cleaning: 2-3 tap water rinses and 2-3 DMQ rinses, vials were baked in a muffle furnace for at least 4 hours at 468 degrees Celsius to remove any organic matter. The lids were soaked in a water-Extran solution (~ 1 capful Extran into 10L hot tap water), rinsed 3 times with tap water, 3 times with DMQ water, and dried at 70 degrees Celsius in an oven.

Quality Control and Assurance measurements and precision

Standards and blanks

Two solid standards (one giving a low and one a high fluorometer reading), and an acetone blank were run before and after each rack of chlorophyll. A filter blank was run for each batch of filters.

The data were corrected by the acetone blank, averaging the values before and after each rack.

Low and high solid state standards were measured each time before and after a rack of samples to track any drift in the system, and were stable throughout the analyses. On some days with cold room temperature, the solid state standards show higher values than expected.

A set of filter blanks collected during the program following the standard collection method were run during analysis. The average of the 16 artificial seawater filter blanks

affected the calculated ChlA by less than 0.002 ug/l. The filter blanks were not applied to the data as the value is too low to have affected the results.

Table 3.2.7-1. Summary of QA/QC measurement during analysis. Values in the Expected column refer to the values measured on calibration day (23 April 2025) while the other values are from the analysis period in September – October 2025.

	Expected	Mean	StDev	%CV	n
Low solid standard (RFU)	40265.26	40622.56	1400	3.45	58
High solid standard (RFU)	149027.01	149829.75	8022	5.35	56
Tau of pure chl- <i>a</i> (Fo/Fa)	2.308	--	--	--	--
T _{room} – to be added	Typically 15 to 20C				
Graduated cylinder blanks (ug/L)	-	0.0006	0.0006	-	8
Brown bottle blanks (ug/L)	-	0.0002	0.0006	-	8
All blanks (ug/L)	-	0.0004	0.0006	-	16

Precision

For biological type data where the variability between replicates increases with measured value we use a relative measure of variability (%CV %relative difference) to determine the precision. For this, we divide the standard deviation of the pair of duplicates by the average and then multiply by 100 for each sample pair. Average %CV for this cruise was 4.72% for 225 duplicate pairs (where avg value was greater than 0.015mg/m³). Of these, 6 had a CV>15% and 0 had a CV>50%. The pooled standard deviation (Sp), of 0.010 ug/l, n=233 after removing 1 outlier identified using Chauvenet criteria.

Notes

- The Room temperature was variable, causing fluctuations in the Solid Standard and Standby Readings (as well as analyst discomfort).
 - We have marked the issue for the ship to fix while in dry dock.
 - We will investigate the temperature logger data against solid standard variability and determine if a correction needs to be made to samples run outside of an acceptable temperature range.
- We had issues again this year with ~30% of the culture tubes purchased from VWR being too big to fit in the cuvette adapter. Likely this is working through the remainder of the tubes purchased last year.
 - We offered the too-big tubes to Celine for use as a reaction vessel for shore-based lab work and she accepted – nice to not have them go to the landfill.
 - ER has had success switching from VWR to FisherBrand for these culture tubes; look into purchasing when we've worked through all the VWR ones.

3.2.8 Bacteria Sample Collection

Céline Guéguen, Magali Pucet (USherbrooke),

P.I. : Céline Guéguen (USherbrooke)

Sampling

Bacteria samples were collected at every station at select depths on all geochemistry casts. Flow cytometry (FCM) samples for bacteria were collected following the protocol given below. Samples were collected and processed alternately by Céline Guéguen (USherbrooke) and Magali Pucet (USherbrooke).

The sample depths were 5, 20, Chlmax, S=32.3, S= 33.1, S=34.4, Tmax, 1000, Bottom. Additional samples were collected along the BL and 140W lines (including MK line) to match the Ba sampling.

The same protocol (see below) used since 2013 was followed this year.

Methods

Sampling:

1. Take one sample from each Niskin bottle. Rinse scintillation vial three times with sample water before collecting actual sample into the vial. Please make note of approximate time elapsed between sampling and adding paraformaldehyde fixative (below).
2. Pipet 1.8 mL of raw seawater sample (now held in scintillation vial) into a 2 mL capacity cryogenic vial. This is done using 1 squirt of pipet set for 1.8 mL. Between samples, 'clean' pipet by drawing and tossing 2 squirts of the new sample, then use next squirt for the cryogenic vial. Use a new tip for each station.

Fixation:

1. Paraformaldehyde (PFA, 10%) stock solutions (10mL) are provided in manufacturer glass ampoules which must be kept at room temperature until use. The ampoules are best opened using the plastic breaking tool supplied. Transfer ampoule contents into a scintillation vial to facilitate pipetting. PFA solution, once opened, should be kept cold (4C) in a refrigerator, but NOT frozen in the freezer.
2. Under the fume hood, pipet 0.2 mL of 10% paraformaldehyde (PFA) into the vial using the eppendorf repeating pipet (repipet). Do this by immersing the tip of the fully-depressed repipet pipet into the PFA, draw up plunger to fill the barrel, and then dispense two times back into the PFA container to help remove bubbles and

- drips from the pipet tip. Next slowly pipet the set 0.2 mL into several of the vials, being careful not to let the tip touch the seawater, nor to make a big splash when the PFA is injected. When there is less than 0.2 mL of PFA left in the repipet, empty and refill the repipet. The repipet can be left with its tip on but cover with aluminium foil to prevent contamination.
3. Note on the repeating pipet settings: The new eppendorf pipet is set on #1 to deliver 0.2mL and uses the blue labeled pipet tips. The old black repeater is set on #2 to deliver 0.2mL and uses the other tips.
 4. Cap each vial using the threaded-screw cover.
 5. Vortex mix the vial, and let it stand at room temperature for not less than 10 minutes.
 6. Place the vial into storage box directly into the -80°C freezer and leave onboard ship for offloading in St-John's NL.
 7. Log samples taken in logsheet recording cast number, niskin number and approximate time between sampling and adding fixative.

3.2.9 Oxygen Isotope Ratio ($\delta^{18}\text{O}$)

Chris Clarke, Paige Hagel (DFO-IOS)

P.I.: Bill Williams (DFO-IOS)

Overview

Oxygen isotopes, ^{16}O and ^{18}O , are two common, naturally occurring oxygen isotopes. Through the meteoric water cycle of evaporation and precipitation, the lighter weight ^{16}O is selected preferentially during evaporation, resulting in a larger fraction of ^{16}O in meteoric water (rain, snow) than in the source water (i.e. seawater). Sea-ice formation and melt on the other hand, does not changes the source water's $^{18}\text{O}/^{16}\text{O}$ ratio (noted as $\delta^{18}\text{O}$) by much. River water is fed from meteoric sources and thus the $\delta^{18}\text{O}$ is a valuable tool used in the Arctic Ocean to distinguish between fresh water from river (meteoric) sources and from sea-ice melt.

Sampling

Samples for $\delta^{18}\text{O}$ were collected at all geochemistry stations, typically from 5 to 400 m depth. At select stations, full depth profiles were collected. Samples were collected into 25 ml glass vials (with Phenolic PTFE/14B Rubber caps) after 3 rinses with sample water. Once at room temperature, the caps were retightened, secured with parafilm, and

the vials inverted for storage. Samples will be analyzed with a Isotope Ratio Mass Spectrometer connected to a H₂O-CO₂ equilibration unit.

3.2.10 Nutrients

Sarah-Ann Quesnel (DFO-IOS)

P.I.: Bill Williams (DFO-IOS)

Sampling

Seawater samples for nutrient determination were collected at every station and depth into new 15 mL polystyrene tubes with no filtering after the tube and cap had been rinsed three times with the sample water. A total of 215 samples were collected in duplicate and stored frozen (-20°C) until analysis day during the JOIS program. During JOIS, a total of 1219 samples were collected, of which 146 were in duplicate. At each station, 2 sets of samples and their duplicates were collected; one set of sample was analyzed onboard within 12 hours of collection, while the other set was frozen at -20 °C for later analysis, if needed. Some samples were re-analyzed from frozen after QA/QC to ensure the feature was real or not.

Frozen samples were thawed at ~45-50°C for 30 min, and let cool to room temperature before being analyzed.

Standards, reference material samples and reagents

Primary stock standards of nitrate (nitrate + nitrite, NO₃, phosphate (PO₄) and silicate (SiO₄) were prepared onboard from pre-weighted dry salts and were calibrated against Kanto certified reference materials lot CS and CR (see table below for certified values). The primary stock standards were prepared in Milli-Q water, using pre-weighted high purity grade dry chemicals (Fluka puriss. grade for sodium hexafluorosilicate, and Fluka ultra p.a. for potassium nitrate and potassium phosphate monobasic), and grade “A” volumetric flasks, according to Barwell-Clarke and Whitney (1996).

A set of 5 working standards, were prepared daily from the primary standard solutions, using freshly prepared 3.4% sodium chloride/0.02% sodium bicarbonate solution and calibrated electronic repeater pipette. Concentrations of the standards were selected to bracket the expected nutrient levels in the samples (NO₃: 0.00 to 23.47 µM, SiO₄: 0.00 to 49.41 µM and PO₄: 0.000 to 2.480µM).

For quality assurance and quality control purposes, Kanto certified reference material (CRM), lot CS and CR, deep water reference (DWR), medium check (2nd lowest working standard) and drift cup (D) samples were analyzed at the beginning, in between stations and at the end of a day’s run.

KANSO	nitrate + nitrite	silicate	phosphate
Lot CO	17.25 $\mu\text{mol/L}$	34.65 $\mu\text{mol/L}$	1.096 $\mu\text{mol/L}$
Lot CR	6.59 $\mu\text{mol/L}$	14.35 $\mu\text{mol/L}$	0.406 $\mu\text{mol/L}$

Table 3.2.10-1: KANSO CRM values

Onboard DWR samples were collected from station CB-21, cast#8, at 3578m depth (sample #171). Water was collected into a carboy after 3 rinses, mixed well and sub-sampled into new polystyrene tubes, frozen at -20°C , and thawed as required in $\sim 45\text{-}50^{\circ}\text{C}$ water.

Reagents were prepared onboard, as required, using ACS grade, or better, dry chemicals (pre-weighted at IOS in May 2025), and water from onboard Milli-Q Direct 8 water purification system that produced $18.2\text{ m}\Omega\text{-cm}$ resistance Type I reagent grade water. The system was supplied with the ship's distilled water, ran through 2 pre-filters removing chlorine and small particles.

Sample analysis

Unfiltered nutrients (nitrate, silicate and phosphate) samples were analyzed within 12 hours of collection by Sarah-Ann Quesnel onboard using a three channel Seal Analytical nutrient Auto-Analyser 3 (AA3), following the methods described by the manufacturer.

A solution of 34 g/L sodium chloride, 0.2 g/L sodium bicarbonate (Sigma, BioXtra grade) was prepared, as needed, and was used to rinse the system between samples, to prepare the working standards and as the blank samples. The platen tubing was changed after 3.5 weeks of running samples, and the pump was serviced at the same time. The cadmium column for nitrate analysis was changed once as Brij reagent was run through the column by mistake, which diminished its efficacy.

At the beginning of each day, the AA3 was allowed to equilibrate for at least 60 minutes, with reagents and wash solutions hooked-up to the platen tubing. Nitrate, phosphate and silicate were analyzed simultaneously with the AA3. A typical sample run would consist of a drift cup, carryover cup, 5 point standard curve, a set of reference material, a set of cadmium column recovery samples, blanks, followed by a station's samples and its replicate. If multiple stations were analyzed in the same day, a set of reference material (medium check, Kanso, DWR, and drift cup) would separate each station. A set of reference material were analyzed at the end of a day's run, along with a second set of cadmium column recovery check samples. After each run, wash solutions were run through the system for cleaning the system for roughly 15 minutes. Data were logged digitally using the AACE software provided with the AA3 system, which calculated all standards, reference materials and sample concentrations, correcting for drift, carryover and baseline. When the nitrate level in surface samples was the same or slightly lower than the sodium chloride solution it was reported as zero.

Precision, Accuracy and L.o.D.

The precision was calculated as the pooled standard deviation (s_p), with outliers rejected by the Chauvenet statistic, and the values for the different sets of samples are given in Table 2 below.

Table 3.2.10-2. Water Sample Precision, L.o.Q. and accuracy summary for UNCLOS.

Chemistry Sample	Units	Minimum Range	Maximum Range	L.o.Q	Precision (s_p)	Number of Replicates (n)	Outliers removed	Accuracy (% recovery)
Nitrate (fresh)	mmol/ m ³	0.00	17.83	0.08	0.03	215	7	98.7-99.8
Silicate (fresh)	mmol/ m ³	1.51	43.59	0.08	0.04	215	9	98.9-99.8
Phosphate (fresh)	mmol/ m ³	0.173	1.979	0.016	0.007	215	11	102.5-103.5

Table 3.2.10-3. Water Sample Precision, L.o.D. and accuracy summary for JOIS.

Chemistry Sample	Units	Minimum Range	Maximum Range	L.o.Q	Precision (s_p)	Number of Replicates (n)	Outliers removed	Accuracy (% recovery)
Nitrate (fresh)	mmol/ m ³	0.00	17.51	0.08	0.02	146	6	96.9-100.6
Silicate (fresh)	mmol/ m ³	2.32	39.03	0.08	0.02	146	7	97.9-99.0
Phosphate (fresh)	mmol/ m ³	0.411	1.934	0.016	0.005	146	8	102.1-104.0

The accuracy of nutrient analysis was assured by daily analysis of Kanso CRM for Nutrients in Seawater (RMNS) (batch CS, NO₃: 17.25 µmol/L, SiO₄: 34.65 µmol/L; PO₄: 1.096 µmol/L, salinity: 34.52 PSU).

Corrections were applied to the samples as follows:

$$[\text{sample}]_{\text{corr}} = [\text{sample}]_{\text{uncorr}} \times \frac{[\text{Kanso CRM}]_{\text{exp}}}{[\text{Kanso CRM}]_{\text{daily avge}}}$$

Where, $[\text{sample}]_{\text{corr}}$ = corrected sample nutrient concentration

$[\text{sample}]_{\text{uncorr}}$ = measured, uncorrected sample nutrient concentration

$[\text{Kanso CRM}]_{\text{exp}}$ = expected Kanso certified material nutrient concentration

$[\text{Kanso CRM}]_{\text{daily avge}}$ = daily average measured Kanso certified material nutrient concentration.

A total of 118 each Kanso certified reference material Lot CS and CR were analyzed to ensure accuracy.

The limit of quantification (the standard deviation of 10 Kanso Lot CR samples X 10 were 0.08 $\mu\text{mol/L}$ for NO_3 , 0.08 $\mu\text{mol/L}$ for SiO_4 and 0.016 $\mu\text{mol/L}$ for PO_4 .

Problems and Solutions

This year, phosphate drift was higher than normal throughout the trip. The software was able to correct properly for the drift, as seen in low %CV of the check samples every day. I suspect it was due to older SDS aliquots being a couple of years old. The newest I had on hand was from 2023. Next year I will bring only new aliquots.

3.2.11 Ammonium

Erinn Raftery, Paige Hagel, Sarah Zimmermann (DFO-IOS), Yuanxin Zhang (Tohoku U.)

P.I.: Bill Williams (DFO-IOS)

Sampling

Ammonium samples were collected for the LSSL 2025-010 program along the Barrow (BL) shelf line and the Mackenzie River (MK) shelf line.

Ammonium samples were collected by the CTD watch, and ammonium concentrations were measured by Erinn Raftery, Yuanxin Zhang and Sarah Zimmermann following the Holmes *et al.* (1999) protocol A (0 to 3 μM), modified for 40 mL sample volume. Samples of 40 mL of seawater were collected into 50 mL acid washed (initially) clear glass test tubes, in duplicate, from 10 L Niskin bottles at each station. Sampling focused on the upper water column, from the surface to the lower halocline around 34.6 PSU. Low ammonium seawater for blanks and standards (0 μM NH_4) was collected from the Atlantic Water Fram Strait Branch temperature maximum (Tmax) from stations

- CB16, Tmax at 430m, Sample 746, collected Oct 7th (2 x 4L amber bottles filled)
- CB2a, Tmax at 465m, Samples 1028 and 1029, Niskin 8 and 9, collected Oct 13th (Carboy filled, then decanted into amber bottle when needed)
- BL8, 600m, Sample 1051, Niskin 7, Collected Oct 13th (2 x 4L amber bottles filled)

Samples were processed onboard in Lab B between 5min and 5.5 hours, though typically within 30min after sampling, by adding the working reagent (WR) to the samples. If samples were not spiked immediately after sampling, they were stored in a 4°C mini fridge in Lab B. After samples and standards had been spiked with WR, they were kept in a buckhorn container under the bench in Lab B to be protected from light exposure and

kept at room temperature. A total of 214 unique samples were collected in duplicate (428 in total) at 17 stations and processed during the cruise along with 13 sets of standards.

Analysis

All glass test tubes and caps (liner-less plastic) were acid washed at IOS in June and packed with a small amount of 10% HCl. During the acid wash, tubes remained in the acid bath for a minimum of twelve hours. After removal from the acid bath, tubes were rinsed three times with Nanopure (DMQ), and 1-2 mL of HCl was added to each test tube. Tubes were then placed in Ziploc bags for shipment.

New for 2025: On board, before the start of sampling, the sample tubes were marked with a permanent marker at the 40mL line, found by adding 40mL of DMQ using a bottle top dispenser. The marked line was then used as reference for filling the tube with 40mL sample seawater from the Niskins during the casts. After adding the line mark, 1mL of working reagent was added to remove any ammonium in the tube, so the tubes were then ready for sample collection. The standard tubes did not need lines but were also filled with DMQ and 1 mL of working reagent so they would have the same treatment. Just before sampling, the tubes were emptied into a waste container. Tubes were rinsed three times with sample before filling.

After the analysis of samples, the sample and WR was kept in the tube. Following the same procedure as the DMQ+WR charged tubes, the WR-sample solution was inverted, disposed of in the Ammonium waste carboy and rinsed three times with sample water prior to collection.

As noted in previous reports, a possible contamination factor for Lab B is the washrooms down the hall. Similar to last year, the ship's crew was asked the not to use cleaning products which contain ammonia when cleaning the nearby washrooms, particularly during sampling/processing on the BL and MK lines. As well, the doors to both washrooms and Lab B were kept closed, and signage was posted to request that cleaning products containing ammonium not be used. We did not post signage not regarding smoking in/around/near the rosette shed, however smokers were asked not to come into the rosette area.

During the 2025-010 cruise, samples and standards were prepared by adding 7.0 (± 0.1) mL of working reagent (WR) to the sample, which was then left to sit in the dark for 8 hours at room temperature (~ 20 °C) in Lab B. After sitting for 8 hours, standards and samples were measured in Lab B with the Trilogy fluorometer and UV/CDOM module. Samples were inverted and then sub-sampled into cuvettes before reading. The fluorometer was operated in UV mode with sensitivity calibrated depending on the expected range of sample concentration, having a range from 0.22 μM standard (s1) –

3.01 μM standard (s8). No samples had concentrations falling outside of calibrated standard curve.

Equipment

- Trilogy Fluorometer model 7200-002 Black SN 721 000530
- Module 7200-067-W Ammonium

Standard and Blank Preparation

Low ammonium water for blanks and standards was collected from the Atlantic Water temperature maximum or slightly deeper (~400 to 600m) from CB16, CB2a and BL8 into acid-cleaned 4L amber bottles or acid-cleaned carboy. When not in use, the Low Ammonium Seawater (LASW) was kept in the fridge in Lab D or the walk in cooler. On average, 3 sets of standards could be made from a 4L bottle, so 2 bottles should have been enough per line (BL and MK) however we ran a test standard before the start of BL and had a bonus station between BL and MK so ended up needing ~3 bottles per line.

Two 4 L batches of the ammonium WR were prepared onboard the LSSL by Jane Eert, however the chemicals never went into solution properly and the WR was disposed of. The problem was discovered to be the sodium tetraborate, as sodium tetraborate decahydrate should have been used. This would have likely been the cause of issues in 2024 as well. A replacement was brought with us to the ship and two new 4L batches were prepared by Erinn Raftery at the start of JOIS. Both batches were used.

All batches were tested prior to sampling.

The standard Ammonium Chloride solutions, primary (2499.48 μM) and secondary (174.96 μM), were prepared onboard by Paige Hagel on 12 October 2025.

Sets of ammonium blank and standards were prepared, one for each station, or group of stations, ranging from 0 μM to 3 μM using a 40 mL bottle-top dispenser and volume calibrated pipettes (S0: 0.00 μM , S1: 0.22 μM , S2: 0.44 μM , S3: 0.65 μM , S4: 0.87 μM , S5: 1.09 μM , S6: 1.30 μM , S7: 2.16 μM , S8: 3.01 μM).

During the cruise there were 13 standard runs in total, obvious outliers were removed and one standard curve had to be tossed. After edits applied, the average r^2 value of the standard runs was 0.9978. The slopes of each linear calibration curve agreed well.

Problems & Solutions

Due to experience with spoilage during shipment, Working Reagent (WR) is prepared fresh on board. Prepared at the start of the trip allows enough time for the WR to stabilize before use at the end of the cruise. This year, Jane Eert prepared WR at the start of the

UNCLOS program (6 weeks prior to the start of JOIS), however there were problems with the sodium tetraborate dissolution. It was discovered this was due to using sodium tetraborate instead of sodium tetraborate *decahydrate*. The correct chemical was brought out with us and a new batch prepared for JOIS which went as expected without any problem.

Contamination appeared to be less of an issue this year (as in 2024) due to the recommendations from previous reports. This year we kept WR in the sample and standard tubes between uses, transported samples from the rosette shack to Lab B in a closed buckhorn. Unlike in 2024 we did not keep lab B door closed and we did not dispense LASW in the rosette shack (it was done in Lab B). We did have a few high blanks that did not fit the standard curve. We wonder if this was due to the LASW or WR dispenser needing more flushes prior to use? The blanks were typically the first tubes to be filled with LASW during standard preparation and first to have WR added. Alternatively it could have been a mistake in standard preparation.

For 2026:

- To share the busy round-the-clock schedule, three people performed the analysis. In the future it would be better to limit this to two. In this way, fewer methods and other variations would be introduced and communication would be simpler. For sampling, typically one person per watch was the designated sampler which reduced variation within sampling.
- Three pipettes were used for making up the standards. The electronic pipette worked well, however there was an issue with a bent charging pin in the pipette. This was bent back and the charger inserted, however it would be good to have a backup pipette in case any of these failed. Backup could be from another analyst (Nutrient, DIC/Alk) but just to be sure we have one.
- Expect to need 12L LASW per line, consider bringing out more amber 4L bottles or use a carboy to store and refill LASW.

Precision

The precision was determined by the pooled standard deviation (s_p) of the duplicate samples.

$S_p = 0.02 \mu\text{M}$, $n=200$ after removing 5 replicate pairs identified using Chauvenet criterion

3.2.12 Biotoxins

Andrew Ross (DFO, IOS)

P.I.: Andrew Ross (DFO-IOS)

Sampling

Biotoxin samples were collected in 1L square plastic PETG culture bottles at select stations and depths. These included CB27, stations along the RS line, and surface water collected from just below the ice 50m along the survey line during Ice Days 2 and 3, which were not sampled in 2024.

The sampling stations (in order of collection) were: AG5, CB1, CB51, CB4, RS4, RS1, RS0, CB9, CB16, OnIce-2, PP7, OnIce-3, BL6, BL4, BL3, BL2, BL1, CB28aa, MK1, MK2, MK3, and CB27.

Samples were collected from the surface (5m depth), the subsurface chlorophyll maximum (SCM), and bottom depth (B-5m or B-10m) at all stations except RS4 (no bottom sample), OnIce stations (surface only), and the BL line stations (no SCM sample, since the chlorophyll maximum was shallow and extended to the surface). Duplicate samples were collected at stations CB51 (surface), CB9 and CB16 (SCM), and CB28aa (bottom).

Following the rosette cast, water samples were collected from Niskin bottles. Biotoxin bottles were rinsed 3 times with sample water before filling. Sample bottles were filled to 1L using the graduation scale on the side of the bottle. Immediately after collection, samples were transferred to the lab for filtration. The approximate time elapsed from collection to beginning of filtration was noted on Biotoxin Filtration Record Sheet.

Following filtration, filters were placed in 5-mL cryovials and stored in the -80 C freezer aft on the Main Deck (500 Level) whereas filtrate was transferred to clean PETG bottles and stored at -20 C in coolers in the Cold Room (559). One sample, from PP7 (bottom), did not filter properly but should still provide accurate measurements of total biotoxin concentrations once the filter and filtrate have been analyzed and the results combined in the usual way.

Many thanks indeed to Collette Leclerc (DFO-IOS) and Dominique Baker (Concordia University) for assisting with the filtration of biotoxin and chlorophyll samples!

Preliminary Results

Preliminary results from samples collected at stations BL1, BL2 and CB28aa in 2024 indicate that several biotoxins including domoic acid (DA), pectenotoxin 2 (PTX2), yessotoxin (YTX), and a number of paralytic shellfish poisoning (PSP) toxins (C1, dcGTX-2 and -3, and GTX-1, -2, -3 and -4) were present at one or more of these locations. The presence of PSP toxins in bottom water at the shallowest stations (BL1 and

CB28aa) is consistent with reports that cysts formed by species of *Alexandrium* that produce PSP toxins have been found in benthic sediments on the northern coast of Alaska (Anderson et al. 2022). Dissolved DA was also found in bottom water at BL1 and at the SCM at BL2 whereas PTX2 was highest in surface waters, and at the SCM at BL2. YTX was highest in surface water at CB28aa, near the mouth of the Mackenzie River. Both YTX and PTX2 were found in filter as well as filtrate samples, suggesting that cells capable of producing these biotoxins (e.g. species of *Protoceratium*, *Gonyaulax* and/or *Dinophysis*) may also have been present.

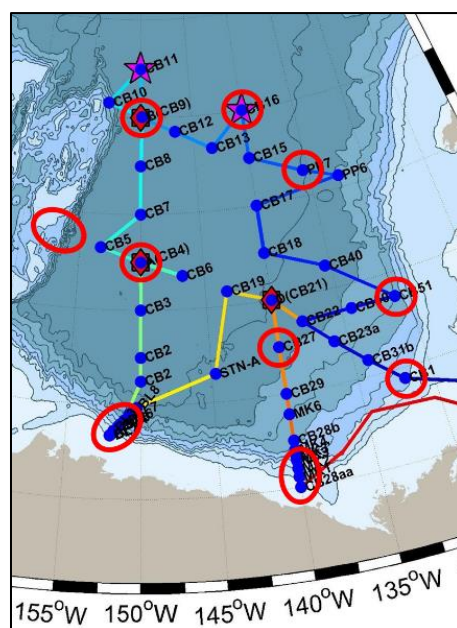


Figure 3.2.12-1: Biotoxin sampling locations during JOIS 2025.

3.2.13 Microbial communities in the Western Arctic Ocean

Biogeography, taxonomic diversity, and metabolic functions of microbial communities in the Western Arctic Ocean

Dominique Baker (Concordia University)

P.I.: David Walsh (Concordia University)

Introduction

Rising temperatures and atmospheric CO₂ are altering the ocean's chemistry and circulation, causing intense stress on the foundations of marine food webs such as microbes. The Arctic Ocean is experiencing fast environmental change brought about by a changing climate, leading to a decline in its ice cover. Our efforts to assess microbial diversity have shown that Arctic communities are altered by environmental change. This project aims to determine if the taxonomic changes in microbial assemblages observed in the Arctic are accompanied by genomic and metabolic changes which may potentially impact ecosystem functioning.

Methodology

This year we started the JOIS cruise from the South of the Beaufort Sea, in a counter clockwise direction in the Canada Basin starting at AG5. The JOIS cruise track followed a general path North following transect 140 W and proceeded west then south down transect 150 W in the Beaufort Sea, in a counter clockwise direction in the Canada Basin, with a few deviations to avoid unfavourable weather conditions. Water column samples were collected at a total of 23 stations to cover a range of previously studied stations (between 2012-2024). The cruise proceeded in the order: AG5, CB31b, CB21, CB19, CB50, CB40, CB4, CB7, RS4, CB8, CB10, CB9, CB11, CB16, CB15, PP7, CB17, CB3, CB2, BL8, CB28b, StnA, and CB27. Samples were collected at eight depths per station: surface water (5m), 20m, SCM (subsurface chlorophyll maximum), the Pacific Summer Water (salinity of 32.3PSU), Pacific Winter Water (salinity of 33.1PSU), temperature maximum, Atlantic water (1000m), as well as either 100m or 10m from the bottom at CB31b, CB21, CB40, CB4, CB9, and CB16. Samples were collected at 2 depths, surface water (5m), and SCM (subsurface chlorophyll maximum) for all remaining stations and depths at which water could be salvaged, as depicted in **Table 1** (save for IBO2 where only surface was collected and CB19 where only bottom water was collected).

Stations	Depths Sampled							
	Surface	20m (mixed layer)	SCM	32.3 PSU	33.1 PSU	Tmax	Atlantic water	Bottom
AG5	x	x	x	x	x	x		x
CB31b	x	x	x	x	x	x	x	x
CB21	x	x	x	x	x	x	x	x
CB19								x
CB50	x	x	x	x	x	x		x
CB40	x	x	x	x	x	x	x	x
CB4	x	x	x	x	x	x	x	x
CB7	x	x	x		x			
RS4	x		x		x	x		
CB8	x		x				x	x
CB10	x		x	x	x	x		
CB9	x	x	x	x	x	x	x	x
CB11	x		x	x				x
CB16	x	x	x	x	x	x	x	x
CB15	x	x	x		x			
IBO2	x							
PP7	x		x	x				x
CB17	x	x	x		x			
CB3	x		x	x			x	
CB2	x		x				x	x
BL8	x	x	x		x			
CB28b	x	x	x		x			
StrnA	x		x					
CB27	x	x	x		x			

Table 3.2.13-1: Table depicting which depths were sampled (x) at each of the stations following the cruise track. Meta stations are depicted in blue.

Seawater filtration

Stations AG5, CB4, CB9, CB16, and CB21 were designated as Meta stations, where a greater volume of water was collected for DNA/RNA extractions. At all other stations water was collected according to what could be salvaged save surface water (5m), and SCM (subsurface chlorophyll maximum) from which 7L of water was taken every time. Water was filtered first through a 3 μ m filter and then through a 0.22 μ m filter. The first filter collected organisms greater than 3 μ m and that which filtered through was collected by the 0.22 μ m filter. When all water had been filtered through the apparatus they were contained and preserved with RNAlater® solution and then stored at -80°C.

Single Cell Genomics

For each station and depth, 1.8 mL of sample were gently mixed with Glycerol-TE buffer before freezing at -80°C for single cell genomic sequencing.



Figure 3.2.13-1: Picture of student on board (Dominique Baker) preparing to preserve DNA samples while another set of water samples filters.

Additional Activities

Isolation Culture

At our most Northern and Southern Meta Stations (CB21, CB16) 1.5mL of seawater was collected from 20m, SCM (subsurface chlorophyll maximum), Pacific Winter Water (salinity of 33.1PSU) and the temperature maximum. Following this, 375 μ l of a 50% V/V glycerol/filter sterilized seawater solution was added to each vial and gently mixed; they were then stored in a cooling container at -80°C.

Below Ice Water Collection and Filtering

This year surface water from below the ice was collected from an ice floe (IBO2) at (77°0.70N, 136°43.120W). Before collection a 5L carboy was rinsed according to protocol with 0.1M HCL. The water was collected by drilling an 8in hole in the ice and hand-hauling a 1.7L niskin bottle. This process was repeated until the desired water volume was procured. Prior to filling the carboy, sampled water was used to rinse the carboy 3 times. Water was collected from approximately 1-2 meters below the ice edge.

The sampled water was left to thaw for approximately 2 hours once on board due to partial freezing during sampling. It was then filtered following the methods discussed for filtering seawater above and preserved as per the same protocol.

Issues

Broken Pump

Upon arrival onto the ship, pumps and tubes were tested for potential leaks. However, it was discovered that one of the pumps was not functioning. Further inspection found the source of the issue to be a stripped gear preventing the connection between the pump and the gear heads from spinning the tubing holders. Numerous efforts by crew engineers and Chris Clarke to rebuild the gear piece were greatly appreciated but unfortunately unsuccessful. This meant sampling from all 8 depths was much more time consuming and rarely possible as the program continued. For future cruises it would be ideal to have a spare pump on board, or at least a repair kit with spare parts.



Figure 3.2.13-2: Image showing the stripped gear causing the issue with the pump.

3.2.14 Salinity

Analyst: Chris Clarke, Paige Hagel, Erinn Raftery, Collette Leclerc (DFO-IOS), Marguerite Larriere (ETH-Zurich)

P.I.: Bill Williams (DFO-IOS)

Sampling

Salinity samples were collected from nearly all bottles on all rosette casts to be used for calibrating the CTD salinity and to verify Niskin sample was from intended depth. Salinity samples were collected in 200 mL glass bottles sealed with disposable nylon inserts and screw caps. Approximately 10% of samples were collected in duplicate and stored in a separate case to be analyzed independently. Water samples were collected from Niskin bottles immediately following a rosette cast, after dissolved gas and other sensitive samples were collected. Salinity bottles and inserts were rinsed 3 times with sample water before filling. Samples were transferred to the temperature controlled lab for storage until they were analyzed onboard.

Analysis at Sea

All samples were analyzed onboard during the program. Samples were given time to reach room temperature before being run on the salinometer. The procedure followed is outlined in the standard IOS protocol for salinity analysis. Room and sample temperature was maintained consistently between 21°C and 24°C as much as possible.

An order placement system was established within the room whereby salinity cases were cycled in order to establish a constant sample temperature. This system ensured two things: 1) the analyst knew which case to begin with and the location of each subsequent case, and 2) each case was held at a stable temperature for an extended period of time before analysis. Bottles were inverted and mixed prior to analysis.

IAPSO Standard Seawater was measured before the beginning of every other day of analysis to standardize the instrument and identify drift, or if the standby number changed by more than 2 units.

The standard water used was batch P167

OSIL batch P167, expiry 21 Feb 2026, K_{15} Value = 0.99988, Salinity = 34.995 PSU

If the standard's conductivity ratio obtained was within ± 0.0001 of the standard K_{15} value on the bottle, the value was accepted. If the value was greater, the cell was flushed and another reading was taken. If the ratio fell outside this range, the standardize dial was used to bring the conductivity reading back into specification.

Deep water reference samples (DWR, see below) were normally run at the beginning and end of each sample case (24 samples), or more often if deemed necessary to assess instrument stability.

Data are reported in practical salinity units (PSU; Lewis & Perkin 1978). **Error! Reference source not found.** Five sets of deep water reference (DWR) samples were collected throughout the cruise:

- DWR-UNCLOS09: Station UNCLOS-09, Cast 6, Niskin 3 sal= 34.9511 PSU
- DWR-973: Station CB3, Cast 43, Niskin 1, depth 3724 m, sal= 34.9521 PSU
- DWR-757: Station CB13, Cast 34, Niskin 1, depth 3682 m, sal= 34.9544 PSU
- DWR-312: Station CB6, Cast 15, Niskin 1, depth 3674 m, sal= 34.9550 PSU
- DWR-121: Station CB22, Cast 22, Niskin 2, depth 3109 m, sal= 34.9398 PSU

To collect the reference samples, the remaining volume of each Niskin was collected into an 10L plastic carboy and mixed thoroughly before sub-sampling into individual 200 mL salinity bottles for storage and analysis as outlined above.

Precision and Accuracy

Precision is given by the pooled standard deviation (s_p) of sample duplicates and was 0.0034 PSU, where $n = 111$ pairs after removing 4 outliers identified using Chauvenet criteria.

Issues with Salinometer

Persistent small bubbles on cell 3 and cell 4, less so on cell 1 and 2: This has been a persistent problem in the last few years. The bubbles were monitored for changes in size and location, but are not able to be eliminated entirely. If a bubble becomes transient during a reading, then it can cause spikes in the readings, so most samples were read without the pump running this year.

Glass cell has some growth/scum: The glass cell has some sort of organic looking growth, perhaps from getting left drained but wet in previous year. Cleaning with CLR and Triton X after sample 482 did not do much to clean it or rid the cell of bubbles, but it did damage the silicon seals at the top of the glass cells. Cleaning was not attempted again throughout the cruise, and did not present any issues otherwise.

Airlock issues on cell 3 and cell 4: After cleaning the system with CLR and TritonX after sample 482, cells 3 and 4 developed a consistent airlock when filling the cells. Autosal was opened up and silicon seals were repaired by adding more silicon. The small tubing above the cells was also inspected, and flushed with MilliQ water. This seemed to fix the issue for the most part, but did not change the persistent bubble issue.

Electronic connections between Autosal and computer: After opening the AutoSal to fix the silicon seals, we observed an issue in which the observed value on the digital readout was not matching the recorded value in the electronic log (program). We ran one case of samples (541-564), and then discovered that the ribbon comms cable had been pinched

when resealing the Autosal. The spare ribbon cable was installed, and the mismatching reading and recorded values issue was resolved. (Mismatched readings also needed for samples 519 and 520).

DWR giving low values. DWR was subsampled from a carboy, which was filled from a Niskin. This allows for us to consistently mix the sample and avoid issues with stratification within the Niskin during sampling. Unfortunately, DWR-121 gave us inconsistent and low values. It is suspected that the carboy and/or sample bottlers were not fully rinsed of MilliQ water.

Recommendations

- Check all tubing within the salinometer for integrity. Leaks have been a problem for 2 (or 3 years).
- Bubble issue on conductivity cell electrodes C3 and C4. This has been a problem for 2 (or 3 years). This may require factory fixing and calibration of cells if fix is not possible in house.
- Silicon seals on cells 1 and 2 need proper repair. It is recommended to get factory repair and calibration, as last calibration was March 2023, and we've had consistent issues with these cells since that time.
- Spare ribbon cable to connect Autosal to logger interface.

3.2.15 Transient Tracers Iodine-129, Uranium-236, CFCs & SF6

Annabel Payne, Marguerite Larriere (ETH Zürich)

PI: Núria Casacuberta (ETH Zürich), Toste Tanhua (GEOMAR)

Background

Transient tracers are introduced to the oceans with a time-dependent signal, allowing the study of time-scales of oceanic processes such as water transport times from one location to another, or deep water ventilation. The anthropogenic radionuclides iodine-129 and uranium-236 are introduced into the ocean by two main mechanism; the release into the atmosphere during nuclear weapons testing in the 50s and 60s and subsequent deposition into the oceans, or by nuclear fuel reprocessing releases, with Sellafield (UK) and La Hague (France) being the two sources from Europe that are then transported into the Arctic Ocean. A second family of transient tracers, the gas tracers, are also anthropogenic in origin. These include chlorofluorocarbons which were released into the atmosphere

from the 1930s, before it was discovered their ozone depleting effects and their use phased out. A second gas tracer is sulphur hexafluoride (SF₆), which is used as an electrical insulator, with atmospheric concentrations of the gas still rising. These tracers are all used in the transit time distribution method to estimate transport of Atlantic and Pacific Waters in the Arctic Ocean.

Motivation

To date, no study has specifically targeted all four tracers to test their interchangeability and therefore robustness of the method. Additionally, the gas tracers have not been sampled in the Canada Basin since 2015, and provide the only tracer pair capable of investigating ventilation times of Pacific Water.

Sampling

During JOIS/BGOS 2025 approximately 160 samples were collected for analysis of CFCs and SF₆ spanning surface to 1500 m depth from 15 stations. Niskins were pre-cleaned with isopropyl alcohol and rinsed with milli-Q water, and all o-rings were swapped out with freshly cleaned and baked rings to reduce risk of contamination from grease or other sources. Gas samples were collected first from the Niskins into 500 ml glass ampoules using stainless steel tubing. Headspace was created by flushing with ultra-pure N₂ gas; ampoules were then flame sealed by melting the stem of each ampoule to create an airtight seal. Gas samples will be shipped to GEOMAR, Germany for analysis. Approximately 200 samples were collected for analysis of iodine-129 / uranium-236. 2-3 L Samples were collected last from the niskins into triple rinsed 3 L LDPE cubitainers or 1.9 L PET juice bottles and packed for shipment to ETHZ where processing and analysis will be carried out.

¹²⁹I, ²³⁶U Sampling at stations:

AG5 (testing), CB1, CB51, CB4, CB7, RS6, RS2,RS1, RS0, CB8, CB9, On-Ice 5m, CB11, CB16, CB13, PP7, CBCG, CB3, CB2, BL4, MK4, MK6, StnA

CFC-12 and SF₆ Sampling at stations:

CB1, CB51, CB4, CB7, CB8, CB9, CB11, CB16, CB13, PP7, CB3, CB2, BL4, MK6, StnA

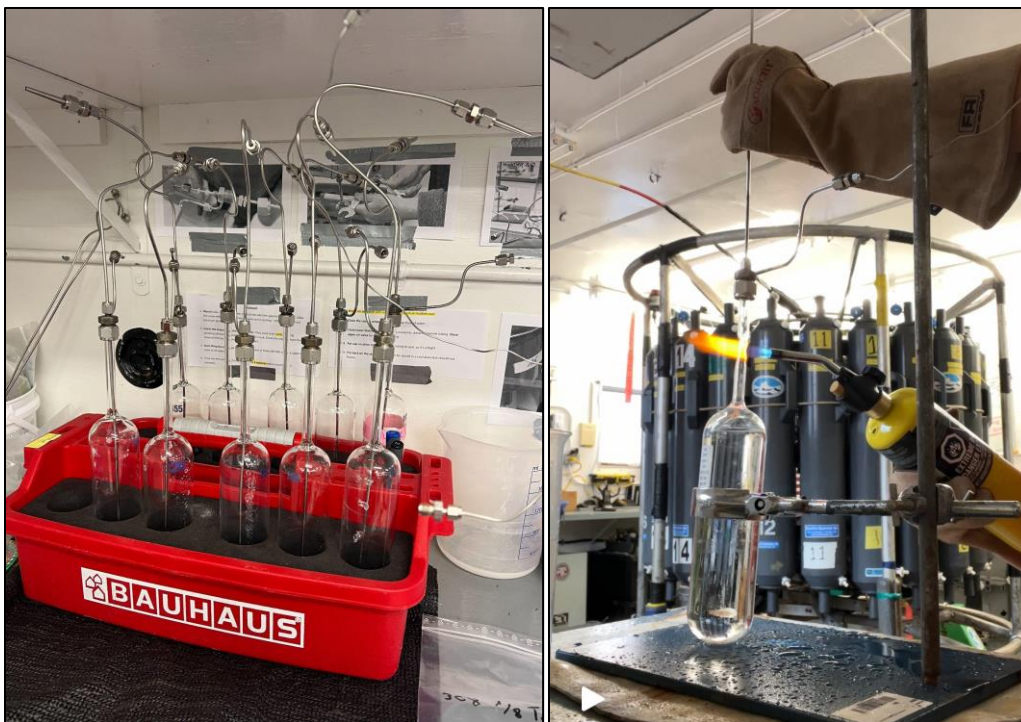


Figure 3.2.15-1: Glass ampoules for gas tracer sampling with stainless steel tubing setup (left), and flame sealing (right).

Issues

Early on the N₂ pressure was too high, leading to the ampoule necks blowing out during sealing. Additionally some ampoules cracked if cold water splashed into the necks while still hot.

3.2.16 Biogeochemistry sampling at ice stations

Ice cores

Michiyo YAMAMOTO-KAWAI (TUMSAT), Tsukushi KOMURA (TUMSAT), Annabel PAYNE (ETH Zurich), Yuanxin ZHANG (Tohoku U)

During the ice observation of the 2025 JOIS cruise, 7 ice cores in total were taken at two ice stations (ice station₂ and ice station₃) for the ice biogeochemistry measurements.

Detailed information of ice stations can be found in the section ‘3.9. Ice Observations’ in this cruise report.

Biogeochemistry Ice Core at Ice Station 2

Four biogeochemistry (BGC) ice cores were collected at 50m-site following the physical ice cores (see ‘3.9. Ice Observations’ section). Cores were collected using a 1m-long 4-diameter corer with a new electric-powered auger head. After collection, ice cores were immediately saved in plastic bags and brought back on board for post-processing by each PI, and then stored or melted under different conditions.

The detailed information for the 4 biogeochemistry ice cores is summarized in the Table below.

Table 3.2.16-1. Information of the biogeochemistry ice cores at ice station 2.

Core ID	Use for	Details	PI
1	Iodine	The whole ice core (~40 cm) was stored in – 18°C cooler for 1 day before melted; Then the ice core was melted in room temperature inside plastic bags, decanted into 3L cubitainers. Stored and sent to ETH Zurich for 129-iodine analysis.	Annabel PAYNE
2	Nutrients / ¹⁸ O	The ice core (total 26 cm) was cut into 0–8, 8–16, 16–26 cm sections, and melted in the + 4°C cooler for 5 days. For each section, ¹⁸ O sample (single) and nutrient (duplicate) samples were collected. Nutrients were measured on board, and ¹⁸ O will be measured at TUMSAT after the cruise. Salinity of each section was measured using the “YSI Pro30” sensor, with a calibration equation of $S=1.117 \times S_{\text{sensor}} - 0.038$.	Michiyo YAMAMOTO-KAWAI & Tsukushi KOMURA
3	Brine	1. The whole ice core (~100cm) was cut into two 50cm sections. 2. Ice cores sections were kept on the helideck and melted slowly at outside to drain the brine for two days (During this process, brine water frozen up again). 3. The re-frozen brine samples were cut off from the main body of the ice core, transferred into new bags, and melted in + 4°C cooler. 4. Two nutrient samples (duplicate) were taken from each brine melted water, and measured on board under the same procedure as CTD-Rossette seawater nutrient samples. 5. The salinity was measured using a hand-held salinity probe (YSI Pro30), with a calibration equation	Yuanxin ZHANG

		<p>of $S=1.117 \times S_{\text{sensor}} - 0.038$.</p> <p>6. The steps 2, 4, and 5 were repeated for the second round of brine drain and measurement. Note only the top 50 cm section had the second brine and the brine did not re-frozen up during second round of drain.</p> <p>8. The “after-brine” ice cores were melted at room temperature within one day.</p> <p>9. Two nutrient samples (duplicate) were taken from the each “after-brine” ice core meltwater and measured on board under the same procedure as CTD-Rossette samples.</p> <p>10. The salinity of “after-brine” ice core meltwater was measured using a hand-held salinity probe (YSI Pro30), with a calibration equation of $S=1.117 \times S_{\text{sensor}} - 0.038$.</p> <p>*Salinity was calibrated with the equation of $S=1.117 \times S_{\text{sensor}} - 0.038$.</p>	
4	Ice Algae	<ol style="list-style-type: none"> 1. The whole ice core (~48 cm) was cut into two 24 cm sections. 2. The two sections of ice core were melted in + 4°C cooler. They took 7 days to be totally melted. 3. The first ice core (A) was melted into 1100mL volume water; the second ice core (B) was melted into 1200 mL water. 4. The melted ice cores were filtered, processed and measured under the same procedure as CTD-Rossette seawater chlorophyll-<i>a</i> samples. 5. The sample A & B took ~20 mins to finish the filtration. 	Yuanxin ZHANG

Biogeochemistry Ice Core at Ice Station 3

One ice core was collected at the 50m-site. About a length of 1 m core was taken from the ice thicker than 1 m. This core was used for iodine, nutrients, and ^{18}O analysis.

Cores for brine and ice algae analysis were collected near the WHOI Mooring and under-ice water sampling site (about 50m from the SIMB site).

After collection, ice cores were immediately saved in plastic bags and brought back on board for post-processing by each PI, and stored or melted under different conditions.

The detailed information for the 3 biogeochemistry ice cores is summarized in the Table below.

Table 3.2.16-2. Information of the biogeochemistry ice core at ice station 3.

Core ID	Use for	Details	PI
1A	Iodine	Middle part of the core (unknown depth) was collected; The ice core was stored in – 18°C cooler for 1 day before melted; Then the ice core was melted in room temperature inside plastic bags, decanted into 3L cubitainers. Stored and sent to ETH Zurich for 129-iodine analysis.	Annabel PAYNE
1B	Nutrients / ¹⁸ O	Four 10-cm sections were taken from the core (top, bottom and two unknown depth), melted in the 4 C cooler for 4 days. For each section, ¹⁸ O sample (single) and nutrient (duplicate) samples were collected. Nutrients were measured on board, and ¹⁸ O will be measured at TUMSAT after the cruise. Salinity of each section was measured using the “YSI Pro30” sensor, with a calibration equation of $S=1.117 \times S_{\text{sensor}} - 0.038$.	Michiyo YAMAMOTO -KAWAI & Tsukushi KOMURA
2	Brine	Only the top ~109 cm of the ice was collected, due to limited length of the corer. The “real” bottom of ice was missed. The ice core was broken up into two sections (44cm and 65cm). 1. From the top section of the core, 20–44cm part was used. The bottom section of the core was further cut into sections of 44–79 cm & 79–109cm. 2. Three sub-sections were kept on the helideck and melted slowly at outside to drain the brine for two days. 3. Two nutrient samples (duplicate) were taken from each brine water, and measured on board under the same procedure as CTD-Rosette seawater nutrient samples. 4. The salinity was measured using a hand-held salinity probe (YSI Pro30), with a calibration equation of $S=1.117 \times S_{\text{sensor}} - 0.038$. 5. The “after-brine” ice cores were melted at room temperature within one day. 6. Two nutrient samples (duplicate) were taken from the “after-brine” ice core meltwater and measured on board under the same procedure as CTD-Rosette	Yuanxin ZHANG

		<p>samples.</p> <p>7. The salinity of “after-brine” ice core meltwater was measured using a hand-held salinity probe (YSI Pro30), with a calibration equation of $S=1.117 \times S_{\text{sensor}} - 0.038$.</p>	
3	Ice Algae	<p>1. The ice core (~60cm) was broken up into two sections (0~35cm & 35~60 cm).</p> <p>2. The two sections were melted in + 4°C cooler for 7 days.</p> <p>3. The top section of the core (C) was melted into 1400 mL volume water; the second ice core (D) was melted into 1070 mL water.</p> <p>4. The melted ice cores were filtered, processed and measured under the same procedure as CTD-Rossette seawater chlorophyll-<i>a</i> samples.</p> <p>5. The sample C and D took ~30 and ~25 mins to finish the filtration.</p>	Yuanxin ZHANG

Under ice water sampling

Chris Clarke, Paige Hagel (IOS)

Surface seawater was taken at ice stations 2 and 3, through the hole made with the ice corer, using a 1.7 L Niskin bottle. Seawater for analysis of Biotoxin, Chlorophyll *a*, nutrients, salinity, ^{18}O , $^{129}\text{I}/^{236}\text{U}$ were filled into a carboy, and then taken into each sampling bottle later on the ship. Niskin bottles filled with seawater were brought back to the ship and sampled for oxygen and DIC/TA, respectively. Note that the DIC/TA samples at Station 3 were taken on the ice and showed a small amount of freezing during sampling.

Data

Isloaa: sciencenet/2025-010-JOIS/Data/Chemistry//2025-010_OnIceStn Samples v2025-10-21.xlsx

3.3 Moorings and Buoys (BGOS)

On board: Jeff O'Brien, Jim Ryder and Tim McDonough (WHOI), Cory Beatty (U. Montana), and Jennifer Kosty (Yale)

PIs: Mary-Louise Timmermans (BGOS, Yale) Isabela Le Bras (BGOS, WHOI), John Toole & Sylvia Cole (ITP/TOP, WHOI)

Summary

2025 operations from the CCGS Louis S. St-Laurent as part of the Beaufort Gyre Observing System (BGOS) included the recovery of three bottom-tethered moorings (deployed in 2024) and the deployment of three moorings at the same locations. Three ice-based observatories were installed, and one Tethered Ocean Profiler (TOP) was deployed in open water. Five TOPs (1 with profiling unit plus surface float and package, and 4 with surface float and package only) were recovered, and two Ice-Tethered Profilers (ITPs) were recovered (one full system and one with surface package only). Dispatches (by Jennifer Kosty, Yale) were sent daily and posted on the BGOS website. A summary of moorings and buoys recovered and deployed are listed in Tables 1 and 2, and descriptions of each activity are given below.

Table 3.3-1: BGOS mooring recoveries and deployments from CCGS Louis S. St-Laurent 2025. *The mooring anchor was ranged on in the pre-recovery survey. Only the acoustic pinger near the top of mooring B was ranged on because of ice in the area, but recovery and deployments of moorings A and D were in open water.*

Mooring	Surveyed location (anchor*)	2025 Recovery	2025 Deployment	2025 Location (drop posn.)	Deploy bottom depth (m)
A	74 59.9961 N 150 00.0479 W *37 m from 2024 drop location	29 Sept. 16:01 UTC	30 Sept. 20:07 UTC	75 00.093 N 150 00.167 W	3825
B	78 00.0989 N 149 59.7949 W *40 m from drop	3 Oct. 17:45 UTC	4 Oct. 20:57 UTC	77 59.455 N 149 58.044 W	3825
D	73 59.9881 N 140 02.902 W *20 m from drop	25 Sept. 15:29 UTC	26 Sept. 20:10 UTC	74 00.018 N 140 03.088 W	3526

3.3.1 Moorings

Bottom-tethered moorings have been maintained in at least three (up to four) locations under the BGOS program since 2003. The moorings and their nominal locations and deployment durations are as follows: Mooring A (75N, 150W; 2003-2025), Mooring B (78N, 150W; 2003-2025), Mooring C (77N, 140W; 2003-2008), and Mooring D (74N, 140W; 2005-2025). The moorings acquire time series at fixed locations of ice draft of sea ice overlying the mooring, heat, freshwater, ocean currents, and sea-level variations, plus other properties. The top float is positioned about 30 m below the sea surface (see e.g., the schematic diagram for Mooring A on the next page, deployed in 2025).

Instruments on each of the moorings are as follows: an Upward Looking Sonar (ULS) (i.e., Ice Profiling Sonar, IPS) sampling ice draft; an Acoustic Doppler Current Profiler (ADCP) sampling upper ocean currents; McLane Moored Profilers (MMPs, two on each mooring recovered and deployed in 2025) making profiles through the water column sampling ocean currents, temperature and salinity; a fixed-depth MicroCAT sampling temperature, salinity and pressure; and a Bottom Pressure Recorder (BPR) sampling pressure fluctuations at the seafloor. Moorings recovered included SAMI-CO₂ and SAMI-pH instruments (University of Montana), but these sensors were not included in the 2025 deployments. In addition, moorings A and D include Acoustic Wave and Current Profilers (AWACs, University of Washington).

The vertically profiling MMPs sample conductivity-temperature-depth (CTD) and velocities in the water column from around 40-m depth to about 2050-m depth, making 2 profiles every two days.

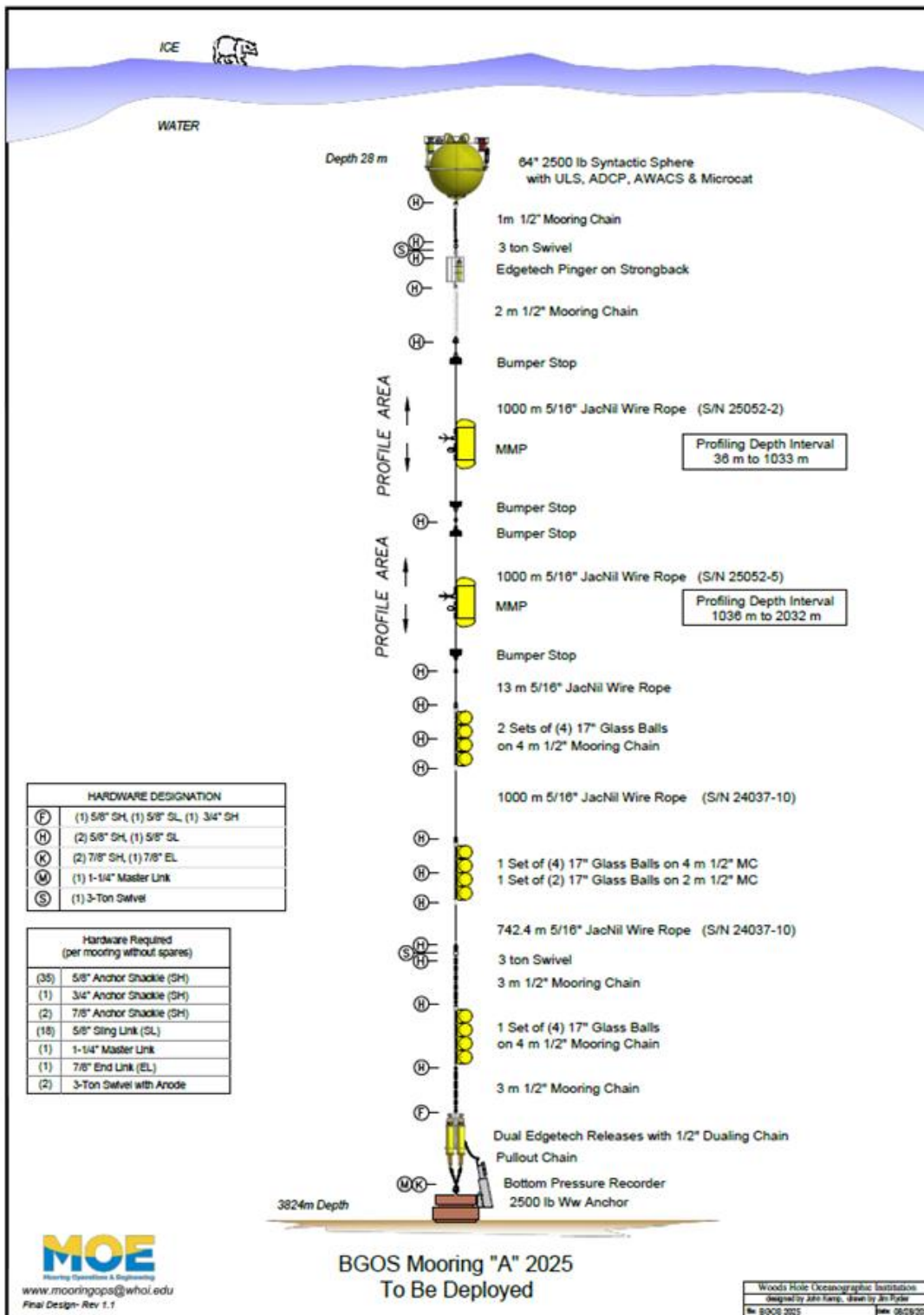
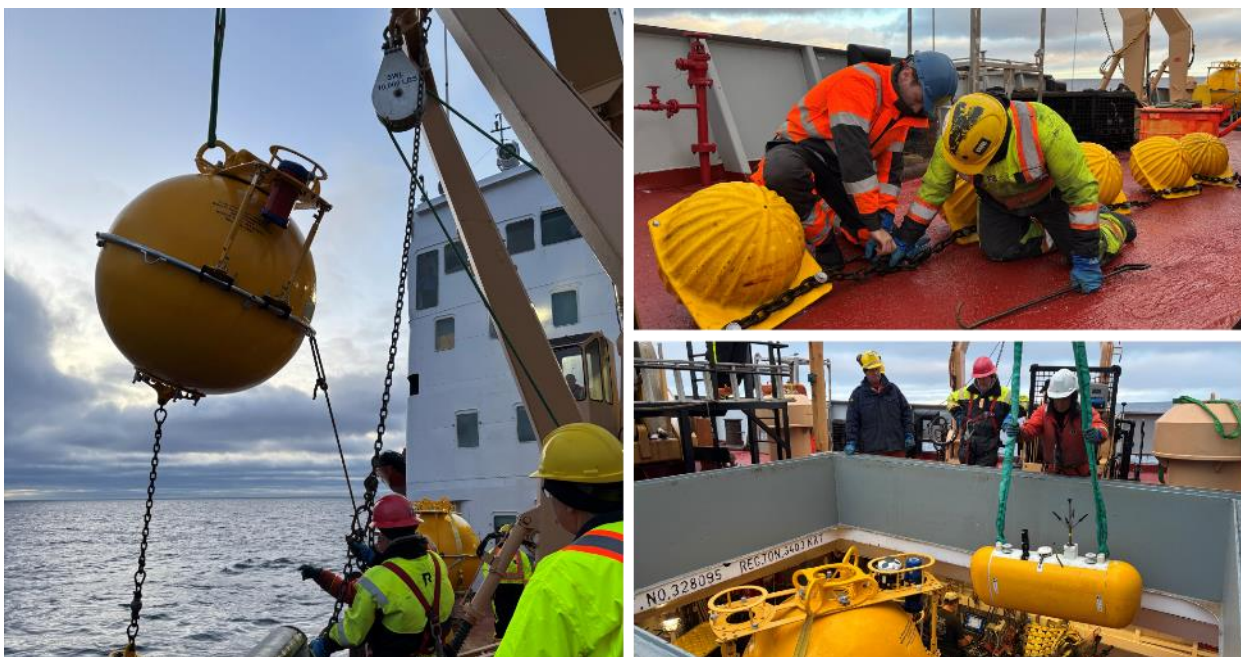


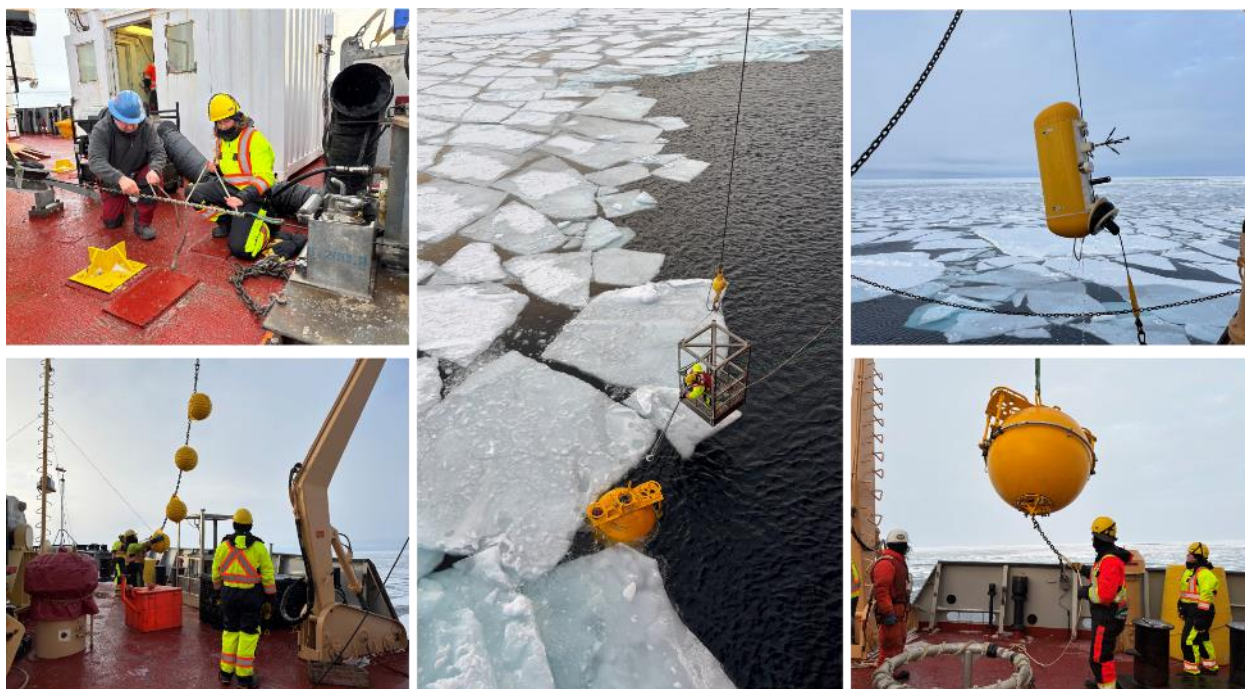
Figure 3.3.1-1. BGOS Mooring A configuration



Recovery of Mooring A. The left-hand photo shows Mooring A's top sphere being winched on deck. The top-right photo shows Tim McDonough and deckhand Devon Fitzpatrick disassembling a set of glass balls recovered from Mooring A. The bottom-right photo shows boatswain Rico Amamio lowering one of Mooring A's MMPs into the forward hold.

Before each recovery, the mooring's location was determined precisely by using Art Newhall's (WHOI) Acoustic Survey Software (available in MATLAB) to range on the releases at the bottom of each mooring. Mooring A and D operations were done in 0% or light ice cover and it was not deemed necessary to additionally range on the ELCAT acoustic pinger located just below each surface float. Ice was more extensive for the deployment/recovery of Mooring B and this top pinger was surveyed for this mooring. Recoveries in 2025 were all in 1-to-2-meter swell and the basket was used each time to hook the surface float. Mooring recovery and anchor-first deployment operations are summarized by WHOI Technical Report 2005-05 (Kemp et al., 2005).

Data return from the recovered moored instruments was very good. The only records that were incomplete were from the MicroCAT on Mooring A, and the upper MMP on Mooring A, which both failed to record data. The MicroCAT was replaced with a new pumped unit, which includes an oxygen sensor, for the 2025 deployment. The cause of failure of the upper MMP on A is not immediately obvious and will be diagnosed when the system is returned to Woods Hole. All other units returned high quality data for the full year. Information on the SAMIs can be found in a separate data report.



Recovery of Mooring B. The upper-left photo shows Cory Beatty and CCG cadet Josianne Fiset preparing to switch wire spools. The bottom-left photo shows members of the deckcrew bringing a set of glass buoyancy balls on board. The middle photo shows deckhand Jerome Sibley clipping Mooring B's top sphere into the winch. The upper-right photo shows one of Mooring B's recovered MMPs. The bottom-right photo shows deckhand Colin Kavanagh guiding Mooring B's top sphere on deck.

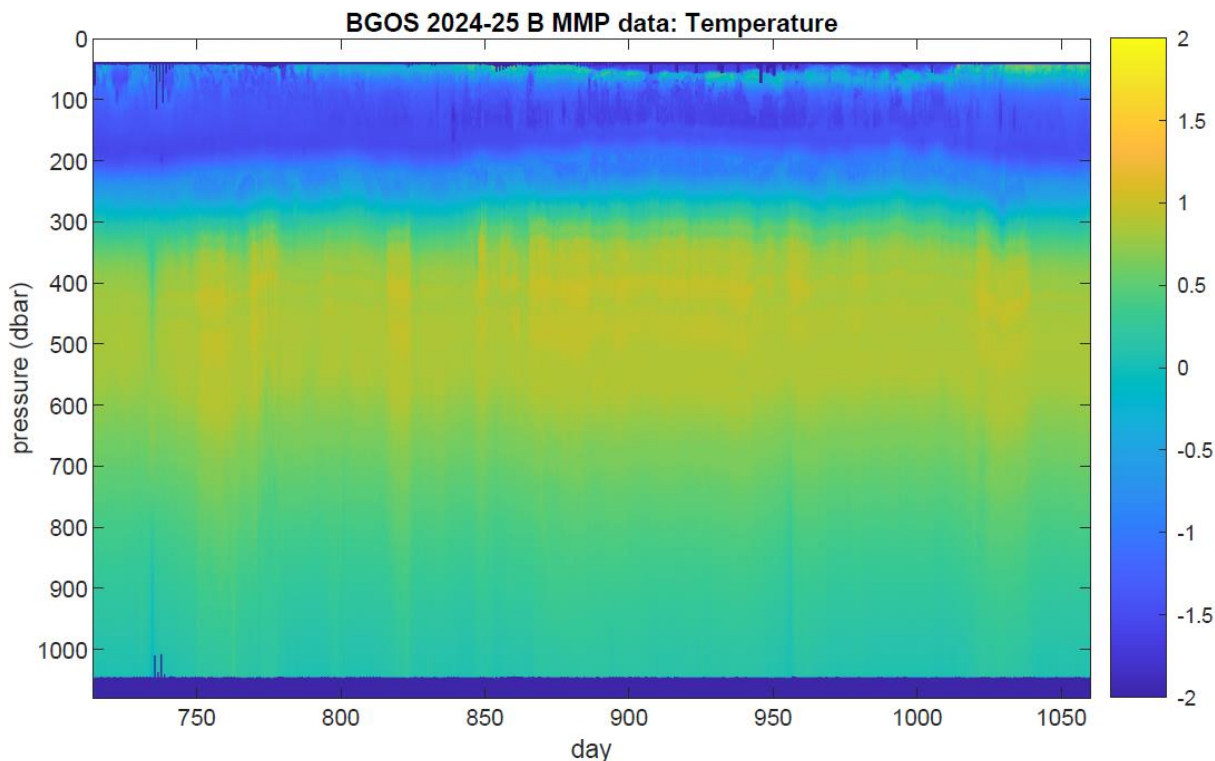


Figure 3.3.1-2. Data from the shallow MMP on BGOS Mooring B 2024-2025. Time-depth (m) section of temperature ($^{\circ}\text{C}$) over the course of the year-long deployment showing a variety of eddies and warm water layers.

3.3.2 Ice Buoys

An important part of the BGOS program is the deployment of automated buoys, designed to drift with a host ice floe and return information about the upper water column, sea ice, snow and the atmosphere year-round and transmit data via satellite. Certain buoys can drift in open water as well as in ice. The following types of automated buoys were deployed during the 2025 expedition (**Table 3.3.2-1**):

- WHOI Tethered Ocean Profilers (TOP), sampling temperature, salinity, & pressure (and sometimes velocity) from the ice-ocean interface to 300m or 760m depth (<https://www2.who.edu/site/itp/>)
- US Army CRREL Seasonal Ice Mass Balance Buoy (SIMB), sampling ice and snow thickness, temperature, and atmospheric pressure (<https://www.cryosphereinnovation.com/>). Two SIMBs (Dartmouth 2024 #16 [SIMB3 2025G] and Dartmouth 2024 #15 [SIMB3 2025H] in IBO 2 and IBO 3, respectively) were deployed.

Tethered Ocean Profiler specifics:

A total of four TOPs were deployed during the 2025 expedition, TOP numbers 17, 18, 19 and 21. As of this writing October 15, 2025, the status of the systems is as follows: TOP17 (which uses a Solumetrix CTD, sampling to 300 m depth) is returning good conductivity and depth with some problems in the temperature. TOP18 and TOP19 (both using RBR CTDs, sampling to 760 m depth) are returning good-quality data. TOP21 (using a D2 Hybrid CTD, sampling to 760 m depth) is functioning normally. The TOP21 surface package incorporates a new sea-level pressure (SLP) sensor that tracks well with a co-located SIMB SLP measurement. The TOP SLP measurement will be used to provide a correction for atmospheric SLP to the seawater pressure minimum from the TOP21 profiler to accurately track the underside of the growing/melting sea ice. This yields an excellent picture of ice thickness evolution over the course of the year.

Table 3.3.2-1: BGOS ice and open-water deployments/recoveries from CCGS Louis S. St-Laurent 2026. IBO = Ice Based Observatory; OW = Open Water deployment [all times local: local + 6 hrs = UTC]

Event	Buoy system	Date (2025)	Location	Ice thickness (m)
IBO 1	TOP19	Oct. 5 18:46	78.9596 N 146.2380 W	0.35
IBO 2	TOP21, SIMB3 2025G, IMB	Oct. 8 16:51	77.0119 N 136.7382 W	0.30
IBO 3	TOP18, SIMB3 2025H	Oct. 9 18:54	76.0981 N 132.9380 W	0.45
OW 1	TOP17	Oct. 11 15:27	75.3915 N 143.4001 W	N/A (open water)
Recovery 1	TOP-V12 [surface pkg/profiler w. Nortek]	Sept. 24 09:22	73.0922 N 133.3051 W	N/A (open water)
Recovery 2	ITP142 Surf and Profiler	Sept. 24 12:43	73.2453 N 134.4367 W	N/A (open water)
Recovery 3	TOP15	Sept. 28 15:30	74.9614 N 141.8538 W	N/A (open water)
Recovery 4	TOP-V13	Oct. 3 17:43	77.7239 N 149.1991 W	N/A (open water)
Recovery 5	TOP14	Oct. 12 11:04	74.2065 N 150.5606 W	N/A (open water)
Recovery 6	TOP11	Oct. 12	73.4111 N	N/A

		19:30	150.1502 W	(open water)
Recovery 7	ITP138	Oct. 13 10:52	72.1149 N 150.3099 W	N/A (open water)

Buoy Deployments:

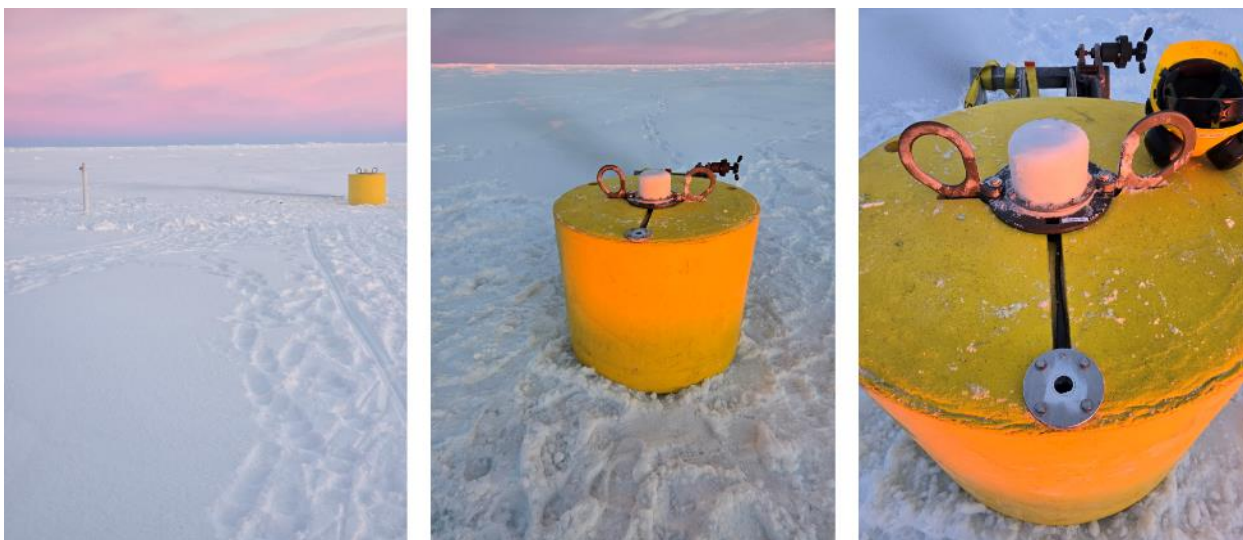


IBO 1: TOP19. This deployment was on a small ice floe made up of smaller multi-year ice pieces fused with new ice. After augering several test holes indicating 25 cm thick ice, a relatively flat area (~35 cm thick) was selected for the site. Ice conditions were not ideal for an IBO, and this location was chosen to avoid transiting further east and ensure separation of ~100 km between IBOs. The buoy team and a few crew were on the ice to help with the deployment and serve as bear guards. The deployment of TOP19 went smoothly overall, taking approximately 3.5 hours from the time the team was sent onto the ice in the man basket until the full team and gear were back on deck. Deployment was completed by 1848 local time, and we left the site around 1925 local time. The TOP is sampling the water column to 760m depth with an RBR CTD. No other instruments were deployed at this site.



IBO 2: TOP21, SIMB3 2025G, IMB. This was a complete IBO installation including TOP21 (with new Sea Level Pressure sensor on its surface package), one SIMB, one IMB, an array of 4 Japan wave motion sensors, and an ice core survey (completed by the team from Japan and IOS staff). Similar to IBO 1, the floe consisted of pieces of multi-year ice fused with new ice. The search for an appropriate floe took some time, and before it was too late (deployment did not start until ~1400 local time), a reasonably flat area away from a ridge (~30 cm thickness) was selected for the TOP deployment. TOP deployment went smoothly with no unforeseen issues (total time for the TOP deployment was ~1.25 hours) the entire IBO took much longer with all the other activities going on and we left the site around 1735 local time. TOP21 is programmed to sample to 760 m depth using a new hybrid D2 CTD. The gangway was used for people transport on this IBO as opposed to the man basket.

The IOS team deployed the SIMB, and full details including photographs and notes can be found here: <https://www.cryosphereinnovation.com/deployment/301434061840390>.



IBO 3: TOP18, SIMB3 2025H. This IBO was again on a small floe consisting of smaller multi-year chunks fused by new ice. This IBO deployment started around ~1520 local time and ended at ~1930 local. A suitable flat location was selected to deploy TOP18 where the ice was 45 cm thick. An SIMB was deployed nearby (at left in the left photo above) and an ice core survey similar to IBO 2 was completed at this IBO. The TOP18 installation was uneventful; it is scheduled to sample to 760 m depth using an RBR CTD. The IOS team deployed the SIMB, and full details including photographs and notes can be found here: <https://www.cryosphereinnovation.com/deployment/301434061843360>.



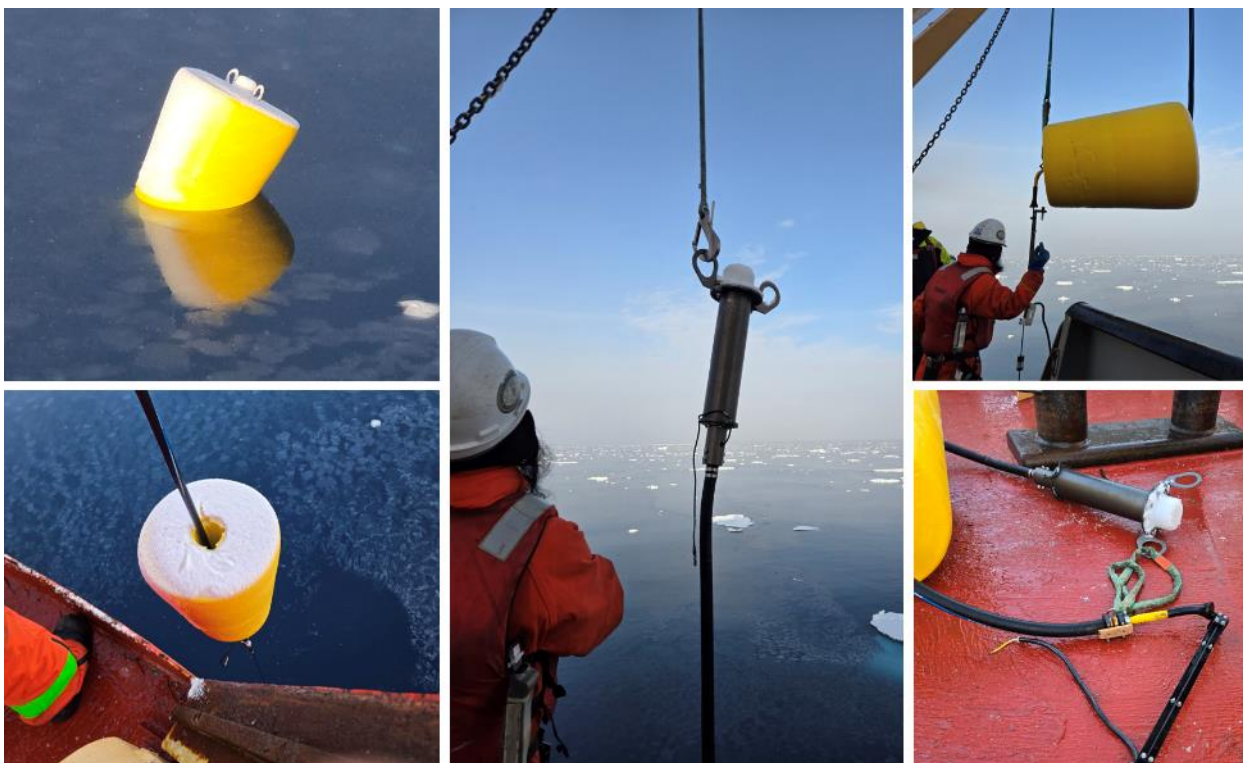
Open water deployment of TOP17. The TOP17 system was deployed from the LSSL fore deck A-frame by the WHOI team and LSSL crew in the marginal ice zone of the central Beaufort Sea. TOP17 uses an older model Solumetrix CTD and samples to 300 m depth. At the time of this writing, the temperature sensor is not operating correctly but the

conductivity cell is producing good measurements. The deployment took less than 1 hour to complete.

3.3.3 Buoy Recoveries



Recovery of TOP-V12. The TOP-V12 system was deployed from the LSSL in Sept. 2024. The ‘V’ is for velocity to describe a new version of the TOP using a Nortek Signature 1000 for velocity measurements. TOP-V12 is also equipped with an Inertial Measurement Unit (IMU) and an RBR CTD. It also features folding (retractable) fins and was deployed through a 14” hole in the ice on the same floe as ITP142 and an AOFB buoy. The full TOP system was recovered. The history of this system was as follows: At around 2230 on 03/07/2025, all contact was lost with the TOP system as well as the AOFB and the SAMI mounted on the upper tether of ITP142 that were deployed on the same flow. Approximately 6 months later (on 09/05/2025 at 1530) the TOP re-surfaced and began communicating, transmitting 6 months of profiles. We can deduce from its proximity to ITP142 that the TOP remained on the same floe the entire time it was not communicating. The floe broke apart a little later in September. The ITP142 GPS drift track will be used to synthesize locations for all profiles from TOP-V12 while it was not sending position information. Dents in the upper surface of the recovered foam and a torn off lift bail are signs of it being pushed under the ice during what was probably a massive rafting event.



Recovery of ITP142. The ITP142 system (minus the SAMI) was recovered not long after TOP-V12. Another sign of the massive rafting event was that the SAMI was torn from its strong back mount just under the ITP potted hose section. After retrieving the surface package and potted section, 790 m of wire rope was reeled in to retrieve the ITP142 profiler. Both ITP142 and TOPV-12 will be refurbished/re-built for deployment in the near future.



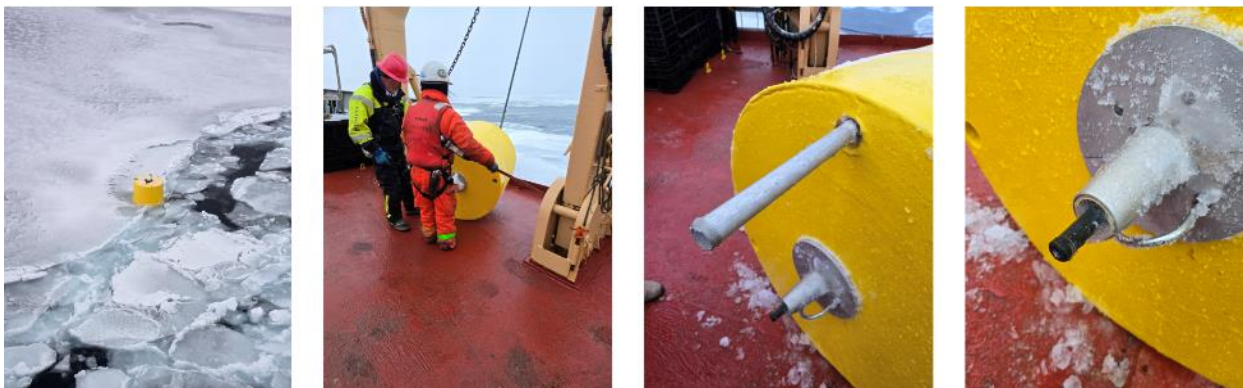
Recovery of TOP15. The TOP15 surface package recovery was quick because the wire rope had parted beneath the buoy. The bent grounding pole indicates further evidence of a rafting event. TOP15 also housed an experimental thermistor chain on the grounding pole that was damaged in this event.



Recovery of TOP13. The TOP13 surface package recovery was also quick with no tether or profiling unit to recover.



Recovery of TOP14. The TOP14 surface package recovery was a quick pick-up with no tether or profiling unit to recover. This unit also had an experimental thermistor chain on the grounding pole, which was torn off in a rafting event.



Recovery of TOP11. The TOP11 system was deployed 2 years ago during the 2023 LSSL cruise. This system used coupled sections of pipe in contrast with the newer 1-piece welded version of the grounding pole. This older version is significantly more vulnerable during rafting events, but also may cause less damage than the newer pole design, which bends such that it can tear the cable out of the upper portion. The strain relief design of the TOP tether and grounding pole design are being reviewed at this time and new designs are planned for next year. Recovery of the TOP11 surface package was quick in the absence of a tether and profiler to recover.



Recovery of ITP138. ITP138 was deployed from the LSSL in September 2023. This was another quick recovery because the tether had parted in the potted hose section so only the surface package was remaining. The surface float was strapped to the surface package with a 2" ratchet strap during deployment providing quick, safe and easy recovery of this unit. All the surface packages recovered this year will be refurbished and returned to service soon.

3.3.4 Sea surface pCO₂, pH, and dissolved O₂

P.I.: Mike DeGrandpre and Cory Beatty (University of Montana, michael.degrandpre@umontana.edu , Cory.Beatty@umontana.edu)

Overview of U.S. National Science Foundation Project: An Arctic Ocean sea surface observing network for the partial pressure of carbon dioxide (pCO₂), acidity (pH), and dissolved oxygen (DO)

This project is a collaboration between the University of Montana, Woods Hole Oceanographic Institution (Jeff O'Brien, Isabela Le Bras and John Toole) and Yale University (Mary-Louise Timmermans). The primary objective is to provide the Arctic research community with high temporal resolution time-series of sea surface partial pressure of CO₂ (pCO₂), pH, temperature, dissolved oxygen (DO) and photosynthetically active radiation (PAR). Sensors for pCO₂ and DO are deployed on WHOI ice-tethered profilers (ITP). Placed on the ITP cable just under the ice, the sensors send their data via satellite using the WHOI ITP interface. On each of the 3 BGOS moorings, a SAMI-CO₂/SAMI-pH pair equipped with DO, PAR and temperature sensors are deployed at a depth of approximately 42 meters.



Figure 3.3.4-1. SAMI CO₂ being deployed on an ITP (left) and CO₂ and pH sensors after recovery on Mooring B (right).

Cruise Objectives

1. Conduct underway $p\text{CO}_2$ measurements to provide data quality assurance for the ITP-based sensors and to map the spatial distribution of $p\text{CO}_2$ in the Beaufort Sea and surrounding margins.
2. Recover SAMI- CO_2 /SAMI-pH pairs with DO and PAR on each of the three BGOS moorings (A, B and D).
3. Assist WHOI with mooring and TOP deployments.
4. Assist with other shipboard research activities and interact with ocean scientists from other institutions.

Cruise Accomplishments

We collected underway $p\text{CO}_2$ data using an infrared equilibrator-based system (SUPER-CO₂, Sunburst Sensors) continuously for 32 days over the 36 day cruise, however the instrument stopped recording data from 10/4 to 10/17/2025. The instrument was connected to the Louis seawater line manifold located in the main lab.

Problems also arose with the SUPER-CO₂'s temperature sensor of the seawater, however this can be compensated for using the TSG's lab's seawater temperature (T1 in TSG data set as opposed to T2 the intake seawater temperature).

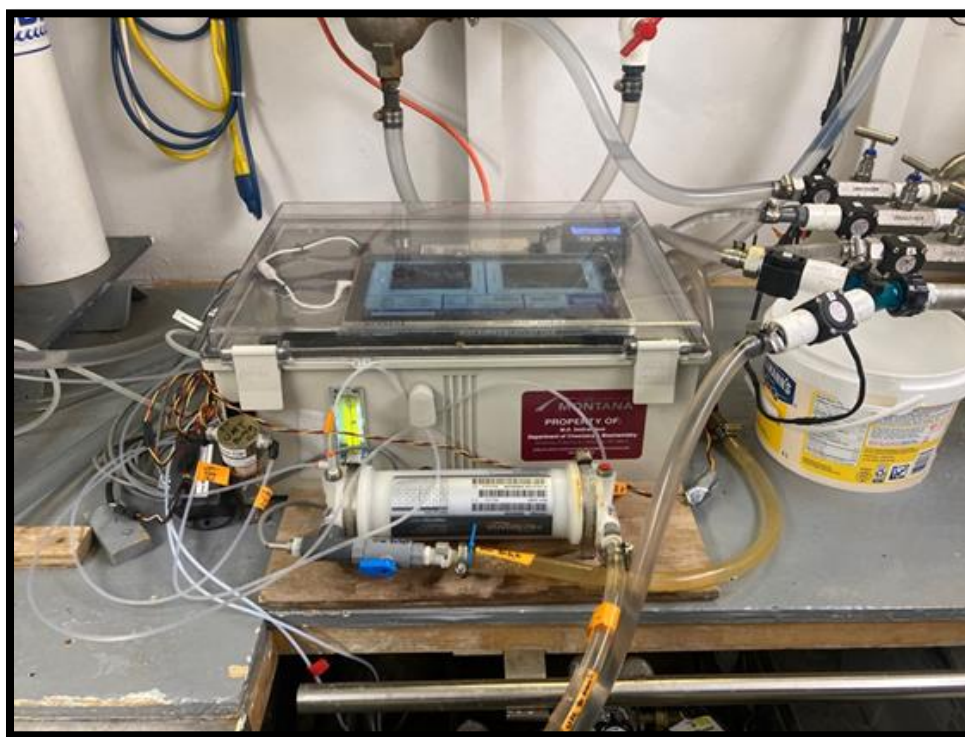


Figure 3.3.4-2. Shipboard underway $p\text{CO}_2$ environmental monitor (SUPER) system connected to the ship's seawater line (at right). (photo from 2024 but similar for 2025).

We recovered SAMI-CO₂ sensors equipped with dissolved O₂ and PAR sensors on the 3 BGOS moorings. The sensor time-series collected for moorings deployed in 2024 are summarized in Table 1 below.

Table 3.3.4-2. DeGrandpre group sensor data collection summary

BGOS-A Mooring				
	<u>CO2</u>	<u>pH</u>	<u>O2</u>	<u>PAR</u>
Instrument ID	C38u	XXX	4175: 1765 (4-pin b/h)	XXX
	XXX	P47u	XXX	9387 (6-pin b/h)
Days of Data	183	148	379	379
BGOS-B Mooring				
	<u>CO2</u>	<u>pH</u>	<u>O2</u>	<u>PAR</u>
Instrument ID	C48u	XXX	4175: 717 (4-pin b/h)	XXX
	XXX	P68u	XXX	9385 (6-pin b/h)
Days of Data	386	386	386	386
BGOS-D Mooring				
	<u>CO2</u>	<u>pH</u>	<u>O2</u>	<u>PAR</u>
Instrument ID	C37u	XXX	4175: 1699 (5-pin b/h)	XXX
	XXX	P5u	XXX	9386 (4-pin b/h)
Days of Data	369	131	369	218

3.4 XCTD Report

Onboard: Kazu Tateyama, Shotaro Muraoka (KIT), Takuji Waseda (UTokyo), and Michi Shibata (MOLM)

PIs: Bill Williams (DFO-IOS), Motoyo Itoh (JAMSTEC), Andrey Proshutinsky, Isabel Le Bras (WHOI), Mary-Louise Timmermans (Yale)

Overview

Profiles of temperature and salinity were measured using expendable probes capable of being deployed while the ship was underway. Profiles were collected at 47 locations along the ship’s track between the CTD stations.

Procedure

Expendable CTD probes (Tsurumi-Seiki Co., Ltd) were deployed from a hand-held launcher LM-3A (Lockheed Martin Sippican, Inc.) from the ship’s stern. The data were communicated from the probe back to the launcher by a fine wire which breaks when the probe reaches its maximum depth. The launcher was connected to the Lockheed Martin Sippican MK-21 Ethernet deck unit and data were logged using the WinMK-21 software installed on the IOS’s laptop “TP2024-04 “Dare I say seagull”. The MK21 firmware and software were updated in 2022 to ensure compatibility with the new XCTD-1N probe.

Connection between the laptop and the deck unit was via an Ethernet switch. The switch was also connected to the science network. The ship’s GPS stream was provided by science server over the network via GPSGate. This year, water depth from the sounder was not displayed on the laptop in a terminal window. Data were automatically written by the WinMK-21 software to the local drive on the laptop. At the end of the cast the operator filled in the log sheet and manually transferred the new files to the science server.

Operational Notes

The Tsurumi-Seiki XCTD-1N probe was used exclusively in 2025.

Probe Type	Number Used	Filename Convention		Max Depth (m)	Max Ship Speed (Kts)
XCTD-1N	60	“C3_ ”		1000	12

Table 3.4-1. XCTD probe operational parameters.

According to the manufacturer’s nominal specifications, the range and accuracy of parameters measured by the XCTD-1N probe are summarized below in Table 2.

Parameter	Range	Accuracy
Conductivity	0 ~ 60 [mS/cm]	+/- 0.03 [mS/cm]
Temperature	-2 ~ 35 [deg-C]	+/- 0.02 [deg-C]
Depth	0 ~ 1000 [m]	5 [m] or 2 [%] (whichever is larger)

Table 3.4-2. XCTD-1N probe operational specifications.

Of the 60 XCTD-1N probes, 47 successfully reached a depth over 500m, typically to maximum depth (1,000 m). Table A-1, A-2 and Figure 1 show a summary and the locations of the all deployments. There were a larger number of failures than usual, 13, due to various reasons: data record ended before reaching desired minimum depth of 500m, noisy data, no response from probe (both creating no file or creating an empty file). In 2024 there were two probes that failed due to no response. The launch cable was replaced for this program but perhaps there is a further or repeated problem with the launcher.

The XCTD ‘stations’ each have a sequential Event Number listed in the paper daily log and the digital XCTD event log. If a probe failed or was repeated because the first probe didn’t reach an acceptable depth, the event number stayed the same. This was helpful for people taking water samples from the TSG underway to link their samples to the XCTDs. The XCTD data filenames were running on a different numbering system. They would increment with each probe use or even just testing the software. The data filenames associated with each event are listed in the table below.

Issues

The launcher was found to have an electrical short during the previous mission so a replacement cable was brought up for the launcher at the start of this program.

Software is confusing. After loading probe the software says "waiting for data" as the computer connects to the probe. The software then says "waiting for launch". A probe was deployed too early as “waiting for data” was misunderstood to mean the probe should be deployed. “How-to” Instructions could be clearer and highlight this.

The GPS feed to the XCTD software was dropping out and the XCTD file would be missing location information. The problem was somehow in GPS-Gate losing the feed and the instance needing to be closed and reopened. The nav window was added to the XCTD software screen so before the launch it was easy to see if the feed was current or frozen. The few casts missing location were fixed by adding the information to the file by hand.

There were more failures with the XCTD launches than in prior years. Some were due to incomplete casts, stopping before getting past 500m, one was due to noisy data, another had ‘probe not recognized’, and similarly the another had a file with no contents. One correction could be to formalize with the mates on the bridge that in ice, the ship needs to stop for XCTD deployment. Some of the short casts were with the ship travelling at 5knt

in icy waters which could have broken the line. For XCTD deployments in ice, the ship should be stopped. Another correction is to have very clear deployment sequence for the critical steps “Waiting for Data”, “Waiting for Launch”, a third concern could be with the equipment. There could still be a launcher problem still even with the repaired cable. The cold air might be forming an ice skin or condensation after its brought inside on the launcher pins which is known to have created problems in the past (Edmand Fok on the Des Groseilliers). The launcher cable was quite twisted due to coiling and uncoiling. Recommend getting a winding wheel as CHS has for their launcher cable and a proper holder for the launcher that keeps it off the floor.

Still to be done:

Confirm the location in the XCTD header matches the event log, and double check position matching time.

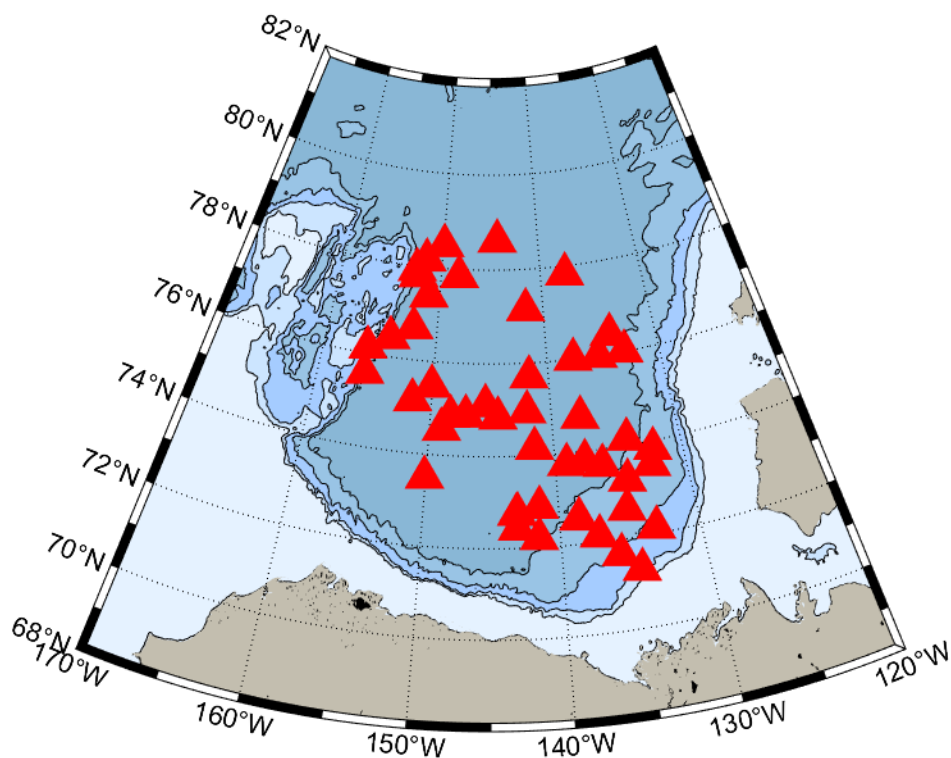


Figure 3.4-1. Locations of the XCTD deployments

3.5 Zooplankton Vertical Net Tows

Chris Clarke (DFO-IOS), Paige Hagel (DFO-IOS)

P.I.: Bill Williams (DFO-IOS)

Sampling

Zooplankton sampling and preservation were conducted on board by Chris Clarke (DFO-IOS), Andrew Ross (DFO-IOS), and Annabel Payne (ETH-Zurich), during the day watch and Paige Hagel (DFO-IOS), Magali Pucet (USherbrooke), and Marguerite Larriere (ETH-Zurich) during the night watch. A standard bongo net system was used with a fitted 153 μ m net on both sides as well as a calibrated TSK flowmeter installed to measure the amount of water flowing through the nets. In addition, an RBR Solo SN 233282 pressure recorder was mounted on the gimble rod to record the actual depth of each net cast.

A total of 29 bongo vertical net hauls were completed. The sampling strategy was to perform net hauls whenever time and weather permitted, provided they did not interfere with the rosette operation or require additional ship time. A single 100m bongo vertical net haul was performed with two samples collected, one from each side of the bongo net. The 2025 cruise occurred later in the year than previous years, resulting in lower temperatures and windy conditions that prevented net events from happening at many of the rosette stations.

Bongos were deployed on the foredeck using the forward starboard A-frame. Rinsing of the nets was accomplished by attaching a hose to the salt-water tap on the port side near the outer door near the lounge. Water was left running during the cast to prevent the hose from freezing. The hose was removed after every station, emptied of water, coiled, and carried to the port foredeck sciences container to keep it warm.

The bongo was fitted with two 150 μ m mesh nets. One side of the bongo was labeled Formalin with TSK serial number 7085 and the other side was labeled Ethanol with TSK serial number 7303. For consistency samples collected from the net marked Ethanol was preserved in 95% ethanol and samples collected from the net marked Formalin were preserved using formalin with final sample concentration 3.7%. The formalin samples will be examined for species identification and the ethanol samples for DNA sequence analysis.

UTC was used to log all times and dates in zooplankton log unless otherwise specified.

Issues and solutions

Some stations with loose flowing ice were challenging for the bridge to maintain an ice free pond for both the bongo and rosette at the same time. For several stations, the nets were held at the bottom of the cast for extra time while the bubblers pushed back ice then the haul was resumed right after the bubblers turned off. This is preferable way to manage fast ice.

Zooplankton operations take place on the starboard side and the saltwater supply for rinsing is drawn further aft on the port side. It would be helpful to have a saltwater source on the starboard side to reduce the length of hose needed to reach the A-frame.

The Zooplankton nets could benefit from more weight. Currently they have 50lbs on them. Mounting more weight would allow for smoother descents, less affected by wind and currents. Shortening the rope the weight attaches too would make it easier to manage the added weight.

Please see Appendix for time and location of bongo net hauls.



Figure 3.5-1. Bongo nets being deployed from the foredeck in 2023 (similar for 2025).

3.6 Phytoplankton Vertical SCOR Net Tows

Marguerite Larriere (ETH-Zurich)

P.I. Meike Vogt (ETH-Zurich)

Sampling

Plankton sampling in the Beaufort Gyre is part of the European Planktoscope project (planktoscope.org), which involves the deployment of a scientific imaging tool for citizens that allows them to visualize micro-phytoplankton (diatoms and dinoflagellates) and zooplankton.

Plankton sampling and preservation were carried out on board by Chris Clarke (DFO-IOS), Andrew Ross (DFO-IOS), and Annabel Payne (ETH-Zurich), during the day watch and Paige Hagel (DFO-IOS), Magali Pucet (USherbrooke), and Marguerite Larriere (ETH-Zurich) during the night watch. A 20 μm mesh SCOR net was used. An RBR Virtuoso pressure recorder was mounted on the gimbals rod to record the actual depth of each net cast. However, due to the low weight of the net, the pressure sensor was unable to record the pressure. To remedy this, we marked the cable so that we knew when the net was at a depth of 20 m.

A total of 57 SCOR net events were completed. The sampling strategy was to perform net hauls whenever time and weather permitted, provided they did not interfere with the rosette operation or require additional ship time. The 2025 cruise occurred later in the year than previous years, resulting in lower temperatures that prevented net events from happening at many rosette stations. At each station where net surveys were conducted, a SCOR net event was carried with two casts to 20 m (duplicate A and B). In addition, at five stations, a third cast was carried out at 80 m in order to compare the diversity of the plankton community at 20 m with that at greater depths. The stations where these operations were carried out were chosen in order to obtain an overview of the Beaufort Gyre, namely CB4 (west), CB11 (north), BL2 (southwest), MK2 (southeast), and CBGC (center of the gyre).

The net was deployed on the foredeck using the forward starboard A-frame. Rinsing of the nets was accomplished by attaching a hose to the salt-water tap on the port side near the outer door near the lounge. Water was left running during the cast to prevent the hose from freezing. The hose was removed after every station, emptied of water, coiled, and carried to the port foredeck sciences container to keep it warm.

Once brought back to the laboratory, the samples were filtered, duplicate A with a 53 μm screen and duplicate B with a 20 μm screen. The difference in mesh size was chosen to compensate for excessively long processing times, i.e. processing samples with a 20 μm

screen took very long. The samples were preserved with Lugol's solution (1 ml) and stored in plastic tubes until processed in Zurich by Dr. Meike Vogt.

UTC was used to log all times and dates in zooplankton log unless otherwise specified.

Issues and solutions

Need more 20um mesh screen to process sample in the laboratory.

Weight on the net was too light to be able to record pressure from the RBR pressure recorder.

3.7 Underway Surface Sea-water Measurements

Sarah Zimmermann and Paul Macoun (DFO-IOS), Céline Guéguen, Magali Pucet (USherbrooke), Cory Beatty (UMontana), Michiyo Yamamoto-Kawai, Tsukushi Komura (TUMSAT)

P.I.s: Bill Williams, Celine Gueguen (USherbrooke), Mike DeGrandpre (UMontana), Michiyo Yamamoto-Kawai (TUMSAT)

Overview

The ship's seawater loop system draws seawater from below the ship's hull at 9 m using a 3" Moyno Progressive Cavity pump. After measuring the intake seawater temperature, seawater travels through ~50m of stainless steel piping to a manifold in a lab off the main science lab. The lab is configured with an integrated Seabird SBE21 thermosalinograph (TSG), Seapoint Chl-a fluorometer and Wetlabs FDOM fluorometer. Recording independently, a second Wetlabs FDOM fluorometer, and a Sunburst SUPER pCO₂ system were connected to the seawater manifold.

Measurements were made for:

- a. Surface temperature (inlet and lab), salinity, and Chlorophyll-a and FDOM fluorescence.
- b. Water samples were drawn for
 - Salinity, Dissolved Inorganic Carbon, Alkalinity, Chlorophyll, and 18O (*DFO-IOS*)
 - Fluorescent Dissolved Organic Matter (*Celine Gueguen, USherbrooke*)

- Alkalinity-only (no associated DIC) and ^{18}O (*Michiyo Yamamoto-Kawai, TUMSAT*) See subsection below.
- c. Partial pressure of carbon dioxide (pCO_2) using a SunBurst SUPER instrument (Mike DeGrandpre, UMontana). See section on Sea surface pCO_2 , pH and dissolved O_2 .
- d. For 2025, the measurement of oxygen to argon ratio was discontinued (Zhangxian Ouyang and Wei-Jun Cai, University of Delaware collected 2023 and 2024).

Details of the set-up, operation, instruments' make, model, serial numbers, calibration, and performance are given in the Appendix.

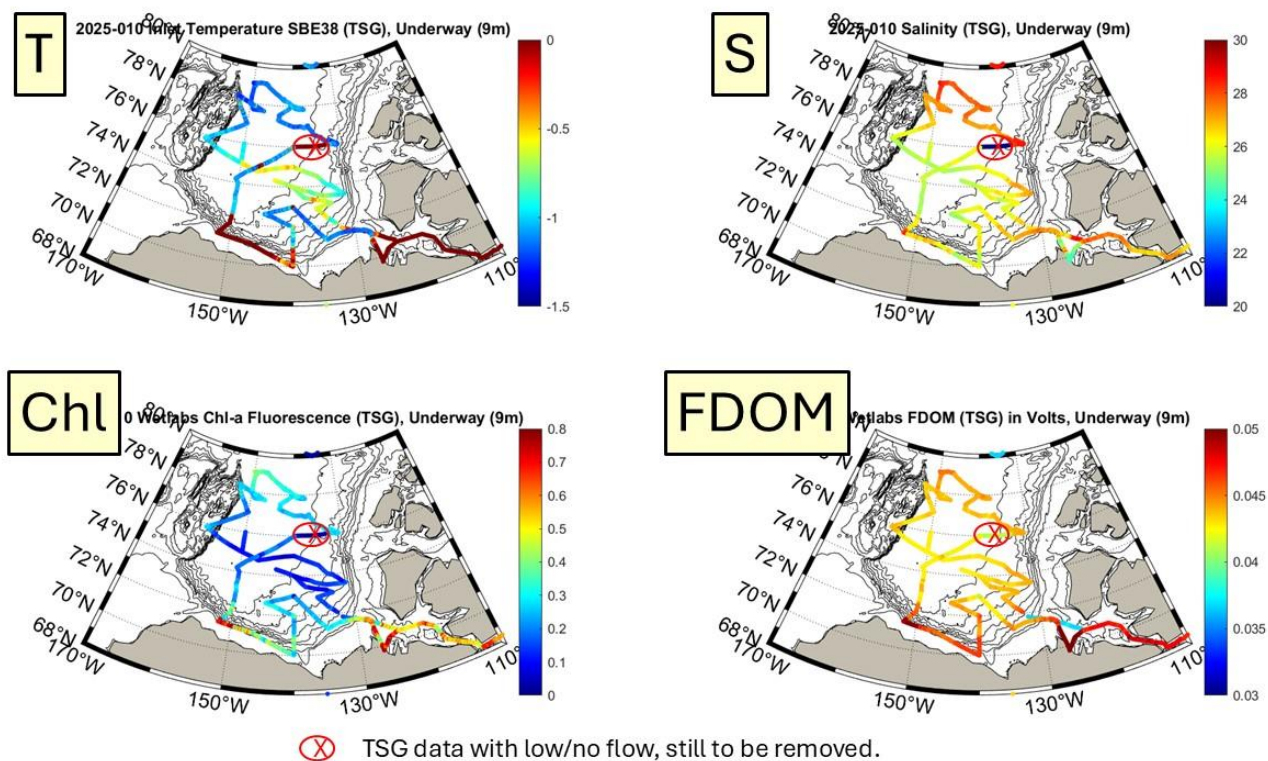


Figure 3.7-1. TSG data from JOIS 2025, where T=Temperature, S = Salinity, Chl = Chlorophyll and FDOM = Fluorescent Dissolved Organic Matter.

TSG sampling for Alkalinity and oxygen Isotope Ratio ($\delta^{18}\text{O}$)

Michiyo Yamamoto-Kawai, Tsukushi Komura (TUMSAT)

P.I.: Michiyo Yamamoto-Kawai (TUMSAT, michiyo@kaiyodai.ac.jp)

Overview

Measurements of Alkalinity and $\delta^{18}\text{O}$ provide information about the distribution of each freshwater source, i.e., sea ice meltwater and meteoric water (Siberian river water, North American river water, and precipitation). The objective is to obtain detailed distribution of river water and investigate its potential influence on the formation of sea ice.

Sampling and analysis

During the 2025 JOIS cruise, 165 and 90 surface water samples were collected from the TSG system for alkalinity and $\delta^{18}\text{O}$ analysis, respectively. Alkalinity samples were analyzed on board using the same procedure as for the CTD/R samples. The $\delta^{18}\text{O}$ samples will be analyzed at TUMSAT; they were stored in 15mL glass vials, with parafilm wrapped over caps for sealing. See the TSG sample log (“2025 TSG Log with CNV and Sample data v2025-10-20c.xlsx”) for detailed information on sampling location and sensor data associated with the TSG system.

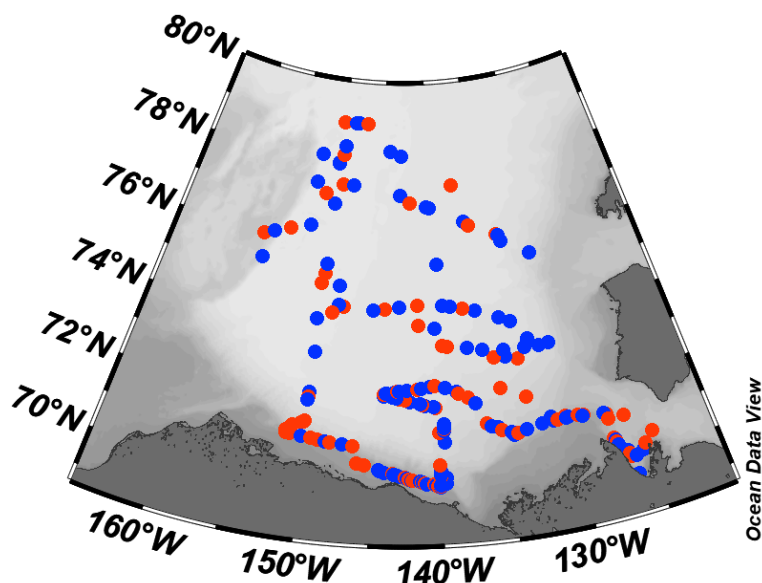


Figure 3.7-2. Map of sampling sites for alkalinity (blue) and for both alkalinity and $\delta^{18}\text{O}$ (red).

3.8 Underway data logging using SCS

Paul Macoun, Sarah Zimmermann (DFO-IOS)

P.I.s: Bill Williams

The ship uses the Shipboard Computer System (SCS) written by the National Oceanographic and Atmospheric Administration (NOAA), to collect and archive underway measurements. This system takes data arriving via the ship's network (LAN) in variable formats and time intervals and stores it in a uniform ASCII format that includes a time stamp.

The Shipboard Computer System (SCS) was used to log:

1. GPS from the ship's Furuno GPS, using NMEA strings \$GPGGA and \$GPRMC. These sentences, available on the science VLAN, were used by CTD, XCTD, TSG and mapping programs.
2. AVOS weather observations of air temperature, humidity, wind speed and direction, and barometric pressure (\$AVRTE)
3. Sounder depth and the applied ship's draft and sound speed
4. Surface Photosynthetically Active Radiation (PAR)
5. Thermosalinograph (TSG), and the inlet sea surface temperature from the SBE38 that is also given in the TSG data stream.
6. Heading from the ship's Gyro (\$HEHDT)
7. Data from the FDOM fluorometer in the seawater loop (FDOM)
8. Derived true wind speed calculated in SCS

Note the AVOS, TSG (and SBE38), PAR and FDOM data are also logged through their own software programs which may be more complete than the SCS record.

In particular, the TSG files will have updated calibration and processing through the SeaBird software. On the other hand, computer feeds (ex. navigation feed to TSG computer) can mean the TSG file is incomplete and the SCS data server as a great backup.

Also note, the timestamp that precedes all the SCS strings is very useful for combining records. This timestamp comes from a computer clock that can drift. However, new for 2023 and continued for 2024, a time-server was used to keep the science server and other data computers (CTD, TSG, XCTD) up to date. If in doubt, check against the GPS time from the GGA or RMC record for the correct time.

The SCS system on a shipboard computer called the “NOAA server” collects *RAW files. The files are periodically restarted and contain up to a weeks’ worth of data.

More information on *.RAW files, string definitions, equipment and instruments, and performance issues are given in the Appendix.

3.9 Ice Observations

3.9.1 Ice Observations on the ship

Overview

As in previous years, the ice observations recorded during the JOIS 2025 cruise will provide detailed information to improve our understanding of interannual variability of sea ice in the Canada Basin and to enhance satellite-based sea-ice information. The minimum sea ice extent in 2025 was 4.55×10^6 km², observed on September 6, indicating a year with greater sea-ice coverage than the 2010s average (Fig. 4.9.1(a)).

Figure 4.9.1(b) shows the cruise track of JOIS2025 and the average sea-ice concentration during the ice observation period (September 20 – October 20), derived from the GCOM-W AMSR2 data.

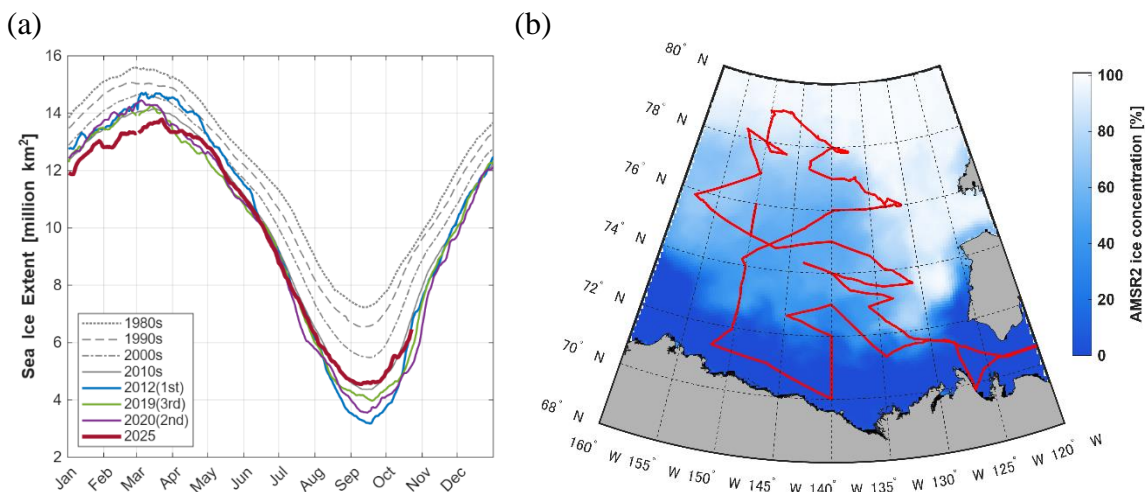


Figure 3.9.1-1. (a) Sea Ice Extent for all years and a comparison of 2025 (red line) from Arctic Data archive System (<https://ads.nipr.ac.jp/>). (b) Averaged AMSR2 sea-ice concentration and ship track during September 20 – October 20.

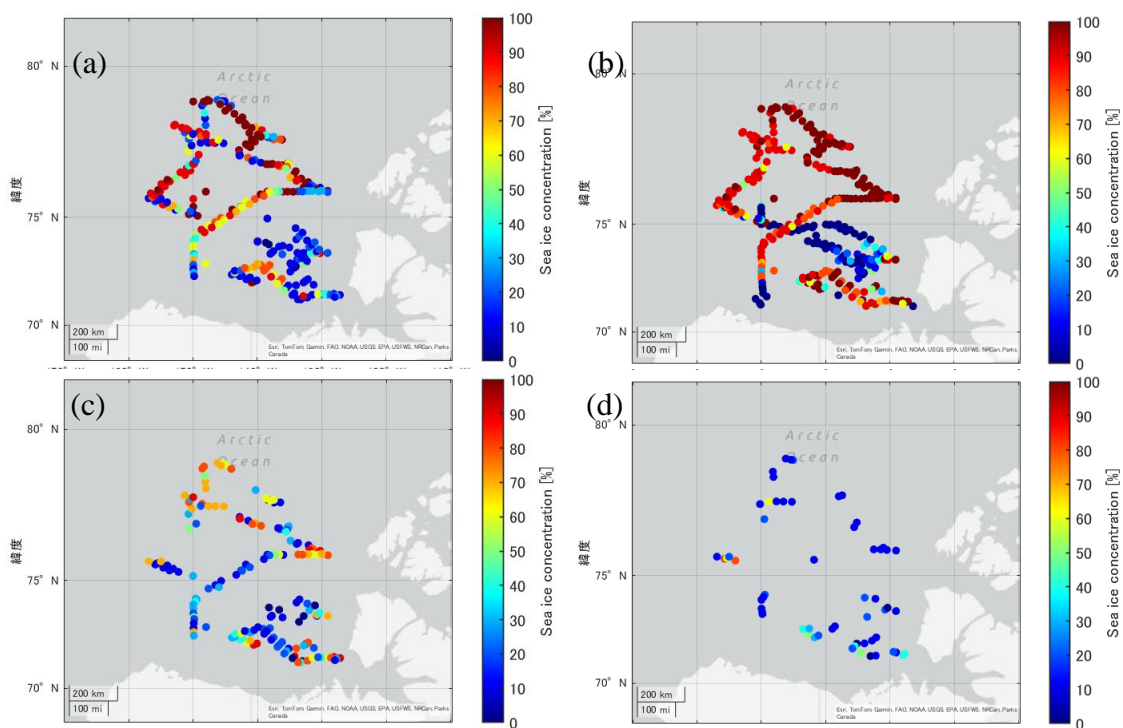
3.9.2 Observations from the Bridge

Kazu Tateyama, Shotaro Muraoka (KIT), Takuji Waseda (UTokyo), and Michi Shibata (MOLM)

P.I.: Kazu Tateyama (KIT), Jennifer Hutchings (OSU)

While the ship was in the ice pack, ice conditions and supporting weather information were recorded every hour within 1nm about the ship when visibility allowed along the ships track. The combined 6-hour Ice and XCTD watch were carried out by the four ice observers, to cover the full 24 hours.

Ice observations were made using the ASSIST protocol. ASSIST is based upon ASPECT (Worby & Alison 1999) bridge observation protocol, with additional information to characterize Arctic sea ice. Additional observables included melt pond characteristics, sediment on ice and an additional ice type – second year ice.



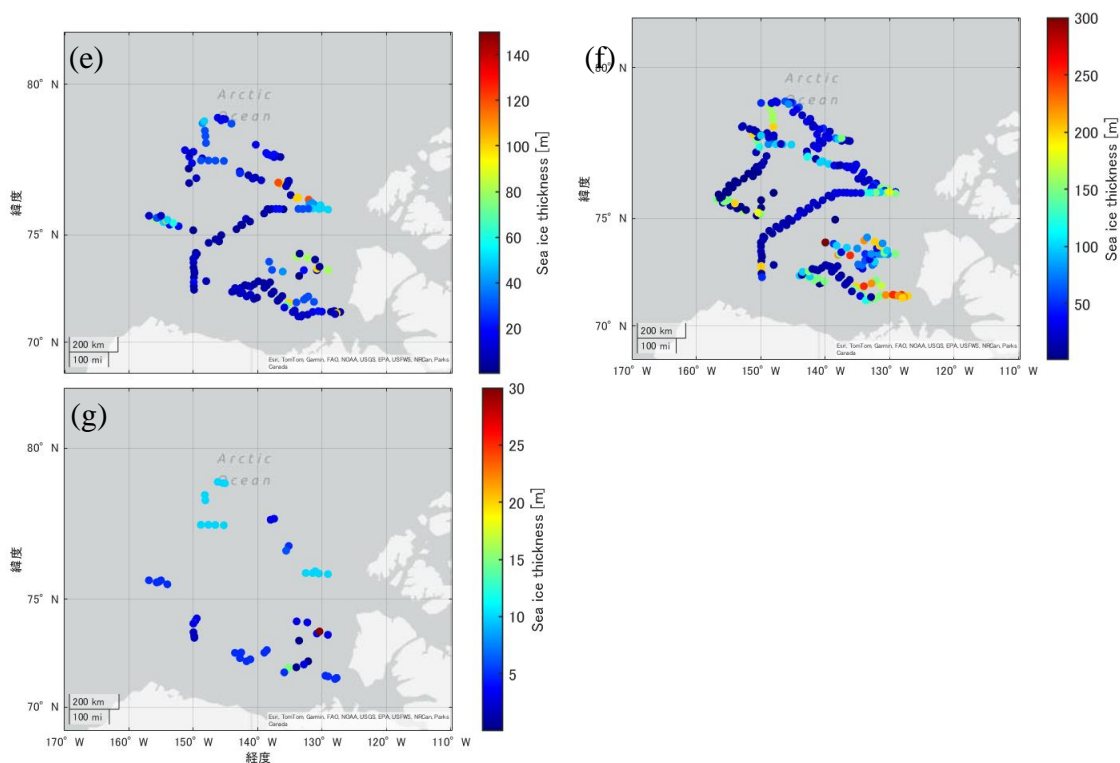


Figure 3.9.2-1. Results of visual ice observations. (a) total ice concentration, (b) primary ice concentration, (c) secondary ice concentration, (d) tertiary ice concentration, (e) primary ice thickness, (f) secondary ice thickness and (g) tertiary ice thickness

Observation has started on 23rd September and ended on 20th October. 391 hourly data were recorded. Figure 4.9.2 show (a) total ice concentration, (b) primary ice concentration, (c) secondary ice concentration, (d) tertiary ice concentration, (e) primary ice thickness, (f) secondary ice thickness, and (g) tertiary ice thickness.

Freeze-up had already begun, and newly formed ice and young ice were observed during more than 80% of the observation period. In particular, multi-year and second-year ice were widely distributed between 130°W and 140°W.

3.9.3 Ice Camera

Kazu Tateyama, Shotaro Muraoka (KIT), Takuji Waseda (UTokyo), and Michi Shibata (MOLM)

P.I.: Kazu Tateyama (KIT), Jennifer Hutchings (OSU)

A new camera called Shipborne Sea Ice Condition Recorder (SSICR) that captures both forward and downward views with a single camera and equipped with a GNSS receiver and 9-axis inertial sensor was installed. The camera was mounted on the starboard forward window frame of the bridge and connected to the science network by adding a hub to the network port for the CTD winch monitoring PC as shown in Fig. 4.9.3. Images were taken once every three minutes and stored on an internal 1 TB SSD, allowing the user to view real-time images and download stored image data via FTP from a web browser through the science network.

Observations were conducted from 18th September to 20th October, and 30,294 images (29.8GB) and GNSS data were recorded. Figure 4.9.4 shows examples of images taken with the front and side lenses.

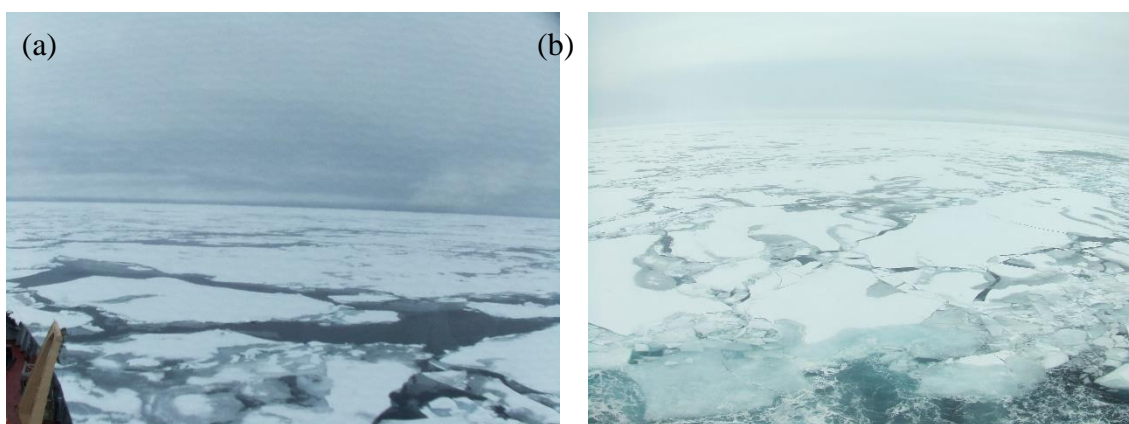
The ortho-corrected images will be used to automatically determine concentration and thickness of sea ice, snow depth, melt pond fraction, ice floe size, cloud amount, and so on.



Figure 3.9.3-1: Location of SSICR with forward and side looking lenses on the starboard side of the bridge.

Table 3.9.3-1. specifications of the SSICR.

Sensor	Specifications	
Camera	Number of pixels	8 mega pixels
	Image Size	3264 x 2488 pixels
	Interval	3min
9-axis inertial	Acceleration	g
	Gyro	dps
	Geomagnetism	gauss

**Figure 3.9.3-2. Examples of images taken by SSICR.**

3.9.4 EM Observation

Kazu Tateyama, Shotaro Muraoka (KIT), Takuji Waseda (UTokyo), and Michi Shibata (MOLM)

P.I.: Kazu Tateyama (KIT), Jennifer Hutchings (OSU)

An Electro-Magnetic induction device EM31/ICE (EM) and a laser altimeter LD90-3100HS were used for indirect sea-ice thickness measurement continuously, installed at foredeck's crane on the portside. EM and laser instruments were covered by a yellow-orange color waterproof fiber reinforced plastic case and should be hanged at 4.5m height above sea surface and in more than 7m separation from ship due to avoid hitting ice and the effect from ship hull as shown in Fig. 4.9.5 (a).

The SEM data loggers were connected to the ship's network using LAN cables (Fig. 4.9.5 (b)). It is now possible to monitor raw data in real time and download hourly recorded data via FTP.

Three calibrations were conducted over open water, and the coefficients for the conversion equation from apparent conductivity to total ice thickness (snow + sea ice) were obtained, as shown in Fig. 4.9.6.

The observations using the SEM were carried out between September 27 and October 18. Figure 4.9.7 shows the observation results for the entire period along the latitude.

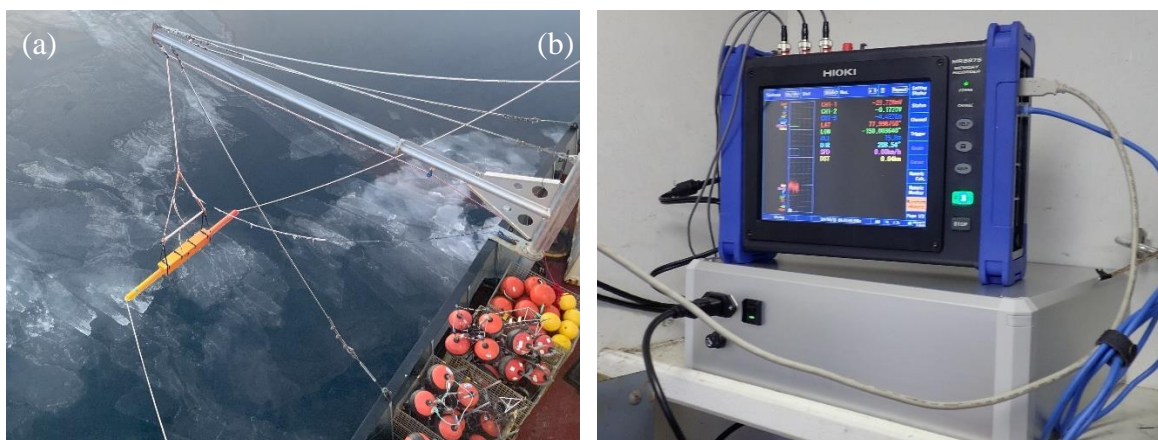


Figure 3.9.4-1. Photos of (a) shipborne SEM and a new boom (b) data logger and power unit.

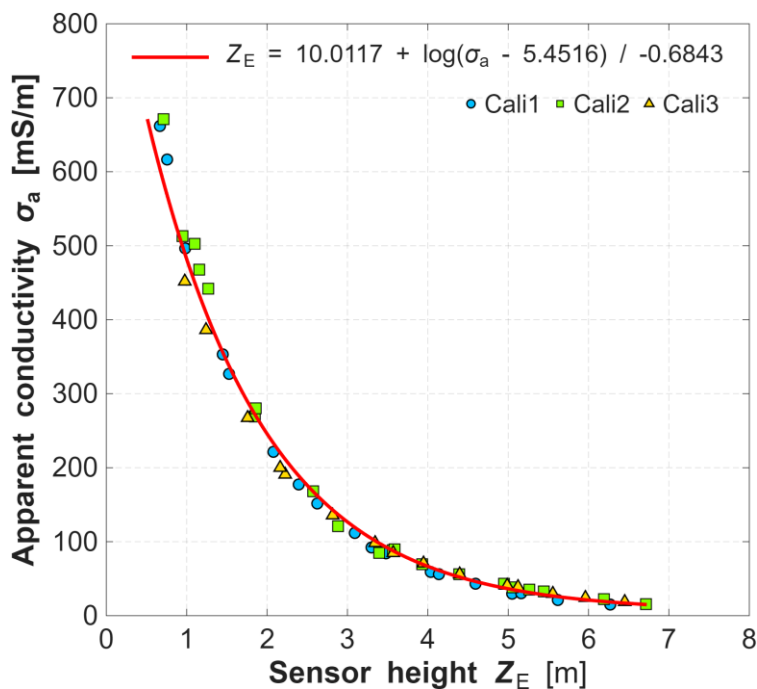


Figure 3.9.4-2. SEM calibration results

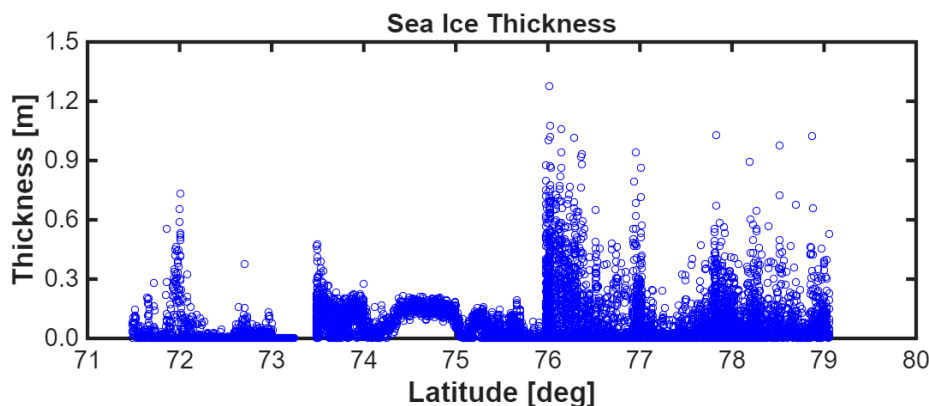


Figure 3.9.4-3. SEM observation results

3.9.5 Passive Microwave Radiometer observation

Kazu Tateyama, Shotaro Muraoka (KIT), Takuji Waseda (UTokyo), and Michi Shibata (MOLM)

P.I.: Kazu Tateyama (KIT),

Observation of passive microwave radiation from sea-ice or sea water were conducted using a portable Passive Microwave Radiometer (PMR) which is developed by Mitubishi Electric Tokki Systems Co., Ltd., Japan. A Microwave/Miliwave Radiometer Systems (MMRS2A) was used for two frequencies and polarizations: 36GHz with vertical and horizontal polarization. A radiation thermometer and a visible camera also provide surface temperature in Kelvin and its visible image. SEM thickness and PMRs were collected sea-ice thickness and its microwave radiometric properties in order to validate and improve the algorithm for estimation of the Arctic snow/sea-ice total thickness by using the AMSR2 [Krishfield et al., 2014].

The brightness temperatures of 36GHz-V and -H and IR observations were carried out while the vessel was on station in sea ice and open water (Fig. 4.9.8) during 27th September to 12 October as summarized in Table 4.9.2.



Figure 3.9.5-1: Photo of PMR observation.

Table 3.9.5-1. Results of passive microwave observation.

Date	Observation Type (Incident angle)	36GHz V-pol (K)				36GHz H-pol (K)			
		Brightness Temperature		Infrared Temperature		Brightness Temperature		Infrared Temperature	
		Ave	Std	Ave	Std	Ave	Std	Ave	Std
9/27	Calibration	275.6	0.2	274.3	0.3	269.4	0.4	270.0	0.1
9/27	Sea ice (Open water)	208.5	0.3	273.6	0.1	127.1	0.4	273.6	0.1
9/27	Sky	31.1	1.3	267.4	0.1	35.4	1.2	267.4	0.1
10/2	Calibration	267.9	0.2	270.5	0.4	262.2	0.4	267.3	0.1
10/2	Sea ice (Young ice, water) (17.5°)	226.9	0.8	269.1	0.3	171.1	4.6	269.1	0.3
10/2	Sea ice	251.6	0.2	268.6	0.1	225.0	0.4	268.6	0.1

	(Young ice) (33.0°)								
10/2	Sea ice (Young ice) (34.7°)	257.5	0.2	268.1	0.1	232.9	0.4	268.1	0.1
10/2	sky	8.1	0.4	245.0	4.0	12.4	0.4	245.0	4.0
10/4	Calibration	273.4	0.4	274.6	0.2	268.5	0.6	271.1	0.8
10/4	Sea ice (Young ice) (34.8°)	256.8	0.4	269.6	0.1	238.2	0.6	269.6	0.1
10/4	sky	20.0	0.2	267.6	0.1	24.3	0.7	267.6	0.1
10/7	Calibration	271.9	0.2	270.1	0.4	266.5	0.5	269.6	0.4
10/7	Sea ice (Young ice) (34.3°)	256.2	0.3	267.3	0.1	242.4	0.6	267.3	0.1
10/7	sky	12.5	0.5	262.9	0.1	18.0	0.4	262.9	0.1
10/11	Calibration	278.1	0.2	277.1	0.2	271.5	0.4	276.7	0.2
10/11	Sea ice (New ice)	241.2	2.1	274.6	0.1	206.0	3.3	274.6	0.1
10/11	Sea ice (New ice) (34.0°)	212.4	3.5	274.3	0.1	181.7	7.0	274.3	0.1
10/11	Sea ice (Open water)	196.5	2.4	274.5	0.1	129.8	3.6	274.5	0.1
10/11	sky	27.4	0.4	271.9	0.1	28.2	0.7	271.9	0.1
10/12	Calibration	283.4	0.3	279.8	0.2	278.0	0.5	285.0	1.5
10/12	Sea ice (Young ice) (35.8°)	251.7	1.4	272.9	0.2	223.2	2.2	272.9	0.2
10/12	Sea ice (Young ice) (35.9°)	254.5	0.6	272.8	0.1	233.0	0.8	272.8	0.1
10/12	Sky	13.4	0.3	271.0	0.1	17.6	0.5	271.0	0.1

3.10 Ice Observations at Ice Stations

Kazu Tateyama, Shotaro Muraoka (KIT), Takuji Waseda (UTokyo), and Michi Shibata (MOLM), Michiyo Yamamoto-Kawai, Tsukushi Komura (TUMSAT), Yuanxin Zhang (TohokuU), Celine Gueguen, Magali Pucet (USherbrooke), Andrew Ross, Erinn Raftery, Collette Leclerc (DFO-IOS), Annabel Payne, Marguerite Larriere (ETH), Dominique Baker (ConcordiaU)

P.I.: Jennifer Hutchings (OSU), Kazu Tateyama (KIT)

Ice thickness transects were taken at 2 ice stations to characterize the sea-ice floe where WHOI's ITPs were deployed. In parallel, ice cores and snow sample were taken for temperature, salinity and density profiles.

Ice and snow measurements were conducted by following the standard JOIS protocol at each ice station.

1. Establishing 100m-long transect line by using tape measure and flags
2. Collecting snow depth, ice thickness and freeboard data along transects at every 10m by using an electrical-powered ice auger with a generator.
3. Collecting ice cores at 50m and 100m by using an ice corer with an electric motor head.
4. Measuring snow pit at 50m and 100m

3.10.1 Overview of ice stations

Ice Station #1

Only the buoy deployment operation was conducted by WHOI.

Ice Station #2

Wave buoy: *Takuji, Shotaro, Michi, Kazu, Xin, Annabel*

Ice transect: *Michi, Erinn, Magali*

Coring: *Takuji, Shotaro, Michiyo, Tsukushi, Xin, Annabel, Andrew*

Snow pit: *Kazu*

Ice was accessed from gangway of port side. First, an equilateral triangle with 30 m on each side was surveyed for the installation of the wave buoy. Ice was drilled by ice corer at the three vertices and the center of the triangle. Then, four buoys were deployed at these points.

Next, a 100m-long survey line was established, and measurements of snow depth, freeboard, and ice thickness were taken every 10 m along the line.

Ice cores were then collected at the 50m and 100m points. A total of four ice cores were obtained for salinity analysis, LiDAR calibration, algae analysis, and $\delta^{18}\text{O}$ measurement.

Ice Station #3

Ice transect: *Michi, Erinn, Magali*

Coring: *Takuji, Shotaro, Michiyo, Tsukushi, Xin, Annabel, Andrew*

Snow pit: *Kazu*

Ice was accessed using man basket of starboard side.

First, a 100m-long survey line was established, and measurements of snow depth, freeboard, and ice thickness were taken every 10 m along the line. At the 50m point, the sea ice was more than 170 cm thick, therefore only one ice core was collected, serving both for the physical and LiDAR analyses. The ice cores for algae and $\delta^{18}\text{O}$ analyses were taken instead at the water-sampling site, where the ice was thinner.

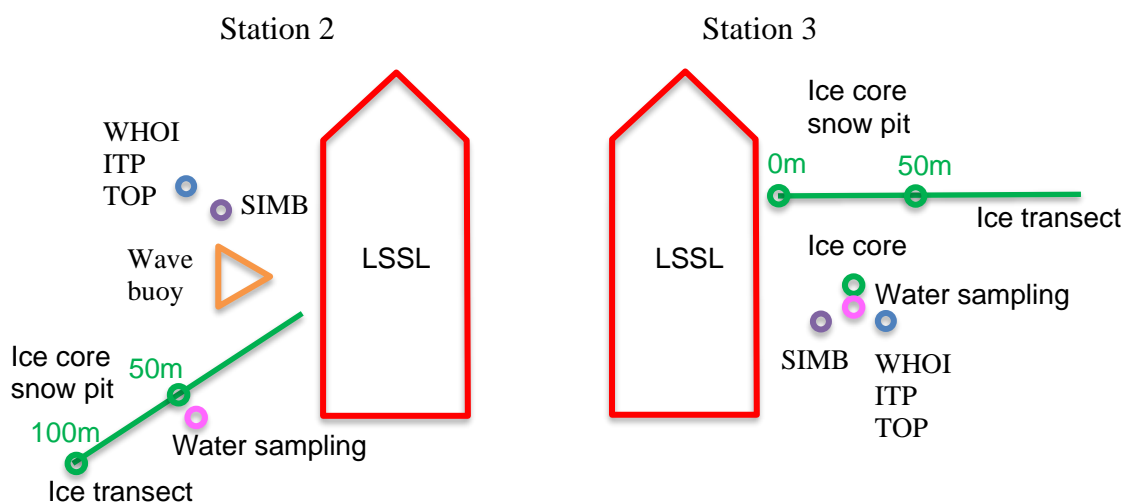


Figure 3.10.1-1. Schematics of point and transects on each ice stations.

3.10.2 Ice Transects

At ice station 2, we conducted two 100 m transects measuring snow depth, ice thickness and ice freeboard every 10 m along the transect lines.

First, the snow was removed using a shovel, and the snow depth was measured at three locations. Next, a 2” ice auger and electric drill were used to make a hole in the sea ice. Ice thickness and freeboard were measured with using a tape measure with a weighted end (“dongle”). The results are shown in Fig.10.

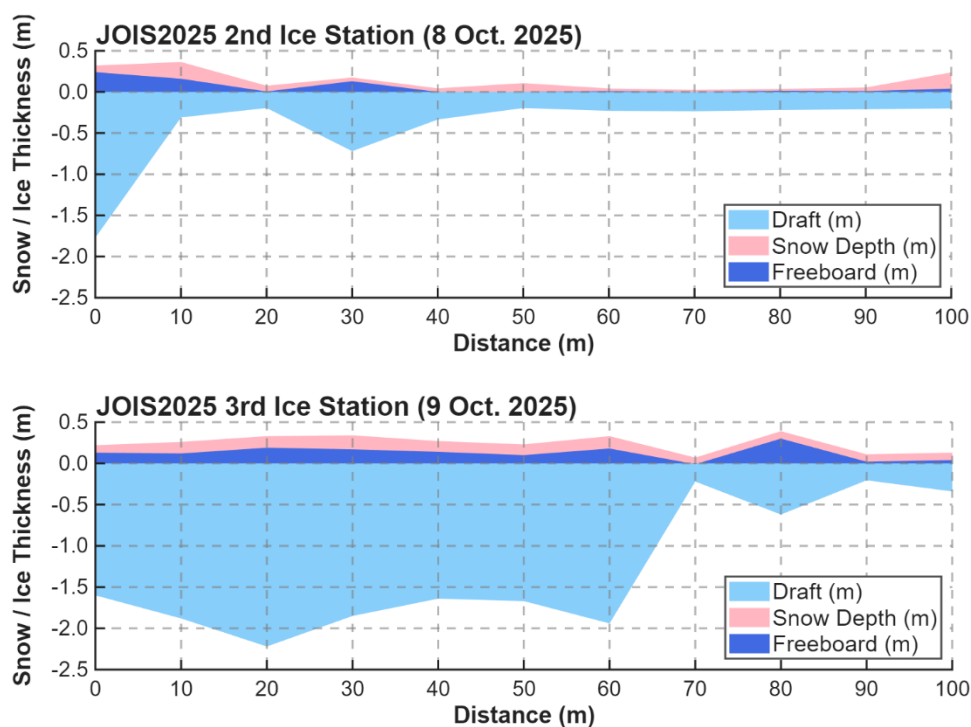


Figure 3.10.2-1. Thickness distributions of snow, ice, and freeboard from ice transects at stations 2 and 3.

3.10.3 Ice cores

Table 4.10.1 shows the summary of collected ice core samples. 6 physics cores in total were taken from station 2 and 3.

Table 3.10.3-1. Summary of collected ice core samples and snow pit observation.

Station	Distance	Core - Property	Snow Pit
2	50m 100m	Temperature, salinity, density, LiDAR, algae, $\delta^{18}\text{O}$	50m -
3	- 50m water	Temperature, salinity, density, LiDAR algae, $\delta^{18}\text{O}$	0m 50m -

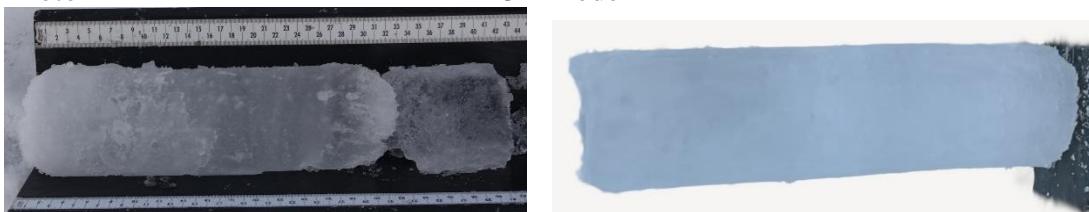
Cores were collected using a 1m-long 4” diameter corer using a new electric powered auger head. Immediately after collecting the core, the temperature was measured at 10cm intervals starting at 5cm. The core was then sectioned into 5cm chunks, measured for density, bagged and melted back on board for salinity measurements. Salinity was measured using a hand held salinity probe.

Figure 4.10.3 presents the ice-core photographs and the corresponding 3D models obtained from LiDAR scans at Ice Stations 2 and 3.

(a) Ice Station #2 at 50m site. Ice core length:43.5cm

Photo

3D model



(b) Ice Station #2 at 50m site. Ice core length:176.0 cm

Photo



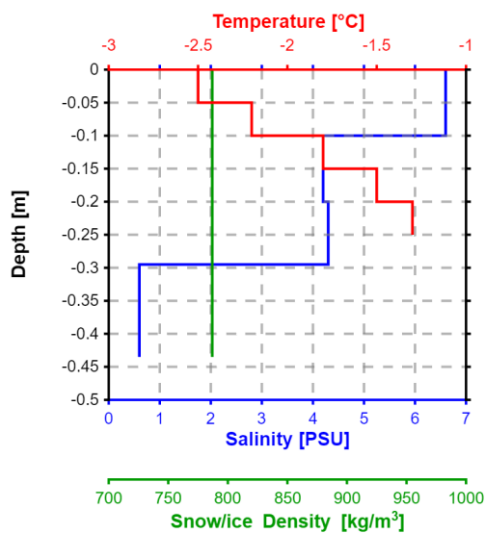
3D model



Figure 3.10.3-1. Photos of ice core samples from ice station (a) 2 and (b) 3.

Temperature, salinity and density profiles were measured at each core site. Figure 12 show temperature, salinity and density profiles of ice.

JOIS2025 2nd ice station at 50m (8 Oct. 2025)



JOIS2025 3rd ice station (9 Oct. 2025)

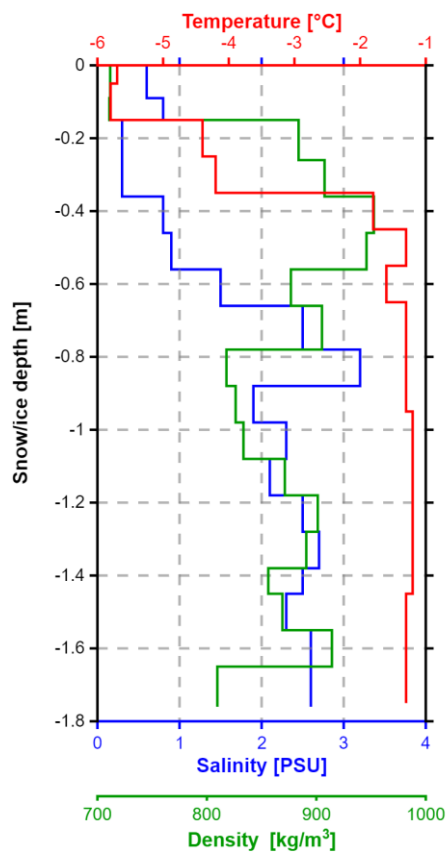


Figure 3.10.3-2. Temperature, salinity and density profiles of ice core samples from Ice station 2 and 3.

3.10.4 Snow Pits

Figure 3.10.4-1 and 3.10.4-2 show an example of a snow cross-section and the snow layer structure and photographs of observed snow crystal types.

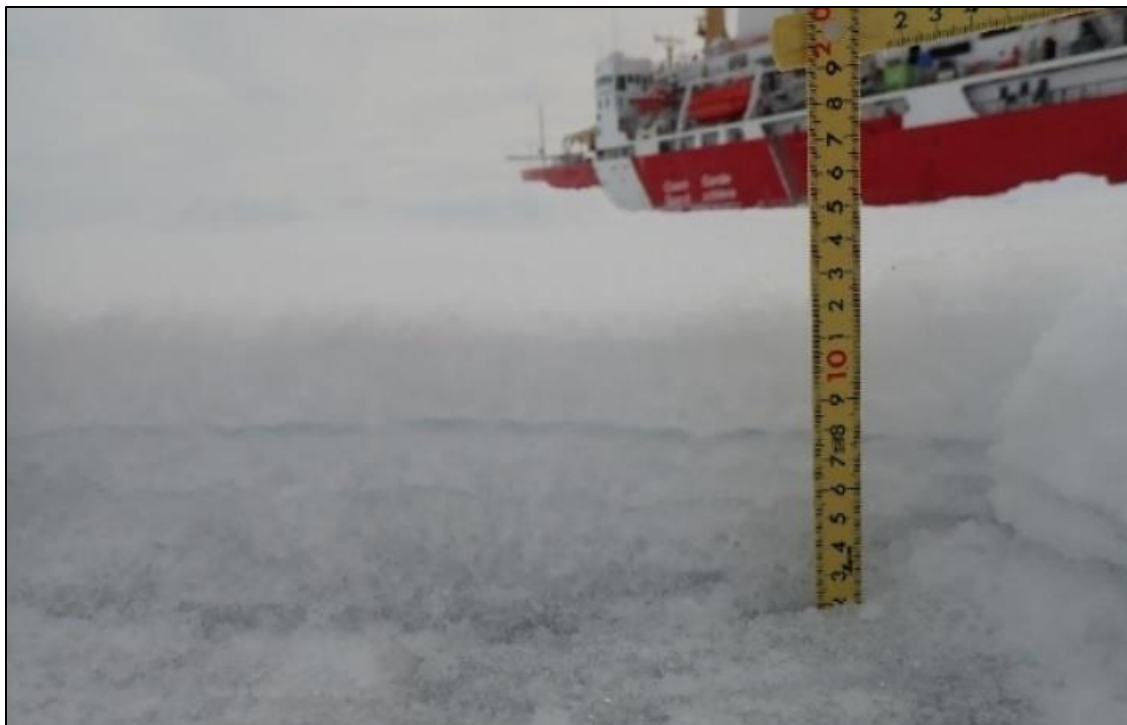


Figure 3.10.4-1 Photo of snow cross-section at station #2 50m.

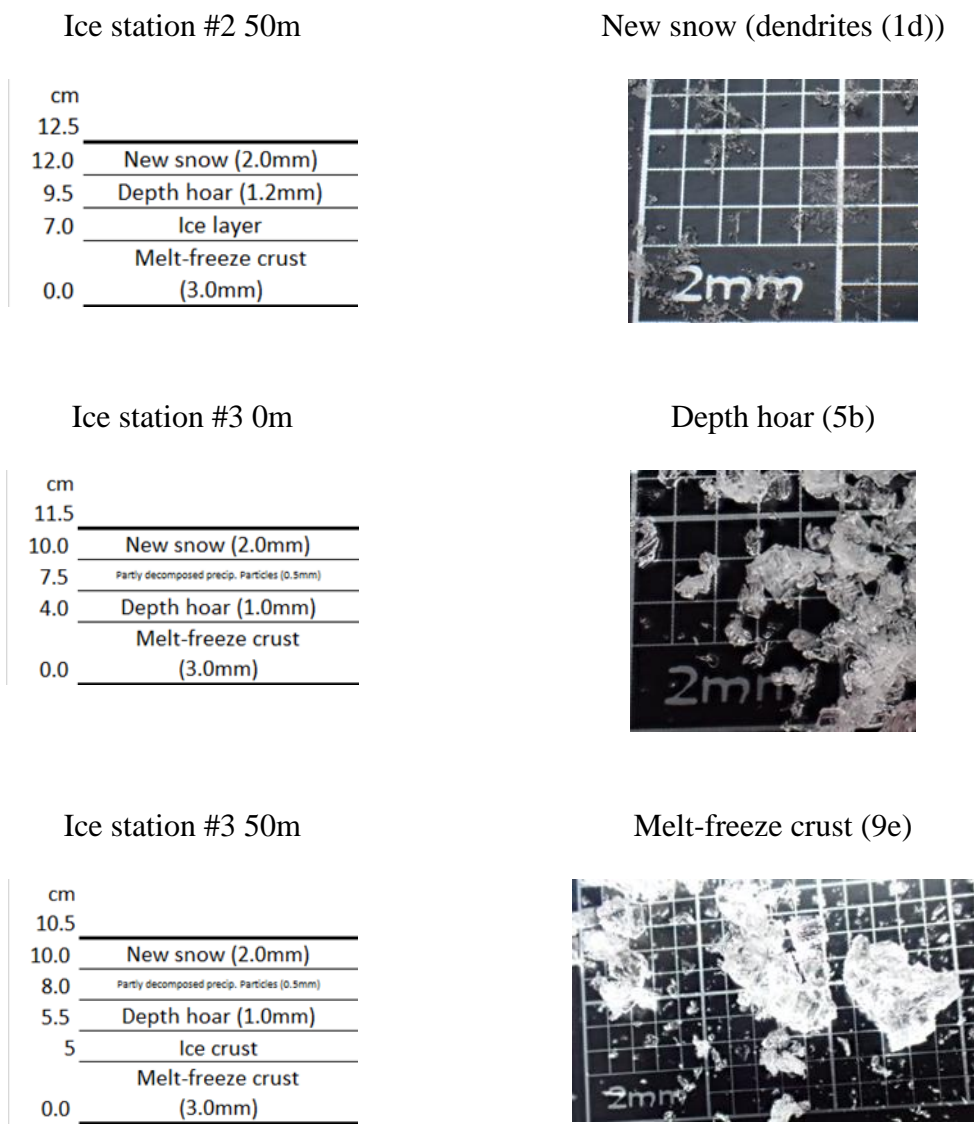


Figure 3.10.4-2 Results of snow layer structures and photographs of representative snow crystals obtained from snow pit observations.

3.10.5 Data Descriptions

lsloaa::sciencenet/2024-011-JOIS/Data/

- /Ice_Watch/
2025IceWatchLogSheet.xlsx
/Ice_Watch_Photos/
- /SSICR (Ice camera)/
cam1: Forward camera
cam2: Sideward camera
gnss: GNSS data
- /SEM/
/csv/1sec, 10min
- /JOIS2025_Icestation_Transect_Core/
JOIS2025_Ice_Stations_Summery.xlsx
JOIS2025_IceStation_IceCore.xlsx
JOIS2025_IceStation_Transect.xlsx
JOIS2025_IceStation_SnowPit.xlsx
/2nd_ice_station (8 Oct 2025)/ and 3rd_ice_station (9 Oct 2025)/
/Ice_Core/
/Ice_transect/
/Snow_pit/
/Photo/

3.11 Ship Performance and Operation in Ice

PI: Takuji Waseda (UTokyo)

3.11.1 Ship performance monitoring

Ship performance monitoring is an essential element of observation in the ice-covered seas. Following the JOIS2023 and JOIS2024, we collected the LSSL's performance data. Table xy lists the data obtained from the engineers of the LSSL. In addition, we have obtained the ECDIS (Electronic Chart Display and Information System) data, augmenting the SCS dataset.

Table 3.11.1-1. Ship performance data summary

Data set type	File name (*.csv)	Variables	Sampling rate
SCS data	RMC_*.raw	GPS Position, Time, Date, SOG & COG	1 s
Bubble system	MM_dd_YY.csv	Electrical current	2 min.
Engineering Log Book	(image file)	Fuel oil day	1 day
Engine control room data	YYYY_MM_dd.csv	propeller shaft revolutions, power, and fuel consumption	~ min.
ECDIS	VoyageLog20251022060246 VoyageLog20251022060339	GPS Position, Time, Date, SOG & COG, HDG, WSP, WDR	irregular

Usage of the data and the source of data

SCS data

Ship speed from the RMC_*.Raw is used for the studies. Other variables, such as heading, wind speed/direction, are in separate files: ASCII-PAR, AVOS, GGA, Knudsen, SBE, TSG, True-Wind. The files are archived in the science server.

Bubble system

The electrical current used to operate the bubble system is recorded every few minutes.

Engineering Log Book

Daily fuel consumption is recorded once a day in the motor control room, covering the 24-hour period from 00:00 to 24:00 on the ship's local time (UTC-6 in JOIS2024). Fuel consumption is calculated by reading the fuel tank level and measuring the difference.

Engine control room data

Includes the propeller shaft RPM and the power of the motors and generators. Although the data acquisition frequency is not completely consistent, data is obtained approximately once per minute. The motors and generators are numbered as 1, 2, 3, 4 and 5 from the port side. The maximum output for each motor is 6,714 kW. Provided by CCG engineers

ECDIS data

The ship data (SOG, COG, HDG, Lon, Lat, Time etc.) and wind speed/direction are recorded at an irregular interval. Should be used if the data is missing in the SCS data.

Preliminary Analysis

The ship speeds are plotted along the cruise track in Figure 10. The originally planned station locations are plotted together. The dates are marked at midnight UTC. The ice was observed throughout the cruise from 9/23 to 10/18, except for the period from 10/13-10/16 when the ship was in open water. The average speed was 6.2 knots, and the maximum speed was 17.5 knots.

On October 10, the ship encountered a thick ice that required ramming operations. An enlarged view of the ship track is shown in Figure 11. Eight ramming operations were conducted to escape from the thick ice area. The ship track shows that the ice field had a constant southward migration. The bubbler was used during the ramming operations. The 3rd officer steered the ship under the guidance of the captain. 2nd officer was at the bridge as well.

Suggestions for the next cruise:

- Document a list of necessary information from the ship crew
- Collect the interim data during the cruise to check the consistency from the past years

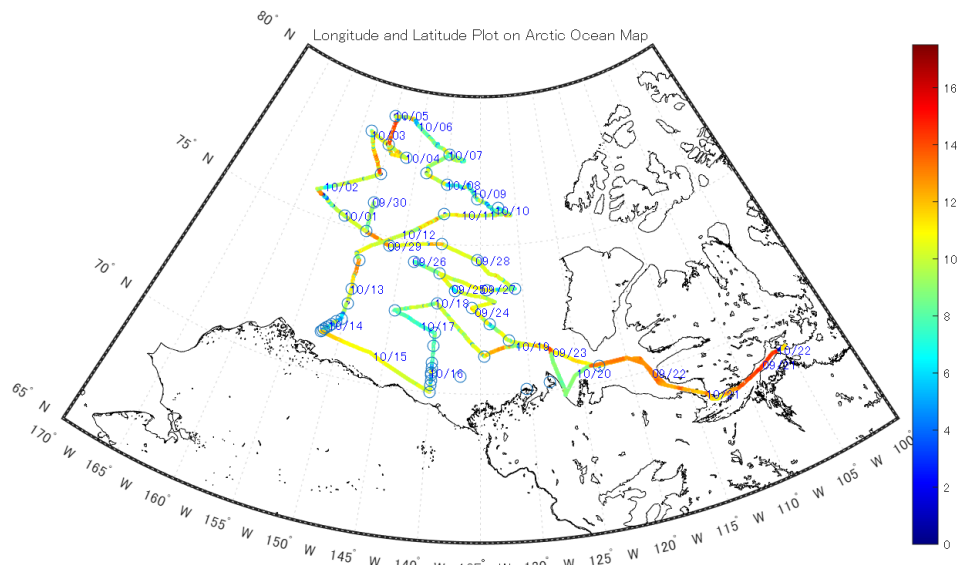


Figure 3.11.1-2. JOIS2025 ship track. Dates are labeled at midnight each day. The color indicates the ship speed (from the RMC data)

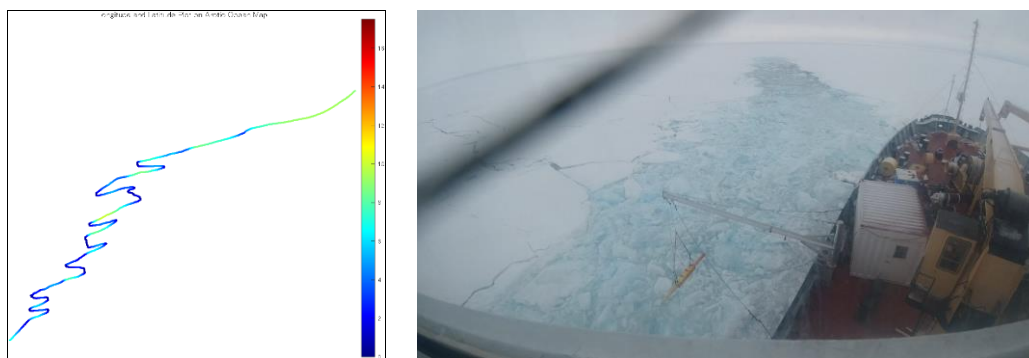


Figure 3.11.1-3. Ship tracks during the ramming operation on 2025/10/10. Eight ramming operations were made. An OSMO Action Camera time-lapse images were recorded concurrently (right). Six ramming operations were recorded by OSMO Action Camera.

3.11.2 Ship-borne and satellite radar monitoring

LSSL is equipped with an ice monitoring system (Rutter, Ice Navigator) that analyzes the Furuno X-band radar video signal. The Rutter Ice radar display was duplicated on a monitor placed on the starboard side of the bridge near the front window. An OSMO camera was placed in front of the monitor to capture the image every 1 s. The measurement was done at an arbitrary time when anything interesting was found. There are predefined options for visualization: “Man Over Board”, “Fog Or Rain”, “Low Sea State”, “Moderate Sea State”, “High Sea State”, “Pack Ice”, “Test”. There wasn’t any particular setting that was most frequently used. The factory defaults provide the base combination of gain and threshold that are manually adjusted for the particular sea ice condition.

Figure x shows a sample image of the Ice-Navigator depicting very narrow breaks separating the vast ice floes (left). The photograph taken from the bridge (center) shows a young gray ice with no small surface topographic features. The radar signal is not scattered from the surface and therefore appears as a dark area. Most likely, the sharp bright lines in the radar image come from the edges of the ice floes; hence, visualizing the narrow breaks. The ship location overlaid on the SAR image. The area is represented as a mixture of bright and dark pixels, corresponding to scattering of a satellite microwave from the same topographic feature that the ship-borne low-grazing angle (incident angle near 90°) radar detected, but with a different incident angle (20-49°) and wavelength (C-band).



Figure 3.11.2-1. Ice-Navigator snapshot (left), photograph from the ship (center) and the SAR image (RADARSAT-2) of the same day (right)

Satellite SAR image was used extensively to find a suitable ice floe for the ice station, see Figure xx from the Ice Specialist’s report. RADARSAT-2 images are update every day at a given position. The procedure to find a floe is:

- ① Detect a rounded shape feature in the SAR image
- ② Examine the texture of the image
- ③ Bright and salt-and-pepper-like texture suggests rough surface topography

- ④ Consider the ship navigation plan and the sea ice drift by wind
- ⑤ Visually observe the sea ice and predicted ice conditions from SAR and make corrections.
- ⑥ When the ship arrives at the target ice floe, scientists give the go and hand over the decision to the captain.
- ⑦ The captain reduces the engine rotation to 50 rpm and observes how the ship slows down.
- ⑧ The captain makes a final decision based on the ice condition to lower the gangway and reposition the ship so that the ice station is located downwind.

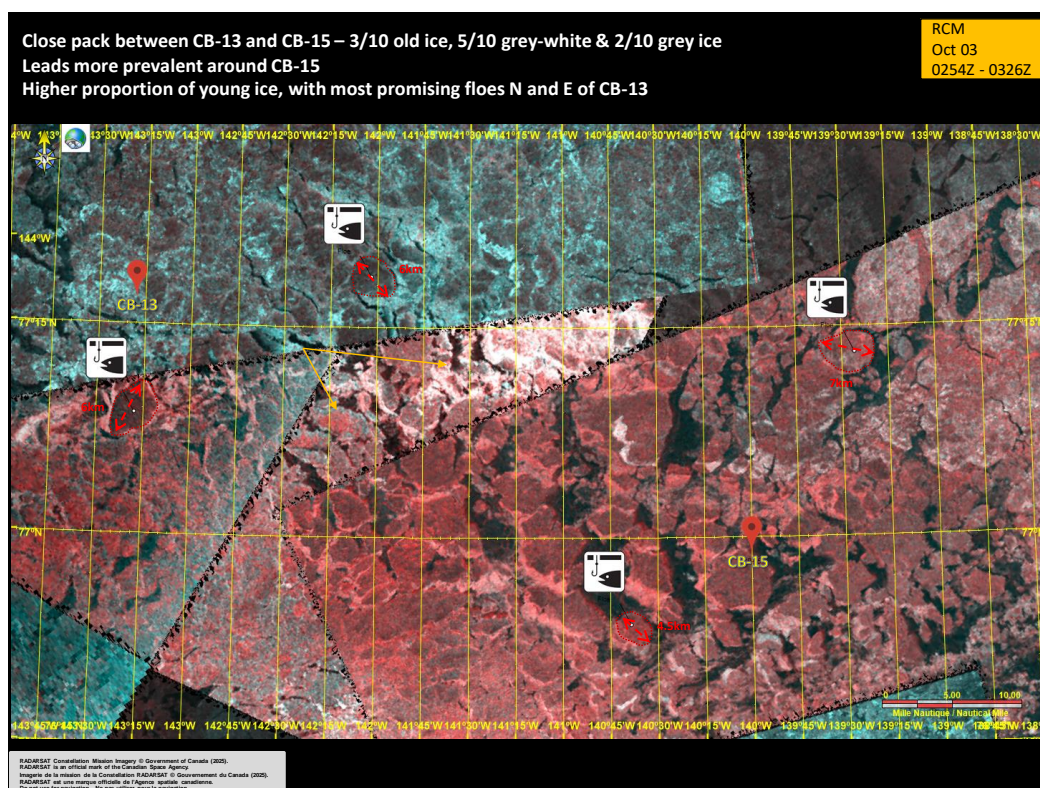


Figure 3.11.2-2: Radarsat-2 image and the target ice floe locations marked by the ice specialist.

Suggestions for improvement:

- Video capture board will be handy to make continuous records of the Ice-Navigator display. Or, run a screen capture program (if possible).
- Concurrent records of the ice monitoring camera (visible) and the ice radar will be better.
- It will be useful to share a low resolution RADARSAT-2 images so people can make plots with SAR image in the background

3.11.3 Future work: Ice breaking monitoring, bubbler

There are two suggestions for future studies of the ship performance. The first is an observation of the breaking ice pattern of the level ice. The second is the test of the bubbler efficiency.

Breaking ice pattern

During the retrieval of the BGOS buoy on 2025/10/03, the young level ice was broken into pieces by intentionally maneuvering the ship back and forth in an area where the buoy is located. An image from the ship can be orthorectified, but a drone image would be ideal. Assessment of ice thickness is useful if the ice flips at the side of the ship. Ship navigation through breaking ice is also of interest. Ship resistance estimate in such condition is rare at full scale.

Bubbler

The effect of bubbler during navigation in ice was studied for CCGS H. Larsen but not for CCGS LSSL. Consultation with the researchers who have studied H. Larsen, suggested to conduct on and off experiments under the same ice condition. Navigating in circle with and without a bubbler would be of interest as well.

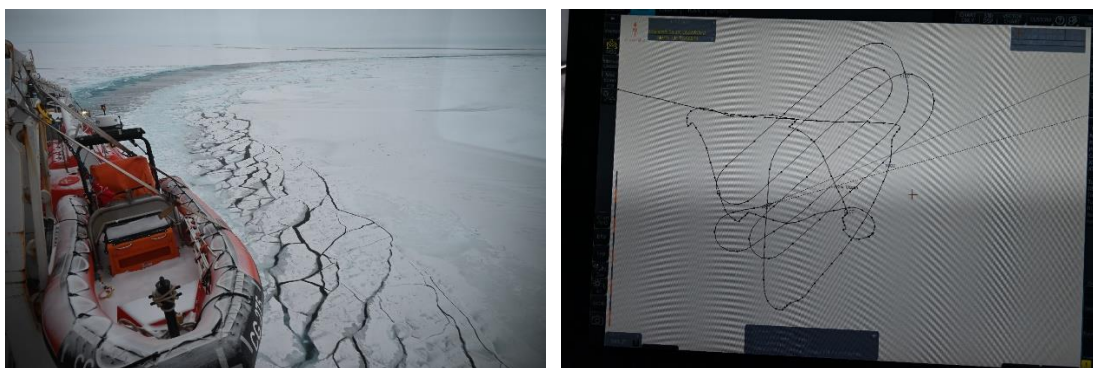


Figure 3.11.3-1. (left) Breaking ice pattern in young level ice. (right) The ship cruise track during the BGOS retrieval on 2025/10/3.

3.12 Infrared camera observation

PI: Takuji Waseda (UTokyo)

3.12.1 Camera system

We installed an infrared camera (hereafter IR camera) at the port side of the fore deck (Figure 3.12.1-1, left and center). A fixture was built by the CCG engineer that attaches to an existing pipe with a flange (Figure 3.12.1-1, right). The fixture can be rotated to change the azimuth angle of the camera. Two bolts are used to fix the azimuth angle.

The specification of the IR camera (Optris XI 640) is given in Table 3.12.1-1. The camera is fixed in a heated camera housing. Two cables come out of the camera housing: a 24 V DC power line and an Ethernet cable, and connects to the connectors in the fore deck science lab. The Ethernet cable is connected to the hub of the science network. A PC that connects to the same LAN can be used to record the data. Table 2 lists the IR camera and the PC network configurations.



Figure 3.12.1-1. Location of the infrared camera: (left) plan view; (middle) Typical setting of the camera pointing forward; (right) camera housing attached to a fixture.

Table 3.12.1-1. Specification of the IR Camera (Optris XI 640)

Spectral range	Resolution (pixels)	Thermal sensitivity	Temperature range	Frame rate	Accuracy	Field of view	Weight
8-14 μm	640x480	0.08°C	-20-900°C	32 Hz	2%	65°x45°	~300g









Table 3.12.1-2. Network configurations of the camera and the PC










	IPv4	Subnet mask	Gateway
Camera	10.1.20.103	255.255.255.0	N/A
PC	10.1.20.41	255.255.255.0	N/A







The Optrix XI 640 camera configurations that may affect the thermal imaging are:




- i) Flag: set to “Min. Interval: 12 sec” and “Use flag” operation
- ii) Emissivity: 1.000, Transmissivity: 1.000
- iii) Reference temperature: “Fixed value” with fitting mode “Offset”, with an emissivity limits, “0.010-1.100”. The Fixed value was changed depending on the air temperature
- iv) Recording mode was set to “Snapshot sequence” at snapshot interval of “1 sec” and a snapshot count limit of “100,000”.
- v) The captured images were saved as “TIFF” files with a prefix “Record” and subdirectory “year-month-day”.

3.12.2 Recorded images (snippets)

Date	Size (GB)	# of files	Remark	Snippet
2025/9/23	9.75 GB	11,904		
2025/9/24	15.5 GB			
2025/9/26	23.2 GB			
2025/9/27	41.6 GB			
2025/9/28	2.32 GB			
2025/9/29	3.84 GB			
2025/9/30	11.7 GB			
2025/10/1	35.9 GB			

2025/10/2	37.8 GB			
2025/10/3	30.8 GB			
2025/10/4	23.6			
2025/10/5	16.5			 
2025/10/6	35.1			
2025/10/7	47.7			
2025/10/8	43.2			
2025/10/9	47.8			

2025/10/10	34.3			
2025/10/11	31.6			
2025/10/12	24.7			
2025/10/13	n/a			
2025/10/14	n/a			
2025/10/15	21.8			
2025/10/16	35.2			
2025/10/17	20.6			

2025/10/17	20.4			
2025/10/18	32.7			
2025/10/19	23.6			

3.12.3 Sample images

A total of 670GB of images were captured in about 25 days of measurement. Overall, the measurement demonstrated the potential of the IR camera in the ice-covered sea. *Scientifically*, we foresee a possible use of the IR camera to detect sea ice thickness. The best condition for sea ice thickness detection seems to be when the air temperature is sufficiently low compared to the water temperature. In the images shown in Figure 8, bright colors show where the water is exposed to air. The freezing temperature is around -1.7 degrees, while the air temperature is between -5 degrees and -10 degrees. The darkest color (purple) resembles the color of the sky, suggesting that the surface temperature of the thick ice is close to the air temperature. On the other hand, a wide area spreads (Figure 8, right) with a color that represents a temperature between water and air. The two example images suggest that the temperature of the thicker ice is closer to the air temperature, while the temperature of the thinner ice is closer to the water temperature. The result implies a possibility of using the IR camera as a method to detect sea ice thickness.

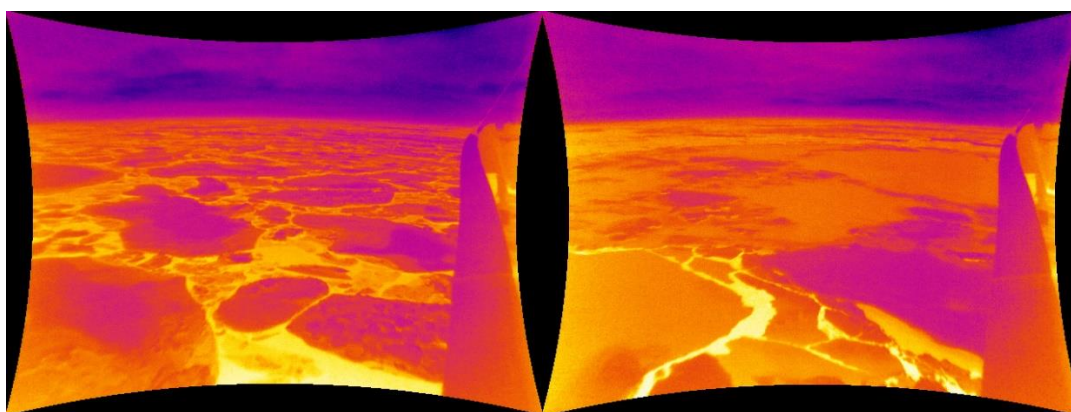


Figure 8. IR Camera images navigating through the MIZ (2025/10/19)

From an *engineering* perspective, the measurement showed a wide range of uses for the IR camera in surveillance purposes. The left image of Figure 9 observes the EM sensor while navigating in an ice-covered sea. The splash from the ship and the wetting of the EM sensor case are visible. The splash is caused by the interaction of the elevated broken-up ice sheet and the flush of water pushed by the bubbler. The water in the EM case and the ropes eventually froze, and the accumulated ice on the ropes exposed the EM sensor to the risk of failure due to its weight. The EM had to be pulled in to the fore deck to clean the ropes. In the right image of Figure 9, the camera was pointed at an area of the 2nd ice station on October 8. People on the ice, as well as the paths along the ice thickness survey transect, wave buoys on ice, and TOP/SIMB/IMB deployment are visible. An on-ice operation rarely happens during nighttime, but the camera can be used to monitor nighttime activities on the ship and to see water droplets impinging on the upper structures on the ship.

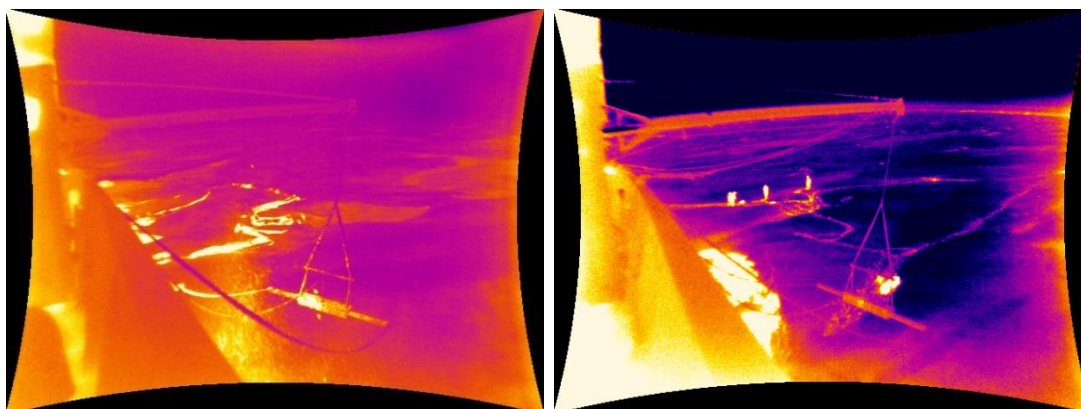


Figure 9. IR Camera images for inspection: (left) splashes are hitting the EM case (2025/10/09); (right) monitoring people working at the ice station

3.12.4 Suggestions for improvement

- Science Network: the bandwidth was not sufficient to show the captured images at the bridge. With a better connection, the IR camera can be used at the bridge to detect sea ice at night, assess the thickness of the ice, monitor activities on the deck, and find wetted areas on the ship.
- Storage: A dedicated computer should be prepared to record the images continuously. The computer can be left in the foredeck science lab.
- Multiple cameras: For sea ice monitoring, a 360-degree view will be ideal. If the resource is limited, monitoring both sides of the ship will be helpful for both *scientific* and *engineering* purposes, with the latter being crucial for avoiding thick ice floes. Visualizing the rear of the ship will be useful to monitor the brash channel if a ramming operation is needed at nighttime or to monitor sea ice movement in the vicinity of CTD/Rosette cast.
- Concurrent use of visible camera: the IR camera monitoring is a yet-to-be-established technology. Therefore, it will be useful to have an additional visual camera to record together.

3.13 Wave buoys

PI: Takuji Waseda (UTokyo)

The wave buoys were deployed on an ice floe for two objectives:

- 1) To detect waves propagating in ice and estimate the directional spectrum
- 2) To estimate the deformation of the ice floe leading to an eventual breakup.

The traces of buoy positions are shown in Figure. 16 left. The sensor firmware was updated to transmit band-passed complex Fourier coefficients hourly. This allows transmission of the time-series, allowing us to analyze the data to detect directional spectrum from the array. Buoy positions are obtained by GPS sensors approximately every 30 minutes. The four sensor array is configured in vertices of an equilateral triangle at 30 m side length and at the center of the triangle (Figure 16 right). The phase differences among the sensors provide information on the propagation direction. Moreover, the relative motion allows us to estimate the rotation and the deformation of the ice floe.

Approximate locations of the deployments are:

Station name	Buoy name(s)	Latitude	Longitude	Date /time
Ice station 2	JOIS25_2,3,4,5	77 00.690 N	136 42.276 W	2025/10/08 21:00:00
SE of CB27	JOIS25_1	72.0878 N	140.7188 W	2025/10/17 07:35:49

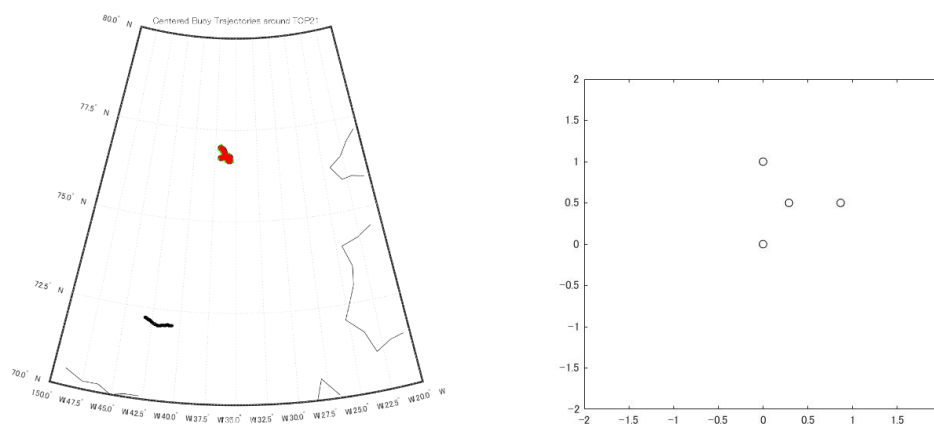


Figure 3.13-1. (left) Traces of buoy positions after deployment. Four wave buoys were deployed on ice during the 2nd ice station (2025/10/08). Their trajectories are plotted together with the TOP21 location (a cluster in the north). A wave buoy with a floater was deployed in open water on 2025/10/16 near the ice edge (black). (right) sensor array configuration forming an equilateral triangle.

3.13.1 Wave sensor array on ice floe

The OpenMetBuoy (OMB) developed by J. Rabault of MetNorway was modified to transmit 240 bins of band-passed Fourier coefficients (with the help of K. Sato of the U. of Tokyo). The six degrees of freedom IMU sensor provides tilt-corrected heave acceleration data recorded at 2 Hz. 2048 samples (equivalent to 17 min. of data) are obtained hourly from 10 minutes past the hour. The Iridium transmission follows the data acquisition (3 SBDs). The data received by the buoy server compiles the Fourier coefficients and synchronizes the data among the four buoys (JOIS25_1,2,3,4), adjusting for the time difference of the start of the IMU data acquisition. There are 4 Lithium batteries used and should last for about a few months at an hourly transmission of the Fourier coefficients. To minimize the battery consumption, we set a threshold to transmit the data based on the variance of the heave signal. For now, 8 mm of significant wave height or 4 times the standard deviation of the signal is set as a threshold. So far, there were no transmission of the data from the sensor array.

Figure 17 depicts the locations of the buoys relative to the center sensor. Together with the OMBs, TOP21 location is shown. Overall, the sensors' relative positions have not changed but there is a slight signature of the rotation of the floe as the spread of the location of the TOP21 seems larger than the others. A GPS error likely causes the scatter of data, but more analysis is warranted to distinguish true signal and noise.

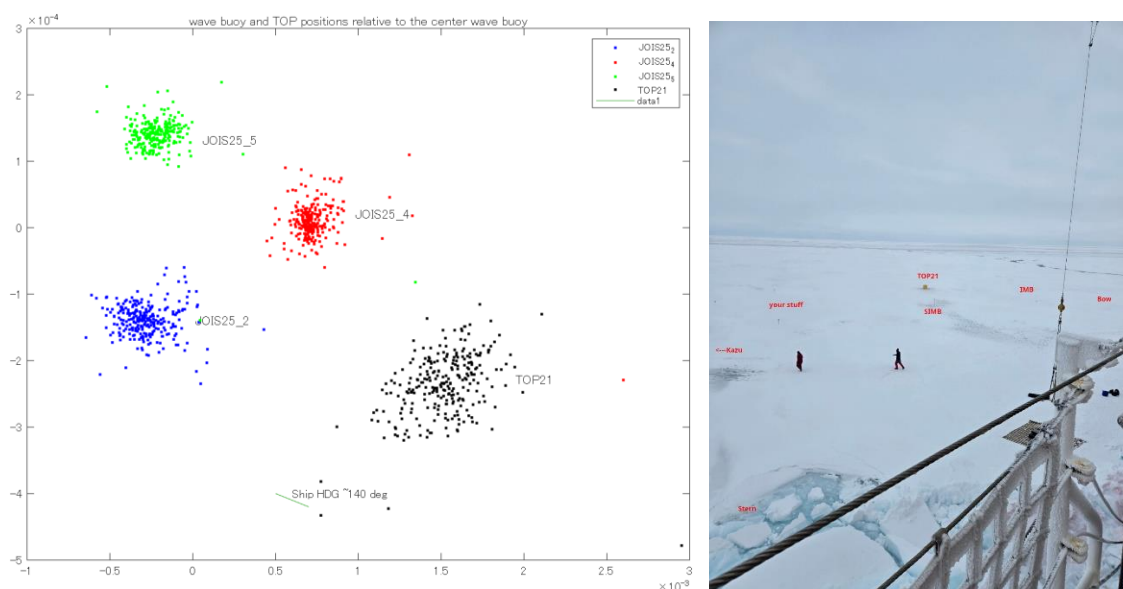


Figure 3.13.1-1. (left) buoy positions relative to the center buoy together with the TOP21. (right) relative locations of the buoys observed from the ship (photo by Jeff O'brien).

3.13.2 Wave buoy with a floater

A floater was assembled on the ship with the fifth wave sensor (JOIS25_1) on board and was deployed in open water on 2025/10/06. The images in Figure 18 depict the buoy (left) and the test deployment with a tether (right). The deployment was initially planned at CB27 but was eventually deployed southeast of CB27 at around 21:30. The buoy suffered the wave force of the large breaking waves caused by the interaction of ship wakes and windsea. Initially, data transmission was intermittent, but as the sea state calmed down, the success rate improved. The poor Iridium connection is likely due to the antenna's tilt being constrained by the height of the box. Trajectories of the buoys are overlaid on top of the AMSR2 sea ice concentration (Figure 19). As the buoy drifted west, the ice edge migrated south and eventually surrounded the buoy. A sample time series from the buoy is shown together with the heave spectrum (Figure 20). Besides the sea state calming down, the ice surrounding the waves has attenuated the swell. As a result, the wave height decreased over time.

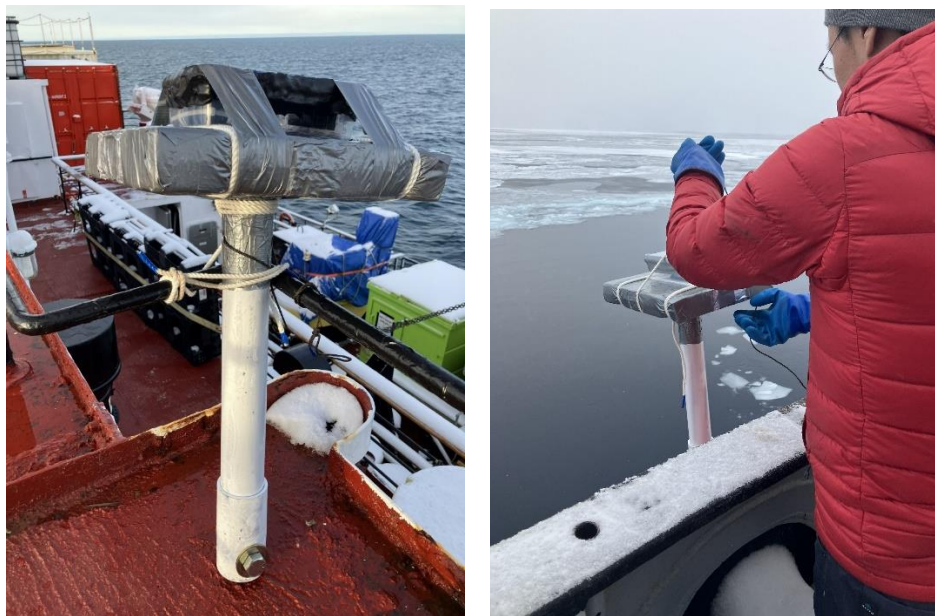


Figure 3.13.2-1. (left) The floater of the 5th OMB (JOIS25_1).

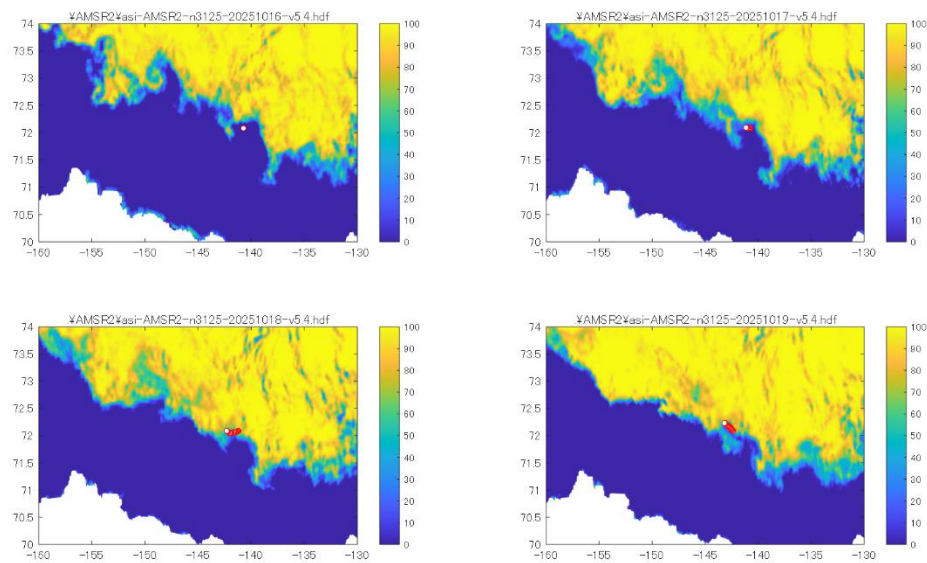


Figure 3.13.2-2. The daily trajectory of the 5th wave sensor on a floater (JOIS25_1), on 2025/10/16, 2025/10/17, 2025/10/18, and 2025/10/19.

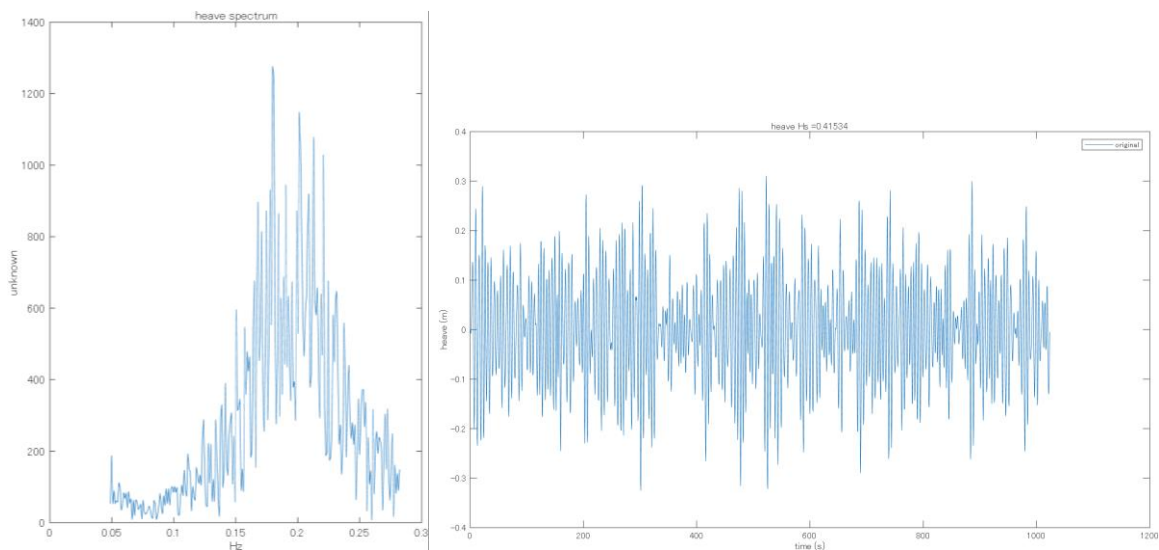


Figure 3.13.2-3. (left) modulus of the heave Fourier coefficients; (right) time series reconstructed from the received Fourier coefficients.

3.13.3 Suggestions for improvement

- Wave sensor cases and PVC pipes should be shipped earlier to DFO
- Battery pack should be ordered in Canada and sent to LSSL before the cruise

- Deployment of wave buoys at the CTD/Rosette stations can be a potential way to distribute the wave sensors in the Beaufort Gyre
- Concurrent deployment of the wave sensor with the WHOI TOP, SIMB, and IMB may provide a complete set of atmospheric, oceanic, ice, and wave data to understand the deformation process of ice floes
- Desiccants are available from the XCTD box
- Supplies needed: double-sided tapes, tape putty, strong duct tapes, cable ties, a long string, ropes
- The laser gauge did not work well in a snow-covered field. Think of a better way to deploy the buoys in a predefined configuration (a string with a marker was used, but it was challenging to get the exact dimensions of the triangle on ice)

3.14 Meteorological Buoys (ECCC)

Paul Macoun (DFO-IOS)

PI: Alex Zucconi (ECCC)

Environment and Climate Change Canada (ECCC) shipped 5 MetOcean Telematics buoys to the CCGS Louis S. St-Laurent in July for deployment during the JOIS 2025 program.

Please see Appendix for location information.

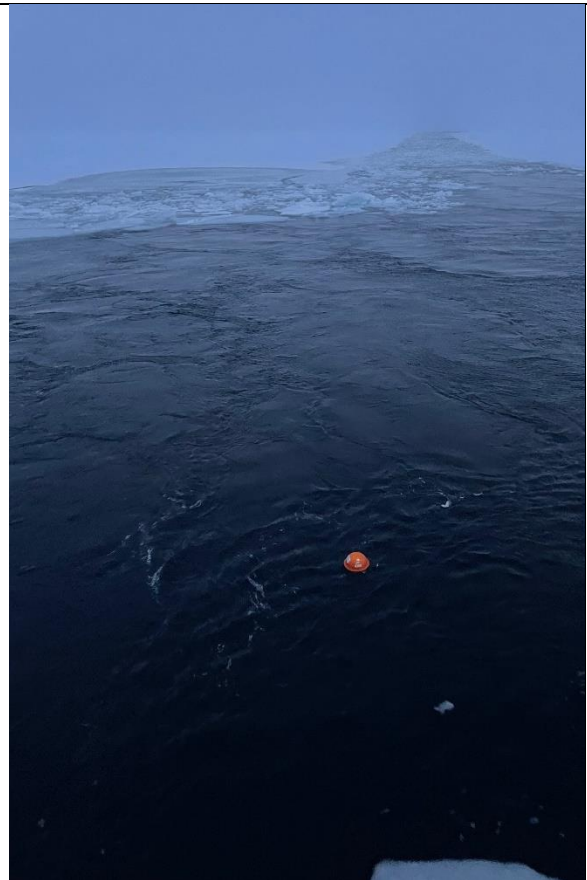
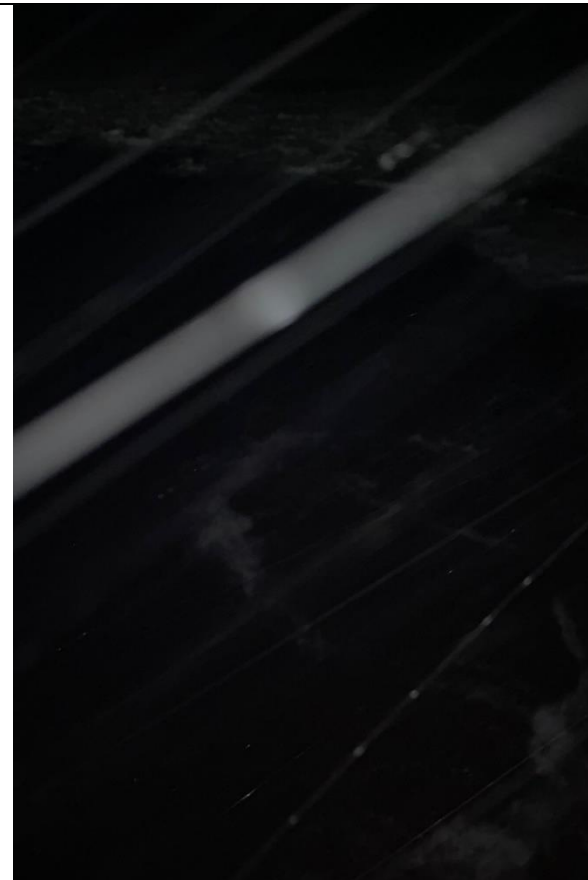


Table 3.14-1. Buoy # & IMEI Information

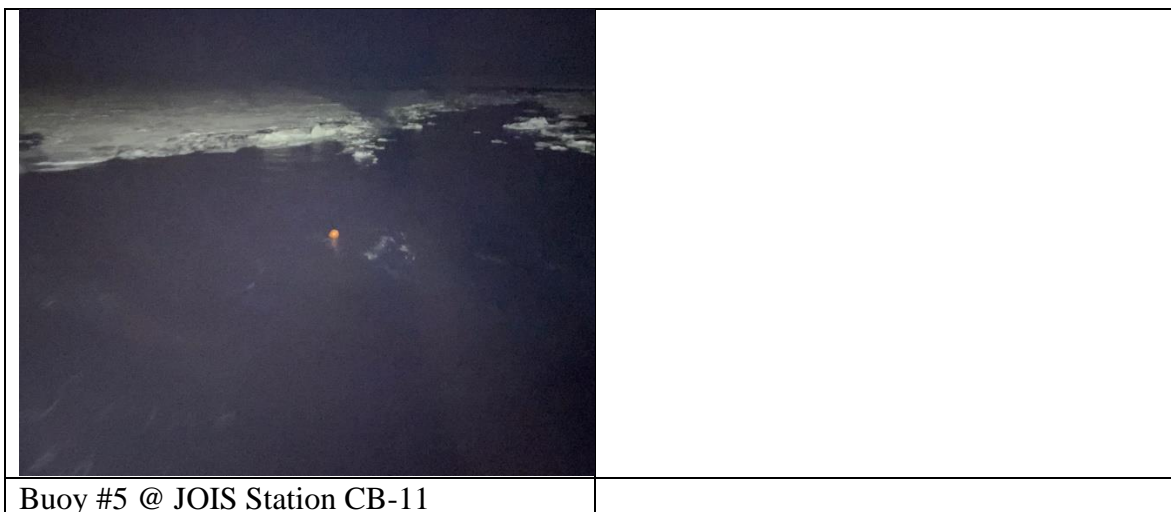
Buoy #	Model	SO#	Serial Number	IMEI
1	SVP-I-XXGS-LP	18205	J20E04	300534065164720
2	SVP-I-XXGS-LP	18205	J20E0Q	300534065168690
3	SVP-I-XXGS-LP	18205	J20EB2	300534065165700
4	SVP-I-XXGS-LP	18205	J20EB5	300534065166690
5	SVP-I-XXGS-LP	18205	J20DGS	300534065162700

Table 3.14-2. Deployment Information

Buoy #	Date	Time (UTC)	Lat (N)	Long (W)	Photo	Site Description
1	2025-10-06	2:36	78.955	146.202	Yes	Deployed @ Ice Station-1
2	2025-10-03	9:40	78.291	153.290	Yes	Deployed @ JOIS Station CB-10
3	2025-10-04	6:25	77.683	146.713	Yes	Deployed @ JOIS Station CB-12
4	2025-10-04	22:39	77.997	149.953	Yes	Deployed @ JOIS Station CB-9
5	2025-10-05	13:27	78.972	149.975	Yes	Deployed @ JOIS Station CB-11

Table 3.14-3. Deployment Photos

	
<p>Buoy #1 @ Ice Station</p>	<p>Buoy #2 @ JOIS Station CB-10</p>
	
<p>Buoy #3 @ JOIS Station CB-12</p>	<p>Buoy #4 @ JOIS Station CB-9</p>



3.15 ARGO floats

Paul Macoun (DFO-IOS)

PI: Tetjana Ross (DFO-IOS), Chris Gordon (DFO-BIO)

The Argo program is an ocean climate monitoring system with over 4000 floats drifting through the world's ocean making real-time temperature and salinity data available to the public in near real-time. The JOIS program has assisted the ARGO effort by launching floats provided by Fisheries and Ocean Canada. The floats were programmed to profile from 2000m to the surface every 10 days, parking at 1000m between casts. If the float could not reach the surface due to sea-ice, the data were transmitted the next time the float reached the surface.

No new floats were launched this year, however, data continue to arrive from previously launched floats in 2023 and 2024.

Float ID	Deployment date	Deployment location	Most recent profile (as of 2025-12-10)	
4902610	2023-09-19	CB23a	2025-09-24	ARGO Float 4902610 - Argo Fleet Monitoring
4902611	2023-10-03	CB2	2025-10-09	ARGO Float 4902611 - Argo Fleet Monitoring
Not given	2024-09-18	StnA	None	Never profiled
4902558	2024-09-19	CB27	2025-09-06	ARGO Float 4902558 - Argo Fleet Monitoring

Table 3.15-1. Floats as of 2025-12-10



Figure 3.15-1. Float ID 4902610 deployed Sep 2023 [ARGO Float 4902610 - Argo Fleet Monitoring](#)



Figure 3.15-2. Float ID 4902611 deployed Oct 2023 [ARGO Float 4902611 - Argo Fleet Monitoring](#)



Figure 3.15-3. Float ID 4902558 Sep 2024 [ARGO Float 4902558 - Argo Fleet Monitoring](#)

The Beaufort Gyre Layer Cake

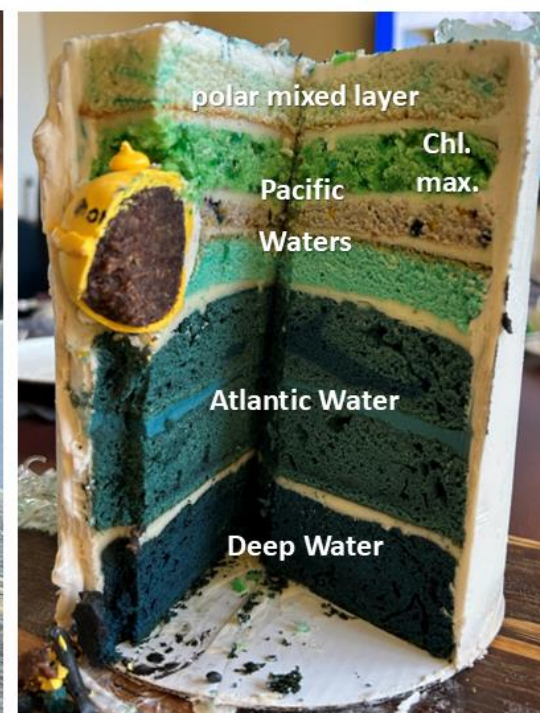
created by Sarah-Ann Quesnel: @c3cakesyyj



Drone view



Mooring measurements



Side view after water-column sampling

The BGOS moorings and buoys in cake form.

4 APPENDIX

4.1 Science Participants

Table 4.1-1. Onboard Science Participants

Number	Personnel	Institution	Role
1	Paul Macoun	DFO-IOS	Co-Chief Scientist, CCG Liaison
2	Sarah Zimmermann	DFO-IOS	Co-Chief Scientist, Data Specialist
3	Paige Hagel	DFO-IOS	Technician, Watch Leader
4	Chris Clarke	DFO-IOS	Technician (lead), Watch Leader
5	Sarah Ann Quesnel	DFO-IOS	Nutrient Analyst (lead)
6	Marty Davelaar	DFO-IOS	DIC Analyst (lead)
7	Andrew Ross	DFO-IOS	Scientist (Bio-Toxins), Watch Stander
8	Erinn Raftery	DFO-IOS	Oxygen Analyst (lead)
9	Collette Leclerc	DFO-IOS	Watch Stander
10	Celine Guegen	U Sherbrooke	Scientist, CDOM (lead), Watch Stander
11	Magali Pucet	U Sherbrooke	CDOM Analyst, Watch Stander
12	Dominique Baker	U Concordia	Microbial Analyst
13	Marguerite Larriere	ETH Zurich	Tracers Analyst, Watch Stander
14	Annabel Payne	ETH Zurich	Tracers Analyst, Watch Stander
15	Jennifer Kosty	Yale	Mooring support, Watch Stander
16	Jeff O'Brien	WHOI	Moorings & Buoys (lead)
17	Jim Ryder	WHOI	Moorings & Buoys Technician
18	Tim McDonough	WHOI	Moorings & Buoys Technician
19	Cory Beatty	U Montana	Mooring & Buoys - pCO ₂ /support
20	Kazu Tateyama	KIT	Scientist, Sea Ice Observations (lead)
21	Michiyo Yamamoto-Kawai	TUMSAT	Scientist, Alkalinity (lead)
22	Takuji Waseda	U Tokyo	Scientist, Waves, Ship Performance
23	Tsukushi Komura	TUMSAT	Alkalinity Analyst
24	Shotaro Muraoka	KIT	Sea ice observations, PMR ops
25	Yuanxin Zhang	U Tohoku	DIC/Chl-A Analyst
26	Michiharu Shibata	MOL Maritex	Ice breaker operations (observer)

Table 4.1-2. Principal Investigators Onshore

Name	Affiliation	Program
Bill Williams	DFO-IOS	DFO Program lead
Isabela LeBras	WHOI	Moorings and Buoy co-lead
Andrey Proshutinsky	WHOI	Moorings and ITP program lead / CTD/Rosette / XCTD
John Toole	WHOI	ITP/TOP Buoys
Mary Louise Timmermans	YALE	Moorings and Buoy co-lead
Mike DeGrandpre	UMontana	pCO ₂ , pH, Underway system, Buoy, Mooring
Motoyo Itoh	JAMSTEC	CTD/Rosette / XCTD
Shigeto Nishino	JAMSTEC	CTD/Rosette
Takashi Kikuchi	JAMSTEC	CTD/Rosette
Don Perovich	CRREL	Ice Mass-Balance Buoy
David Walsh	ConcordiaU	CTD/Rosette / Microbial Diversity
Akash Sastri (John Nelson)	DFO-IOS	Zooplankton
John Smith	DFO-BIO	CTD / Rosette, ¹²⁹ I, ²³⁶ U
Nuria Casacuberta Arola	ETH Zurich	CTD / Rosette, ¹²⁹ I, ²³⁶ U, CFC-12, SF ₆ , ³⁹ Ar, ¹⁴ C
Jennifer Hutchings	OSU	Ice Observations
Wei-Jun Cai	UDelaware	δ ¹³ C-DIC
Tetjana Ross	DFO-IOS	Argo Floats
Chris Gordon	DFO-BIO	Argo Floats
Alexander Zucconi	ECCC	Met SVP Buoys
Puneet Jaswal	ECCC	Met SVP Buoys
Ignatius Rigor	UW, IABP	IMB Buoy

Table 4.1-3. Affiliation Abbreviations.

Abbreviation	Definition
APL	Applied Physics Laboratory, University of Washington, Seattle, Washington, USA
BIO	Bedford Institute of Oceanography, DFO, Dartmouth, NS, Canada
ConcordiaU	Concordia University, Montreal, Qc, Canada

CRREL	Cold Regions Research Laboratory, New Hampshire, USA
DFO	Department of Fisheries and Oceans, Canada
ETH Zurich	ETH Zurich, Switzerland
IOS	Institute of Ocean Sciences, DFO, Sidney, BC, Canada
JAMSTEC	Japan Agency for Marine-Earth Science Technology, Japan
KIT	Kitami Institute of Technology, Kitami, Hokkaido Prefecture, Japan
NPS	Naval Postgraduate School, Monterey, California, USA
OSU	Oregon State University, Corvallis, Oregon, USA
TUMSAT	Tokyo University of Marine Science and Technology, Tokyo, Japan
UDeleware	University of Delaware, Newark, Delaware, USA
UMontana	University of Montana, Missoula, Montana, USA
USherbrooke	University of Sherbrooke, Quebec, Canada
UTokyo	University of Tokyo, Tokyo, Japan
WHOI	Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA
YaleU	Yale University, New Haven, Connecticut, USA

Table 4.1-4. Project website URLs.

Project	Website Address
Beaufort Exploration Project	https://www2.whoi.edu/site/beaufortgyre/
Beaufort Gyre Observing System dispatches	https://www2.whoi.edu/site/beaufortgyre/expeditions/2025-expedition/
Ice-Tethered Profiler buoys	https://www2.whoi.edu/site/itp/
Ice Mass Balance buoys	https://www.cryosphereinnovation.com/ http://imb-crrel-dartmouth.org/
ARGO buoys	https://argo.ucsd.edu/ https://www.aoml.noaa.gov/argo/
Phytoplankton (we performed ship of opportunity sampling)	https://www.planktoscope.org

4.2 Location of Science Stations

The scientific crew boarded the *CCGS Louis S. St-Laurent* icebreaker in Cambridge Bay, NU, on 18 September, 2025 and departed Cambridge Bay, NU on 23 October, 2025.

Locations of CTD/Rosette, XCTD, zooplankton vertical net, as well as the mooring and buoy recovery and deployments are listed in the tables below.

4.2.1 CTD/Rosette

Table 4.2.1-1. CTD/Rosette cast locations

CTD Cast #	Station Name	CAST START DATE and Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m) Knudsen 12kHz Sounder	Cast Depth (m) (Max CTD depth)	Sample Numbers Start, End		Ice Coverage (tenths) (Rough Estimate by CTD Operator)	Comment for Cruise Report
1	AG-5	9/22/2025 16:13	70.5492	122.9133	647	638	1	24	0	spar
2	AG5	9/22/2025 19:49	70.5485	122.9232	648	635	25	47	0	Geochemistry Cast.
3	CB1	9/23/2025 15:21	71.7847	131.8557	1110	1105	48	71	3	Special trip order: Nisk 3, 5, 4
4	CB31b	9/24/2025 0:05	72.3483	134.0202	2068	2058	72	95	7	Testing mooring releases, paused on upcast 50 m above bottom. Lot of large chunks of sea-ice around rosette.
5	CB23a	9/24/2025 7:18	72.8998	135.9950	2730	2733	96	119	0	Closed deep Theta min bottle at 2500m instead of at 2400m. Started using the ice-chummy during upcasts to blow seawater off the incoming wire before passing through the sheave.
6	CB22	9/25/2025 2:37	73.4470	138.0073	3101	3109	120	143	2	
7	CB21DNA	9/25/2025 10:35	74.0002	139.9975	3500	1001	144	167	0	Two casts at station to capture all the water needed. Once cast shallow, one cast full depth. Niskin 3: Vent not closed (sample147). Maybe twice Hg in sample 149 of d13C. FDOM sensor swapped out (Wetlabs ECO CDOM #8362 removed, #6677 put in).
8	CB21	9/25/2025 19:36	74.0015	140.0145	3512	3512	168	191	0	Full depth cast. Special trip order: 13,1,14. Strong feature 200 to 325m -eddy?.
9	CB19	9/26/2025 4:04	74.3032	143.3052	3694	3690	192	215	0	Niskin 5: Lanyard broke, bottle closed., Jelly tentacle on frame particularly Niskins 13 and 17. Similar feature as CB21 at 300m but weak.

10	CB21	9/26/2025 14:10	74.0013	139.9963	3513	500	na	na	0	CTD only. Repeat cast to remeasure unusual profile
11	CB50	9/27/2025 6:49	73.5010	134.2580	2900	2876	216	239	0	
12	CB51	9/27/2025 17:02	73.4972	130.8797	2500	2474	240	263	8	Large piece of ice hit wire.
13	CB40	9/28/2025 5:30	74.4978	135.4433	3255	3150	264	287	1	Downcast: at 2800m winch was not paying out evenly. We came up/down a few times and then went a bit slower. Returned to 60 m/min at 2900m. SPAR off for maintenance, but dark out so OK, leave vaules as zero.
14	CB18	9/28/2025 15:48	74.9998	139.9955	3622	3615	288	311	0	Stopped at 3000m on upcast for acoustic mooring release testing. Transmissometer acting up btw 400 and 600m. SPAR mounted over CTD container, temporarily for this cast.
15	CB6	9/29/2025 5:31	74.6917	146.6840	3774	3675	312	335	0	Changed transmissometer for this cast with SN1052 off and SN993 on but kept same cable on CTD. SPAR mounted back on 01 level above wood dock+container.
16	CB4	9/29/2025 20:11	74.9992	150.0003	3830	3818	336	359	0	First cast at CB4, full depth.
17	CB7	9/30/2025 4:10	75.9985	149.9982	3830	3819	360	383	5	Multiple Niskins (#2 to 7) accidently tripped at bottom (clipboard resting on space bar).
18	CB4 DNA	9/30/2025 20:38	74.9982	150.0263	3824	1002	384	407	0	Second cast at CB4, shallow cast.
19	CB5	10/1/2025 3:33	75.2980	153.3028	3840	3831	408	431	new grease ice	CTD cast restarted during surface soak so no in-air readings. Restart needed to fix BOT block display.
20	RS-6	10/1/2025 9:59	75.5112	155.2693	3845	3834	432	455	7	
21	RS4	10/1/2025 15:04	75.6240	156.0642	2227	2213	456	479	8	Jelly on wire in the upcast
22	RS2	10/1/2025 19:09	75.6642	156.2963	1433	1428	480	500	3	Special trip order: 11, 22, 12
23	RS1	10/2/2025 0:02	75.7432	157.1043	968	949	502	521	8	
24	RS0	10/2/2025 2:42	75.8498	157.9977	570	557	522	540	7	Bubbler used most of cast, strong winds, 10deg wire angle on upcast.
25	CB8	10/2/2025 19:06	77.0000	150.0043	3825	3822	541	564	9	Lots of ice and CTD sat on deck for a while in cold before deployment. Big ice chunks hit the wire repeatedly (1125, 1321, 1382, 1595, and 3821m). Bubbler on extensively when at surface.
26	CB10	10/3/2025 7:38	78.2983	153.2165	2408	2280	565	588	10	Altimeter did not kick in at depth given by sounder, likely due to steep slope. Stopped CTD based on sounder depth.

27	CB12	10/4/2025 3:16	77.6988	146.7362	3812	3803	589	612	10	Air temperature -14C, wind speed 8knt. CTD on deck !5min waiting for ice to clear. Special trip order: 1, 20, 2 . Jelly on wire.
28	CB-9Dp	10/4/2025 11:29	78.0002	150.0068	3822	3729	613	636	10	First cast at CB9, full depth.
29	CB9Sh	10/4/2025 21:40	78.0005	149.9920	3825	501	637	660	10	Second cast at CB9, shallow cast. Polar bear in area (all during mooring deployment).
30	CB11	10/5/2025 8:04	78.9993	150.0587	3825	3726	661	684	10	Special trip order: 2, 9, 3.
31	ICE1	10/6/2025 2:12	78.9585	146.2318	3811	1001	685	708	10	Changed cast from full depth to 1000m due to station keeping difficulty and timing for next station.
32	CB16-Sh	10/7/2025 4:30	78.0028	139.9868	3754	301	709	732	10	First cast at CB16, shallow cast.
33	CB16-Dp	10/7/2025 7:00	77.9965	139.9853	3754	3657	733	756	10	Second cast at CB16, full depth. Niskin19 (sample 751) endcap leaking. Note the bubbler were not on for this cast so may make interesting comparison with Ros-32 where bubblers had been on.
34	CB13	10/7/2025 19:11	77.2992	143.2927	3783	3773	757	780	10	Special trip order: 1, 21 ,2.
35	CB15	10/8/2025 3:03	76.9945	139.9857	3729	3716	781	804	10	
36	ICE2	10/9/2025 1:12	77.0238	136.8313	3660	1002	805	828	10	SPAR sensors cleaned.
37	PP7	10/9/2025 8:06	76.5362	135.4320	3575	3477	829	852	10	
38	ICE3	10/10/2025 3:09	76.0753	132.9742		1001	853	876	10	CTD sat on deck for 5min then brough back inside the rosette shack as sea-ice was continuing to make station set-up difficult. Soaked at 30m for 5min at start of station to hopefully remove any ice buildup. Primary salinity bad until part way through upcast, likely due to ice buildup. Used secondary salinity.
39	PP6	10/10/2025 7:37	76.2582	132.4957	3051	3027	877	900	10	
40	PP5	10/10/2025 15:21	76.0013	130.8883	2912	2400	901	924	10	
41	CB17	10/11/2025 10:37	75.9943	139.9533	3691	3592	925	948	10	WHOI data logger not turned on. Swapping of temperature and conductivity sensors for tests. See CTD report. (Swapped T1C1 to T2C2 position Swapped #1493's T1C1 into #756's T1C1 position)
42	CBCG	10/12/2025 0:01	75.3985	143.5212	3755	3743	949	972	6	

43	CB3	10/12/2025 19:10	74.0023	150.0063	3824	3815	973	996	9 (new ice)	Moving ice - ice hit wire at 10m. Kept CTD at 10m for a while waiting for ice to clear. Ice on wire at 267m on downcast, stopped descent for a while. Styrafoam cup cast.
44	CB2	10/13/2025 4:17	72.9968	149.9902	3750	3738	997	1020	8	Special trip order: 18,21,19,20,22. Styrafoam cup cast #2. Swapping of temperature and conductivity sensors for tests. See CTD report. (Replaced T1C1 (had been #1493's T1C1) with #756's T2C2 Left #756's original T1C1 in T2C2 position).
45	CB2a	10/13/2025 10:44	72.5103	150.0760	3733	3626	1021	1044	8	
46	BL8	10/13/2025 19:00	71.9528	150.2997	2988	2956	1045	1068	0	
47	BL7	10/13/2025 23:57	71.8198	150.7633	2579	2568	na	na	0	CTD only. Ice concentration not recorded but assumed to be 0/10 based on neighboring casts.
48	BL6	10/14/2025 2:59	71.6815	151.1435	2084	2080	1069	1092	0	Special trip order: 7,21,8
49	BL5	10/14/2025 6:32	71.5958	151.3593	1583	1571	na	na	0	CTD only. Ice concentration not recorded but assumed to be 0/10 based on neighboring casts.
50	BL4	10/14/2025 8:49	71.5237	151.5788	1152	1142	1093	1116	0	Niskin 16 (#1108): missed intended depth of 130 and closed at 125m 32.25psu instead. Niskin 23 (#115) did not fire so samples taken from second surface bottle however ran out of water for DOM sample.
51	BL3	10/14/2025 12:14	71.4653	151.8223	505	488	1117	1134	2	Special trip order: 15, 17, 16, 18. Jelly on rosette frame (Niskins 4 to 8).
52	BL2	10/14/2025 15:46	71.3922	151.9290	169	167	1135	1147	0	Large salinity gradient near bottom.
53	BL1	10/14/2025 17:12	71.3648	152.0538	82	68	1148	1155	0	Jelly on rosette frame (Niskin 18).
54	SLOPE	10/15/2025 3:31	71.0533	146.6028	1681	1000	1156	1179	0	Niskins 1 to 3 tripped to keep sample number order but no samples collected (on purpose).
55	CB28aa	10/15/2025 20:00	70.0035	140.0127	58	51	1180	1186	0	
56	MK1	10/15/2025 22:07	70.2277	140.0027	231	226	1187	1200	0	
57	MK2	10/16/2025 0:59	70.4007	139.9985	503	491	1201	1219	0	Special trip order:2, 4, 3, 5, 6...16, 18, 17, 19.
58	MK3	10/16/2025 4:01	70.5722	140.0097	777	761	1220	1241	0	
59	MK3'	10/16/2025 6:24	70.6490	140.0073	1000	1257	na	na	0	CTD only. Ice concentration not recorded but assumed to be 0/10 based on neighboring casts.

60	MK4	10/16/2025 8:37	70.8088	140.0010	1450	1452	1242	1265	0	Rosette sat for 1 hour before sampling while oxygen bottle top dispenser being fixed. Niskin 12 (1253): Leaky end cap. Special trip order: 20,22,21,23.
61	CB28b	10/16/2025 12:28	71.0027	140.0058	2071	2073	1266	1289	0	Special trip order: 18, 21, 19, 20, 22
62	MK6	10/16/2025 18:49	71.5697	140.0022	2474	2463	1290	1313	0	
63	CB29	10/17/2025 0:04	71.9958	139.9927	2685	2668	1314	1337	1	
64	StnA	10/17/2025 14:43	72.5970	144.6738	3420	3323	1338	1361	7	Special trip order: 1,7,2. Interesting feature at 2700m, lower oxygen, higher temp, lower transmissometer on downcast but not seen on upcast.
65	CB27	10/18/2025 4:32	73.0022	140.0282	3223	3219	1362	1385	8	Big chunk of ice hit wire at 3200m. Egg study on this cast.

4.2.2 XCTD

Table 4.2.2-1. XCTD cast deployment locations. All probes were type XCTD-1N. File name starting with C3 also indicate probe type was XCTD-1N.

Event Log ID	Filename	CAST START DATE and Time (UTC)	Latitude (°N)	Longitude (°W)	Probe Serial Number	Cast Depth (m)	Comment, Ice concentration, Ship speed.
XCTD-1	C3_00041.edf	9/23/2025 19:33	72.1376	133.1480	23014035	1000.0	launched successfully, 3/10 ice, 9knots
XCTD-2	C3_00042.edf	9/24/2025 4:49	72.6294	135.0117	23014034	1000.0	launched successfully, knots
XCTD-3	C3_00043.edf	9/24/2025 20:26	73.2550	134.6413	23014030	1000.0	launched successfully, flat/calm, 9knots
XCTD-4	C3_00044.edf	9/25/2025 8:28	73.7562	139.1129	23014033	1000.0	launched successfully, 9knots
XCTD-5	C3_00047.edf	9/26/2025 1:00	74.1577	141.5277	23118244	1000.0	launched successfully, knots
XCTD-6	C3_00048.edf	9/27/2025 0:05	73.8204	138.1020	23118247		failed. Deployed when software said "waiting for data" instead of "waiting for launch"., 9knots
XCTD-7	C3_00049.edf	9/27/2025 0:54	73.8020	137.6802	23118250	1000.0	launched successfully, 9knots
XCTD-8	C3_00050.edf	9/27/2025 3:11	73.6528	136.3699	23118253	1000.0	launched successfully, 10knots
XCTD-9	C3_00054.edf	9/27/2025 12:15	73.4923	132.6236	23118251	1000.0	launched successfully, 6knots
XCTD-10	C3_00055.edf	9/27/2025 22:34	73.8317	132.3019	23118252	1000.0	launched successfully, locations added by hand to the edf, 9knots
XCTD-11	C3_00056.edf	9/28/2025 2:22	74.1336	134.2088	23118249	1000.0	launched successfully, 10knots

XCTD-12	C3_00057.edf	9/28/2025 11:49	74.7440	137.6540	23118243	1000.0	launched successfully, location recorded toward the end of the cast., 10knots
XCTD-13	C3_00058.edf	9/28/2025 21:54	74.9537	141.9965	23118248	1000.0	launched successfully, locations added by hand to the edf, 5knots
XCTD-14	C3_00059.edf	9/29/2025 1:49	74.8377	144.4087	23118246	1000.0	launched successfully, 10knots
XCTD-15	C3_00060.edf	9/29/2025 10:42	74.8525	148.3226	23118245	1000.0	launched successfully, 10knots
XCTD-16	C3_00064.edf	9/30/2025 1:19	75.4760	150.0553	23118242	1000.0	launched successfully, 10knots
XCTD-17	C3_00065.edf	10/1/2025 0:24	75.1440	151.6012	24113623	1000.0	launched successfully, 10/10 pancake ice, 10knots
XCTD-18	C3_00066.edf	10/1/2025 17:57	75.5893	155.9649	24113620	852.7	launched successfully, 5.6knots
XCTD-19	C3_00067.edf	10/2/2025 8:14	76.1329	156.0641	24113618	612.5	launched successfully, 7.5knots
XCTD-20	C3_00068.edf	10/2/2025 11:35	76.4125	154.1502	24113615	732.8	launched successfully, 9knots
XCTD-21	C3_00069.edf	10/2/2025 14:53	76.6860	152.1731	24113617	1000.0	launched successfully, 4knots
XCTD-22a	C3_00070.edf	10/3/2025 0:28	77.3881	151.0442	24113614	136.1	failed (only 136m), 9/10 young ice, 9knots
XCTD-22b	C3_00071.edf	10/3/2025 0:35	77.3961	151.0561	24113621	1000.0	launched successfully, 9/10 young ice, 9knots
XCTD-23a	C3_00072.edf	10/3/2025 3:09	77.7985	152.2754	24113624	223.5	failed (only 223m), 10/10 SY ice, 4.9knots
XCTD-23b	C3_00073.edf	10/3/2025 3:12	77.8017	152.2831	24113625	118.0	failed (only 118m), 10/10 SY ice, 2knots
XCTD-23c	C3_00074.edf	10/3/2025 3:15	77.8042	152.2898	24113622	187.0	failed (only 186m), 10/10 SY ice, 0knots
XCTD-23d	C3_00075.edf	10/3/2025 3:21	77.8084	152.3011	24113619	1000.0	launched successfully, 10/10 Young+SY ice, 0knots
XCTD-24	C3_00076.edf	10/3/2025 4:12	77.9259	152.4866	24113616	1000.0	launched successfully, 10/10 Young+SY ice, 0knots
XCTD-25	C3_00077.edf	10/3/2025 11:57	78.1493	151.5876	24103500	362.9	launched successfully, 10/10 Young+SY ice, 1knots
XCTD-26	C3_00078.edf	10/4/2025 8:38	77.8515	148.1728	24103496	1000.0	launched successfully, lead to open water, 5knots
XCTD-27a	C3_00079.edf	10/5/2025 1:15	78.4853	149.8934	24103493	152.4	failed (only 152m), 5knots
XCTD-27b	C3_00080.edf	10/5/2025 1:19	78.4888	149.8876	24103499	1000.0	launched successfully, 10/10, 0knots
XCTD-28	C3_00081.edf	10/6/2025 8:39	78.6187	144.3192	24103495	1000.0	launched successfully, 10/10, 0knots
XCTD-29	C3_00085.edf	10/6/2025 23:54	77.8288	137.5366	24113601	1000.0	launched successfully, 10/10, 0knt. Turning back west., 0knots
XCTD-30	C3_00088.edf	10/8/2025 0:14	77.1413	141.6663	24103492	1000.0	launched successfully, 10/10, 0knots
XCTD-31	C3_00089.edf	10/9/2025 13:19	76.4197	134.1346	24103600	695.5	launched successfully, 10/10, 0knots
XCTD-32	C3_00092.edf	10/10/2025 22:58	76.0101	133.0927	24103497	1000.0	launched successfully, 10/10, 0knots
XCTD-33	C3_00093.edf	10/11/2025 2:54	75.9924	135.4292	24103494	1000.0	launched successfully, 10/10, 0.5knots
XCTD-34	C3_00094.edf	10/11/2025 6:23	76.0008	137.6824	24103491	651.3	launched successfully, 10/10, 2knots
XCTD-35	C3_00095.edf	10/11/2025 17:04	75.7023	141.6735	24103469	419.9	launched successfully, 10/10, 3knots
XCTD-36	C3_00096.edf	10/12/2025 6:22	75.1053	145.4483	24103472	1000.0	launched successfully, 8/10, 2.1knots

XCTD-37	C3_00097.edf	10/12/2025 9:30	74.8696	147.0660	24103468	1000.0	launched successfully, 6/10, 5knots
XCTD-38a	C3_00098.edf				24103475		failed and empty file, 5knots
XCTD-38b	C3_00099.edf	10/12/2025 13:18	74.5634	149.0207	24103478	398.2	launched successfully, 10/10, 5knots
XCTD-39	C3_00100.edf	10/13/2025 0:35	73.5023	150.0810	24103467	1000.0	launched successfully, 10/10, 0knots
XCTD-41	C3_00101.edf	10/17/2025 6:18	72.1958	141.5291	24103471	1000.0	launched successfully, 10/10, 8knots
XCTD-42	C3_00102.edf	10/17/2025 10:36	72.4228	143.0768	24103474	1000.0	launched successfully, 10/10, 7knots
XCTD-43a	C3_00103.edf	10/17/2025 21:47	72.7458	143.1084	24103477	461.4	measurement terminated at 420 m, 8knots
XCTD-43b	C3_00104.edf	10/17/2025 22:02	72.7518	143.0342	24103476	1000.0	launched successfully, 10/10, 5knots
XCTD-44	C3_00105.edf	10/18/2025 1:08	72.8758	141.4050	24103470	1000.0	launched successfully, 10/10, 0knots
XCTD-45a	C3_00106.edf	10/18/2025 11:30	72.5635	138.5790	24103473	384.4	failed (384m), 5knots
XCTD-45b	C3_00107.edf	10/18/2025 11:34	72.5587	138.5656	24103486	322.2	failed (322m), 5knots
XCTD-45c	C3_00108.edf	10/18/2025 11:40	72.5534	138.5548	24103487	1.4	failed (1m), noisy data, 0knots
XCTD-45d	C3_00109.edf	10/18/2025 11:45	72.5532	138.5564	24103484	1000.0	launched successfully, 10/10, 0knots
XCTD-46a	C3_00110.edf	10/18/2025 15:24	72.1389	137.2408	24103483	326.4	failed (326m), 0knots
XCTD-46b	C3_00111.edf	10/18/2025 15:32	72.1386	137.2425	24103480	627.9	launched successfully, 10/10, 0knots
XCTD-47a	no file				24103481		failed, 5knots
XCTD-47b	C3_00115.edf	10/18/2025 19:45	71.6734	135.8806	24103479	1000.0	launched successfully, 10/10, 5knots
XCTD-48	C3_00116.edf	10/18/2025 23:06	71.2844	134.6216	24103490	977.2	launched successfully, 10/10, 5knots

Table 4.2.2-2 Placeholder - XCTD cast deployment locations for CCGS Sir Wilfrid Laurier in support of the JOIS/BGOS program (Cruise ID #####-### DFO-IOS).

No XCTDs launched from Sir Wilfrid Laurier this year (did not sail to Arctic)

4.2.3 Zooplankton – Vertical Bongo Net Hauls

Summary of samples taken at each station. At each station 2 samples were collected using the same net mesh size 150µm. One net's samples were preserved in 95% ethanol, the other in buffered formalin.

Table 4.2.3-1. Zooplankton vertical bongo net hauls.

Date Time (UTC) GPS	Station	Net Event	CTD Event	Positional Information		Wire Out (m)	Wire Angle	Sounder Depth BE (m)	Sampling Processing	Comments
				Latitude	Longitude					
22-09-2025 19:07:47	AG-5	3	1	70 32.894 N	122 54.943 W	100	0	645	Ethanol	same event
22-09-2025 19:07:47	AG-5	3	1	70 32.894 N	122 54.943 W	100	0	645	Formalin	same event
23-09-2025 16:18:32	CB-1	6	3	71 47.021 N	131 52.035 W	100	0	1115	Ethanol	same event
23-09-2025 16:18:32	CB-1	6	3	71 47.021 N	131 52.035 W	100	0	1115	Formalin	same event
24-09-2025 01:12:48	CB31b	9	4	72 20.89 N	134 2.234 W	100	0	2070	Ethanol	same event, sounder turned off for mooring release test
24-09-2025 01:12:48	CB31b	9	4	72 20.89 N	134 2.234 W	100	0	2070	Formalin	same event
24-09-2025 08:04:48	CB-23a	12	5	72 53.959 N	135 59.482 W	100	0	2730	Ethanol	same event
24-09-2025 08:04:48	CB-23a	12	5	72 53.959 N	135 59.482 W	100	0	2730	Formalin	same event
25-09-2025 03:03:12	CB-22	13	6	73 26.768 N	138 0.182 W	100	0	3099	Ethanol	same event
25-09-2025 03:03:12	CB-22	13	6	73 26.768 N	138 0.182 W	100	0	3099	Formalin	same event
25-09-2025 20:00:37	CB-21	16	8	74 0.105 N	140 0.958 W	100	0	3513	Ethanol	same event; oil/soap sheen on surface but net did not pass thru
25-09-2025 20:00:37	CB-21	16	8	74 0.105 N	140 0.958 W	100	0	3513	Formalin	same event:oil/soap sheen on surface but net did not pass thru
26-09-2025 04:27:08	CB19	19	9	74 18.294 N	143 18.389 W	100	0	3695	Ethanol	
26-09-2025 04:27:08	CB19	19	9	74 18.294 N	143 18.389 W	100	0	3695	Formalin	
27-09-2025 07:33:09	CB-50	24	11	73 30.04 N	134 15.148 W	100		2900	Ethanol	
27-09-2025 07:33:09	CB-50	24	11	73 30.04 N	134 15.148 W	100		2900	Formalin	

27-09-2025 16:46:40	CB-51	27	12	73 29.836 N	130 52.853 W	100		2500	Formalin	lat/long/time from daily science log, NMEA not working
27-09-2025 16:46:40	CB-51	27	12	73 29.836 N	130 52.853 W	100		2500	Ethanol	lat/long/time from daily science log, NMEA not working
28-09-2025 05:52:40	CB-40	28	13	74 29.807 N	135 26.844 W	100	5		Formalin	
28-09-2025 05:52:40	CB-40	28	13	74 29.807 N	135 26.844 W	100	5		Ethanol	
28-09-2025 16:30:55	CB-18	33	14	74 59.908 N	140 0.063 W	100			Ethanol	
28-09-2025 16:30:55	CB-18	33	14	74 59.908 N	140 0.063 W	100			Formalin	
29-09-2025 06:34:10	CB-6	37	15	74 41.285 N	146 41.732 W	100			Formalin	
29-09-2025 06:34:10	CB-6	37	15	74 41.285 N	146 41.732 W	100			Ethanol	
29-09-2025 20:38:41	CB-4	38	16	74 59.986 N	150 0.265 W	100			Ethanol	bongos stopped @ 20m and 80m on the way down to mark wire
29-09-2025 20:38:41	CB-4	38	16	74 59.986 N	150 0.265 W	100			Formalin	bongos stopped @ 20m and 80m on the way down to mark wire
30-09-2025 04:52:41	CB-7	43	17	75 59.815 N	149 59.693 W	100			Ethanol	Bubbler off line and brought slush up, abandoned first BONGO 42. This time used bubbler to clear new ice before brining it up.
30-09-2025 04:52:41	CB-7	43	17	75 59.815 N	149 59.693 W	100			Formalin	
01-10-2025 03:49:57	CB-5	46	19	75 17.885 N	153 17.973 W	100			Ethanol	
10/1/2025 3:49	CB-5	46	19	75 17.885 N	153 17.973 W	100			Formalin	
05-10-2025 07:47:04	CB-11	52	30	79 0.067 N	150 3.766 W	100		3824	Formalin	Bubbler turned on at bottom
05-10-2025 07:47:04	CB-11	52	30	79 0.067 N	150 3.766 W	100		3824	Ethanol	
11-10-2025 10:55:54	CB-17	55	41	75 59.53 N	139 56.726 W	110			Ethanol	eggs attached to the wire during the event
11-10-2025 10:55:54	CB-17	55	41	75 59.53 N	139 56.726 W	110			Formalin	eggs attached to the wire during the event
12-10-2025 00:17:55	CBCG	56	42	75 24.041 N	143 31.288 W	100		3755	Ethanol	
12-10-2025 00:17:55	CBCG	56	42	75 24.041 N	143 31.288 W	100		3755	Formalin	
12-10-2025 20:02:19	CB-3	60	43	74 0.343 N	150 0.471 W	100		3824	Ethanol	
12-10-2025 20:02:19	CB-3	60	43	74 0.343 N	150 0.471 W	100		3824	formalin	

13-10-2025 04:41:55	CB-2	63	44	72 59.858 N	149 59.959 W	100		3755	Ethanol	
13-10-2025 04:41:55	CB-2	63	44	72 59.858 N	149 59.959 W	100		3755	Formalin	
13-10-2025 10:38:54	CB-2a	66	45	72 30.666 N	150 4.358 W	110	20		Formalin	
13-10-2025 10:38:54	CB-2a	66	45	72 30.666 N	150 4.358 W	110	20		Ethanol	
13-10-2025 19:23:24	BL-8	67	46	71 57.18 N	150 17.856 W	100		2986	Ethanol	
13-10-2025 19:23:24	BL-8	67	46	71 57.18 N	150 17.856 W	100		2986	Formalin	
14-10-2025 03:19:24	BL-6	70	48	71 40.91 N	151 8.198 W	100			Ethanol	
14-10-2025 03:19:24	BL-6	70	48	71 40.91 N	151 8.198 W	100			Formalin	
14-10-2025 09:22:24	BL-4	75	50	71 31.382 N	151 34.712 W	110	15	1146	Formalin	
14-10-2025 09:22:24	BL-4	75	50	71 31.382 N	151 34.712 W	110	15	1146	Ethanol	
14-10-2025 15:35:39	BL-2	79	52	71 23.569 N	151 56.043 W	100			Formalin	
14-10-2025 15:35:39	BL-2	79	52	71 23.569 N	151 56.043 W	100			Ethanol	
15-10-2025 19:28:09	CB-28aa	80	55	70 0.202 N	140 0.705 W	53			Ethanol	
15-10-2025 19:28:09	CB-28aa	80	55	70 0.202 N	140 0.705 W	53			Formalin	
15-10-2025 21:52:54	MK-1	83	56	70 13.649 N	140 0.232 W	100	10		Ethanol	
15-10-2025 21:52:54	MK-1	83	56	70 13.649 N	140 0.232 W	100	10		Formalin	
16-10-2025 00:23:09	MK-2	84	57	70 23.942 N	139 59.845 W	100	5		Ethanol	
16-10-2025 00:23:09	MK-2	84	57	70 23.942 N	139 59.845 W	100	5		Formalin	
16-10-2025 04:14:54	MK-3	88	58	70 34.304 N	140 0.655 W	100	5		Ethanol	
16-10-2025 04:14:54	MK-3	88	58	70 34.304 N	140 0.655 W	100	5		Formalin	

4.2.4 Phytoplankton – Vertical SCOR Net Hauls

Summary of samples taken at each station. At each station 1 to 3 samples were collected using the same net mesh size, 20 μ m, but were processed in different ways. All samples preserved with Lugols.

Table 4.2.4-1. Phytoplankton vertical SCOR net hauls.

Date Time (UTC) GPS	Station	Net Event	CTD Event	Positional Information		Wire Out	Wire Angle	Sounder Depth BE (m)	Sampling Processing	Comments
				Latitude	Longitude					
22-09-2025 18:46:17	AG-5	1	1	70 32.915 N	122 54.645 W	20	0	643	Lugol	lat/long/time from daily science log, NMEA not working
22-09-2025 18:53:02	AG-5	2	1	70 32.891 N	122 54.808 W	20	0	643	Lugol	
23-09-2025 15:46:17	CB-1	4	3	71 47.021 N	131 51.625 W	20	0	1112	Lugol	
23-09-2025 15:58:47	CB-1	5	3	71 47.025 N	131 51.758 W	20	0	1110	Lugol	
24-09-2025 00:31:17	CB-31b	7	4	72 20.859 N	134 1.602 W	20	0	2067	Lugol	
24-09-2025 00:39:47	CB-31b	8	4	72 20.869 N	134 1.727 W	20	0	2069	Lugol	
24-09-2025 07:42:48	CB-23a	10	5	72 53.965 N	135 59.585 W	20	0	2730	Lugol	
24-09-2025 07:50:18	CB23a	11	5	72 53.957 N	135 59.568 W	20	0	2730	Lugol	
25-09-2025 03:19:37	CB-22	14	6	73 26.729 N	138 0.009 W	20	0	3099	Lugol	
25-09-2025 03:28:07	CB-22	15	6	73 26.698 N	137 59.962 W	20	0	3099	Lugol	
25-09-2025 20:12:37	CB-21	17	8	74 0.117 N	140 1.108 W	20	0	3516	Lugol	oil/soap sheen on surface but net did not pass thru
25-09-2025 20:19:22	CB-21	18	8	74 0.116 N	140 1.151 W	20	0	3516	Lugol	oil/soap sheen on surface but net did not pass thru
26-09-2025 04:40:53	CB-19	20	9	74 18.303 N	143 18.462 W	20	0	3695	Lugol	
26-09-2025 04:48:38	CB-19	21	9	74 18.313 N	143 18.472 W	20	0	3695	Lugol	
27-09-2025 07:10:39	CB-50	22	11	73 30.057 N	134 15.348 W	20		2900	Lugol	

27-09-2025 07:18:39	CB-50	23	11	73 30.046 N	134 15.322 W	20		2900	Lugol	
27-09-2025 16:26:40	CB-51	25	12	73 29.846 N	130 53.053 W	20		2510	Lugol	lat/long/time from daily science log, NMEA not working
27-09-2025 16:33:50	CB-51	26	12	73 29.818 N	130 52.929 W	20		2019	Lugol	lat/long/time from daily science log, NMEA not working
28-09-2025 06:06:10	CB-40	29	13	74 29.782 N	135 26.993 W	20	5	3260	Lugol	
28-09-2025 06:16:40	CB-40	30	13	74 29.751 N	135 27.034 W	20	5		Lugol	
28-09-2025 16:07:55	CB-18	31	14	74 59.901 N	140 0.196 W	20	5	3621	Lugol	
28-09-2025 16:15:10	CB-18	32	14	74 59.919 N	140 0.174 W	20	5	3622	Lugol	
29-09-2025 06:13:55	CB-6	34	15	74 41.287 N	146 41.715 W	20			Lugol	
29-09-2025 06:20:25	CB-6	36	15	74 41.291 N	146 41.696 W	20			Lugol	
29-09-2025 20:51:26	CB-4	39	16	74 59.995 N	150 0.343 W	20			Lugol	
29-09-2025 20:59:11	CB-4	40	16	74 59.982 N	150 0.375 W	80			Lugol	
29-09-2025 21:07:41	CB-4	41	16	74 59.982 N	150 0.367 W	20		3825	Lugol	
30-09-2025 05:10:01	CB-7	44	17	75 59.81 N	149 59.6 W	20			Lugol	
9/30/2025 5:18	CB-7	45	17	75 59.799 N	149 59.557 W	20		3827	Lugol	
01-10-2025 04:06:12	CB-5	47	19	75 17.887 N	153 18.094 W	20		3844	Lugol	
01-10-2025 04:13:57	CB-5	48	19	75 17.913 N	153 18.119 W	20		3844	Lugol	
05-10-2025 07:14:19	CB-11	49	30	79 0.279 N	150 4.142 W	20		3827	Lugol	sample froze on the deck
05-10-2025 07:25:04	CB-11	50	30	79 0.213 N	150 4.013 W	20		3824	Lugol	sample froze on the deck, Did this one twice, first time bubblers were not on, reset nets and tried again once bubblers were on
05-10-2025 07:31:19	CB-11	51	30	79 0.168 N	150 3.94 W	80		3824	Lugol	80m depth cast
11-10-2025 10:36:09	CB-17	53	41	75 59.669 N	139 57.221 W	20			Lugol	
11-10-2025 10:41:39	CB-17	54	41	75 59.63 N	139 57.085 W	20			Lugol	
12-10-2025 00:32:40	CBCG	57	42	75 23.997 N	143 31.209 W	80		3755	Lugol	
12-10-2025 00:38:55	CBCG	58	42	75 23.966 N	143 31.166 W	20		3755	Lugol	
12-10-2025 00:45:25	CBCG	59	42	75 23.934 N	143 31.097 W	20		3755	Lugol	Bubbler before SCOR 3
12-10-2025 20:03:40	CB-3	61	43	74 0.343 N	150 0.471 W	20		3824	Lugol	

12-10-2025 20:06:40	CB-3	62	43	74 0.348 N	150 0.43 W	20		3824	Lugol	
13-10-2025 10:20:39	CB-2a	64	45	72 30.803 N	150 3.641 W	20			Lugol	
13-10-2025 10:27:39	CB-2a	65	45	72 30.755 N	150 3.981 W	30	25		Lugol	
13-10-2025 19:36:54	BL-8	68	46	71 57.182 N	150 17.862 W	20		2968	Lugol	
13-10-2025 19:42:39	BL-8	69	46	71 57.185 N	150 17.823 W	20		2980	Lugol	
14-10-2025 03:32:09	BL-6	71	48	71 40.87 N	151 8.051 W	20		2087	Lugol	
14-10-2025 03:38:39	BL-6	72	48	71 40.899 N	151 7.947 W	20			Lugol	
14-10-2025 09:04:09	BL-4	73	50	71 31.425 N	151 34.779 W	25	5	1146	Lugol	
14-10-2025 09:10:09	BL-4	74	50	71 31.413 N	151 34.76 W	20		1146	Lugol	
14-10-2025 15:09:09	BL-2	76	52	71 23.554 N	151 57.063 W	20			Lugol	
14-10-2025 15:14:39	BL-2	77	52	71 23.542 N	151 56.82 W	20			Lugol	
14-10-2025 15:21:54	BL-2	78	52	71 23.591 N	151 56.544 W	80			Lugol	
15-10-2025 19:44:39	CB-28aa	81	55	70 0.198 N	140 0.683 W	53		58	Lugol	
15-10-2025 19:46:54	CB-28aa	82	55	70 0.202 N	140 0.702 W	20		58	Lugol	
16-10-2025 00:37:54	MK-2	85	57	70 24.042 N	139 59.813 W	80			Lugol	
16-10-2025 00:44:39	MK-2	86	57	70 24.066 N	139 59.848 W	20			Lugol	
16-10-2025 00:50:09	MK-2	87	57	70 24.062 N	139 59.881 W	20			Lugol	

4.2.5 Mooring and Buoy Operations

The mooring anchor was ranged on in the pre-recovery survey. Only the acoustic pinger near the top of mooring B was ranged on because of ice in the area, but recovery and deployments of moorings A and D were in open water.

Table 4.2.5-1. BGOS mooring recoveries and deployments from CCGS Louis S. St-Laurent 2025.

Mooring	Surveyed location (anchor*)	2025 Recovery	2025 Deployment	2025 Location (drop posn.)	Deploy bottom depth (m)
A	74 59.9961 N 150 00.0479 W <i>*37 m from 2024 drop location</i>	29 Sept. 16:01 UTC	30 Sept. 20:07 UTC	75 00.093 N 150 00.167 W	3825
B	78 00.0989 N 149 59.7949 W <i>*40 m from drop</i>	3 Oct. 17:45 UTC	4 Oct. 20:57 UTC	77 59.455 N 149 58.044 W	3825
D	73 59.9881 N 140 02.902 W <i>*20 m from drop</i>	25 Sept. 15:29 UTC	26 Sept. 20:10 UTC	74 00.018 N 140 03.088 W	3526

Table 4.2.5-2. BGOS ice and open-water deployments/recoveries from CCGS Louis S. St-Laurent 2025.

IBO: Ice-Based Observatory; OW = Open Water deployment , ITP: Ice-tethered Profiler; TOP: Tethered Ocean Profiler; SIMB: Seasonal Ice Mass Balance Buoy, AOFB: Arctic Ocean Flux Buoy, SAMI: pCO₂ system, MetBuoy: MetOcean's buoys from ECCC measuring atmospheric pressure and temperature, OMB: OpenMetBuoy from University of Tokyo measuring waves in ice. All times local: local + 6 hrs = UTC]

Event	Buoy system	Date (2025) and local time (local +6hrs = UTC)	Location	Ice thickness (m)
IBO 1	TOP19	Oct. 5 18:46	78.9596 N 146.2380 W	0.35
IBO 2	TOP21, SIMB3 2025G, IMB	Oct. 8 16:51	77.0119 N 136.7382 W	0.30
IBO 3	TOP18, SIMB3 2025H	Oct. 9 18:54	76.0981 N 132.9380 W	0.45
OW 1	TOP17	Oct. 11 15:27	75.3915 N 143.4001 W	N/A (open water)
Recovery 1	TOP-V12 [surface pkg/profiler w. Nortek]	Sept. 24 09:22	73.0922 N 133.3051 W	N/A (open water)
Recovery 2	ITP142 Surf and Profiler	Sept. 24 12:43	73.2453 N 134.4367 W	N/A (open water)
Recovery 3	TOP15	Sept. 28 15:30	74.9614 N 141.8538 W	N/A (open water)
Recovery 4	TOP-V13	Oct. 3 17:43	77.7239 N 149.1991 W	N/A (open water)
Recovery 5	TOP14	Oct. 12 11:04	74.2065 N 150.5606 W	N/A (open water)
Recovery 6	TOP11	Oct. 12 19:30	73.4111 N 150.1502 W	N/A (open water)
Recovery 7	ITP138	Oct. 13 10:52	72.1149 N 150.3099 W	N/A (open water)

Environment and Climate Change Canada (ECCC) sent 5 MetOcean buoys for deployment during the program. These buoys aid the ECCC's weather measurements and forecasting.

Table 4.2.5-3. Meteorological Buoys – Deployment information for all ECCC MetOcean buoys.

#	Model	SO#	Serial Number	IMEI Number	Date	Time (UTC)	Lat (N)	Long (W)	Photo	Site Description
1	SVP-I-XXGS-LP	18205	J20E04	300534065164720	6-Oct-25	2:36	78.96	146.20	Yes	Deployed @ Ice Station-1
2	SVP-I-XXGS-LP	18205	J20E0Q	300534065168690	3-Oct-25	9:40	78.29	153.29	Yes	Deployed @ JOIS Station CB-10
3	SVP-I-XXGS-LP	18205	J20EB2	300534065165700	4-Oct-25	6:25	77.68	146.71	Yes	Deployed @ JOIS Station CB-12
4	SVP-I-XXGS-LP	18205	J20EB5	300534065166690	4-Oct-25	22:39	78.00	149.95	Yes	Deployed @ JOIS Station CB-9
5	SVP-I-XXGS-LP	18205	J20DGS	300534065162700	5-Oct-25	13:27	78.97	149.98	Yes	Deployed @ JOIS Station CB-11

4.3 CTD/Rosette Sensor Configuration

ROS 1 to 65 (all casts)

V0 = chlorophyll fluorometer

V1= transmissometer

V2 = dissolved oxygen

V3 = altimeter

V4 = CDOM fluorometer

V5 = free

V6 = Cosine PAR

V7 = Rinko III (UserPolynomial)

CTD

CTD#	Make	Model	Serial#	Used with Rosette?	Casts Used
Primary	SeaBird	911+	756	Yes	All casts
Secondary	SeaBird	911+	1493		Not used; backup

Calibration and Accuracy Information CTD #756 PRIMARY							
Sensor		Accuracy	Pre-Cruise		Post Cruise		Comment
Name	S/N		Date	Location	Date	Location	
Pressure Sensor, Digiquartz with TC	756	Nominal 1.2 m	26-Feb-2010	SeaBird Lab			
Temperature, SBE3plus	4397	Nominal ± 0.001 °C	08-Nov-2024	SeaBird Lab			See use in table below
Conductivity, SBE4C	2992	Nominal 0.003 mS/cm	21-Dec-2024	SeaBird Lab			See use in table below
Pump, SBE5T	05-3610	(SN given in logbook)	New:2003				Pre-cruise: new

							bulkhead connector
Secondary Temp., SBE3plus	4402	Nominal ± 0.001 °C	08-Nov-2024	SeaBird Lab			See use in table below
Secondary Cond., SBE4C	2984	Nominal 0.003 mS/cm	19-Nov-2024	SeaBird Lab			See use in table below
Secondary Pump, SBE5T	05-3615	(SN given in logbook)	New:2003				Pre-cruise: new bulkhead connector
Set from SBE9#1493:							
Temperature, SBE3plus	6726	Nominal ± 0.001 °C	08-Nov-2024	SeaBird Lab			See use in table below
Conductivity, SBE4C	6137	Nominal 0.003 mS/cm	19-Nov-2024	SeaBird Lab			See use in table below

Sensor configuration for testing channels and sensors, temperature and conductivity.

Configuration	Casts	Sensor	Primary	Secondary
1	UNCLOS All Casts, JOIS/BGOS Casts 1 to 40:	Temperature	4397	4402
		Conductivity	2992	2984
2	JOIS/BGOS Casts 41 to 43	Temperature	6726	4397
		Conductivity	6137	2992
3	JOIS/BGOS Casts 44 to 65 (end)	Temperature	4402	4397
		Conductivity	2984	2992

Calibration and Accuracy Information, External Sensors							
Sensor		Accuracy	Pre-Cruise		Post Cruise		Comment
Name	S/N		Date	Location	Date	Location	
SBE 43 Dissolved Oxygen sensor	1117		30-Jun-2023	SeaBird Lab			CTD Voltage Channel 2 On Primary pump; UNCLOS Casts 1,2
SBE 43 Dissolved Oxygen sensor	2599		05-Nov-2024	SeaBird Lab			CTD Voltage Channel 2 On Primary pump; UNCLOS Casts 3 to end, all of JOIS/BGOS.
Altimeter, Valeport VA500	80262		08-Feb-2022	Valeport			CTD Voltage Channel 3 Scale factor 15, Range limit 100m
Seapoint Fluorometer (Chl-a)	3651		Jun-2014; 2 pt check at IOS: 21-Feb-2025	Seapoint; 2 pt check at IOS			CTD Voltage Channel 0 On Secondary Pump; UNCLOS Casts 1 to 10.
Seapoint Fluorometer (Chl-a)	3654		16-Jul-2014; 2 pt check at IOS: 21-Feb-2025	Seapoint; 2 pt check at IOS			CTD Voltage Channel 0 On Secondary Pump; UNCLOS Casts 11, all of JOIS/BGOS
Wetlabs C-Star Transmissometer	CST-1052DR		08-May-2025	IOS (In-house light/dark test)			CTD Voltage Channel 1. All UNCLOS, JOIS/BGOS casts 1 to 14.
Wetlabs C-Star Transmissometer	CST-993DR		29-May-2025	IOS (In-house light/dark test)			CTD Voltage Channel 1. JOIS/BGOS casts 15 to end.
WETLabs ECO CDOM	8362		New: 28-Jun-2023	WETLabs			CTD Voltage Channel 4. All UNCLOS, JOIS/BGOS Casts 1 to 6.

WETLabs ECO CDOM	6677		New: 3-Apr-2021	WETLabs			CTD Voltage Channel 4. JOIS/BGOS Casts 7 to end
Satlantic Cosine Log PAR	517		2014-Jun-25	Satlantic			CTD Voltage Channel 6
Biospherical Surface PAR QSR2200	20498		2-Apr-2025	Biospherical			
Biospherical PAR QSR2150 (Continuous)	50228		31-Mar-2025	Biospherical			External to CTD data
Alec Rinko III dissolved oxygen sensor	0259, Film B		17-Dec-2024 22-Sep-2025 18-Oct-2025 19-Oct-2025	IOS; On board x3			CTD Voltage Channel 7

Deck Units

Type	Make	Model	Serial #	Comment
Deck Unit	Seabird	11plus	1281	Primary. This was used for 2025
Deck Unit	Seabird	11plus	689	Backup. Not used.

Rosette Pylons

Type	Make	Model	Serial #	Comment
Water Sampler Carousel	Seabird	32	1231	Pylon used for all casts; trigger head never needed swapping.
Water Sampler Carousel	Seabird	32	452	Pylon as backup. Not used.

Seabird specifications on sensors:

SBE 3plus temperature sensor

Range -5.0 to +35 °C

Resolution 0.0003 °C at 24 samples per second

Initial Accuracy 2 ± 0.001 °C

Response Time³ [sec.] 0.065 ± 0.010 (1.0 m/s water velocity)

Self-heating Error < 0.5 sec. to within 0.001 °C

SBE4c conductivity sensor

Measurement Range 0.0 to 7.0 Siemens/meter (S/m)

Settling Time 0.7 seconds to within 0.0001 S/m

Initial Accuracy 0.0003 S/m

Stability 0.0003 S/m/month

Time Response 0.060 seconds (pumped)

Digiquartz pressure sensor

Measurement Range Pressure 0 to 6800m (10,000 psi)

Accuracy 0.018% of full scale

Resolution (at 24 Hz) Pressure 0.001% of full scale

Time Response Pressure 0.015 second

4.4 Seawater Loop Measurements

Details on set-up, operation, instruments and performance are below.

4.4.1 Seawater Loop

The ship's seawater loop system draws seawater from below the ship's hull at 9 m using a 3" Moyno Progressive Cavity pump Model #2L6SSQ3SAA, driven by a geared motor. 2025: The pump installed Aug 2016 failed during Atlantic crossing and was replaced Aug 2025 with the spare.

The pump rated flow rate is 10 GPM. It supplies seawater to the TSG lab, a small lab just off the main lab where a manifold distributes the seawater to instruments and sampling locations. This system allows measurements to be made of the sea surface water without having to stop the ship for sampling. The water is as unaltered as possible coming directly from outside of the hull through stainless steel piping without recirculation in a sea-chest.

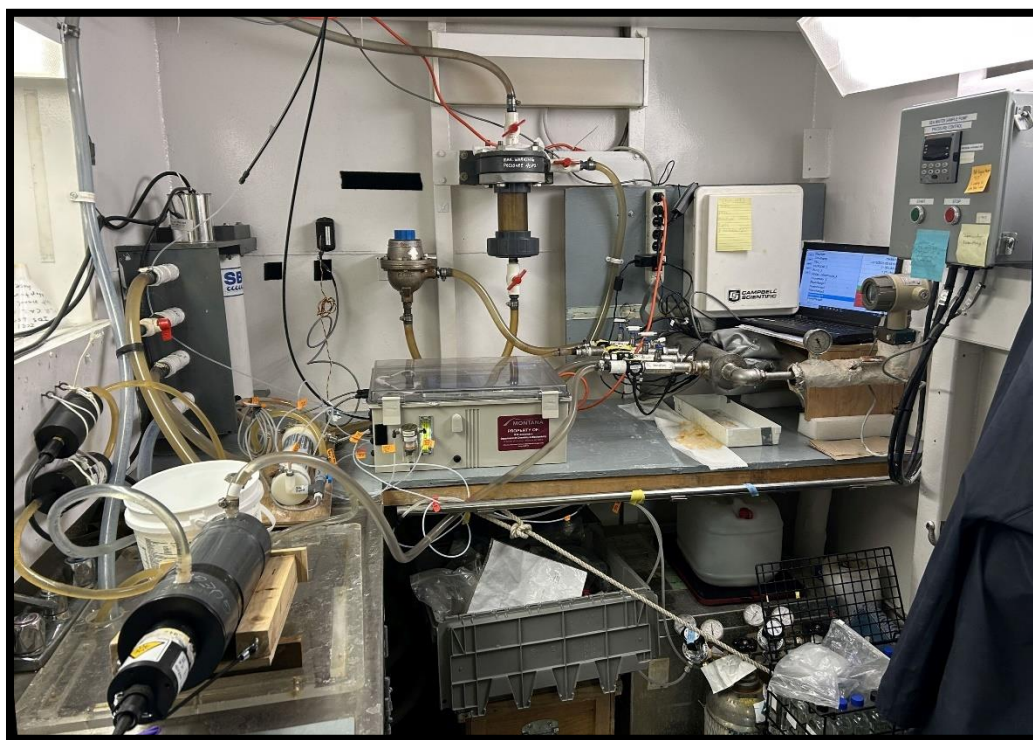


Figure 4.4.1-1. Seawater loop system w/ Chl-a and FDOM sensors attached to left wall, the second FDOM sensor in wood cradle next to sink. The pCO₂ system sits on the center of the back bench. The manifold's needle valves, flowmeters, data logger in white box and laptop are on the right side of the room. The seawater loop

provides uncontaminated seawater from 9m depth to the science lab for underway measurements (photo 2025).

Beginning in 2023, calibrated flow valves were used that displayed and logged flowrate in real time. This was done using a Campbell Scientific interface box and software. In addition, the plastic ball valves were replaced with metal needle valves giving much finer control over the flowrate.

New for 2025: The white Campbell Scientific interface box was mounted to the back wall.

In the engine room



Figure 4.4.1-2. Seawater passes through a filter (in front of engineer) before going to the pump (on blue platform). When the ship is in sea-ice the flow is switched from one filter to the other to allow the necessary frequent clearing out of slush from the filter. Photos on left from previous years, the photo on right from 2025

The SBE38 Inlet Temperature is connected to the TSG remotely. It is installed in-line, approximately 4m from pump at intake in the engine room. This is the measurement to use for sea-surface temperature (as opposed to the seawater temperature measured by the SBE21 in the TSG lab).

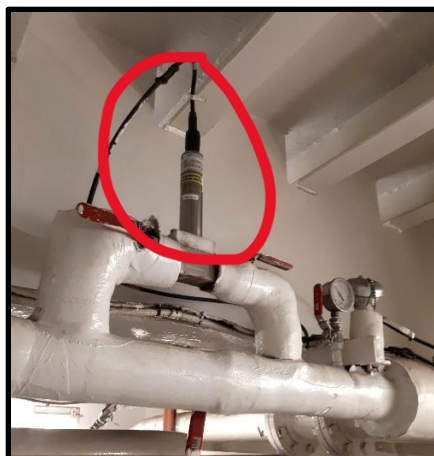


Figure 4.4.1-3. SBE38 temperature sensor in the engine room (2023).

NOTE THE RED HANDLE AT BOTTOM OF PHOTO. THIS VALVE IS CORRECTLY IN THE CLOSED POSITION DURING OPERATION. This handle is hidden from view when open, but needs to be closed to force flow past the temperature sensor to get accurate seawater measurements

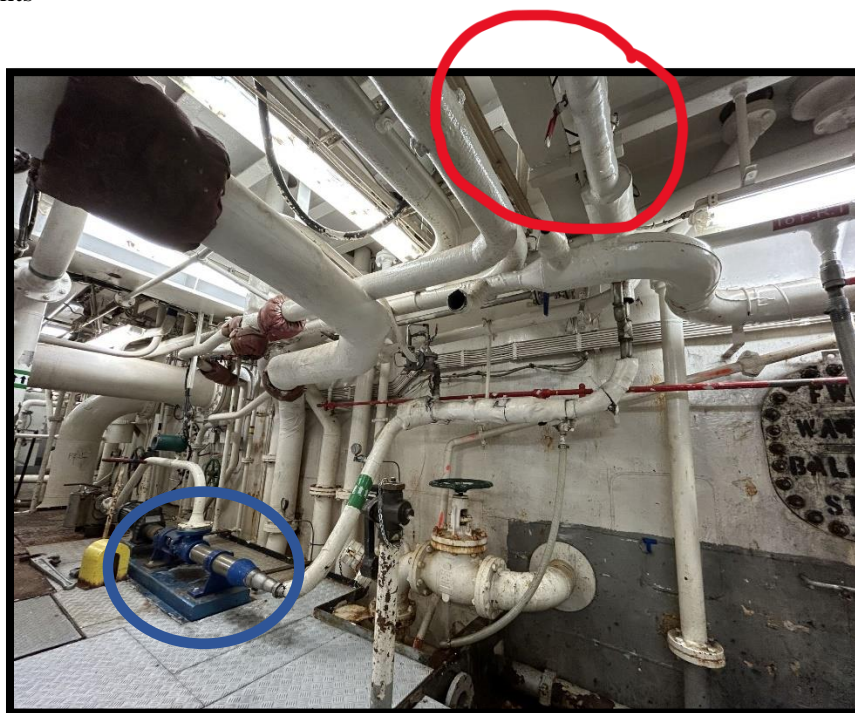


Figure 4.4.1-4. The pump (blue), and SBE38 temperature sensor (circled in red). Photo from 2025.

In the TSG lab

Control of the pump from the lab is via a panel with on/off switch and a Honeywell controller. The controller allows setting a target pressure, feedback parameters and limits on pump output.



Figure 4.4.1-5. Honeywell controller for the pump, located in the TSG lab.

On the first manifold arm is a Kate's mechanical flow rate controller followed by a vortex de-bubbler, installed inline to remove bubbles in the supply to the SBE-21 thermosalinograph (TSG). This is the only flow that was de-bubbled.

A second manifold arm ran to the TSG's Chl-a fluorometer and FDOM sensor.

A third arm of the manifold went to an automated system for measurements of pCO₂. Measurements were made with an infrared equilibrator-based system (SUPER-CO₂, Sunburst Sensors) by Cory Beatty, and Mike DeGrandpre (UMontana). Data were recorded through the cruise with discreet DIC, Alkalinity water samples drawn for comparison.

The fourth arm of the manifold ran to the U de Sherbrooke FDOM sensor.

The TSG data were collected through SeaBird's Seasave acquisition program v Seasave V 7.26.7.107 onto a laptop using a serial to USB adapter cable. GPS was provided to the SBE-21 data stream using the NMEA from PC option rather than the interface box. A 5 second sample rate was recorded.

The computer used GPSgate software and the ship's science LAN to shuttle data: bring in the ship's GPS, bring in the SBE38 (inlet temperature) data from the engine room to the TSG instrument, and to pass out the TSG and SBE38 data to the ship's data collection system (SCS). The software program GPSgate provided the conversion between USB, TCP/IP, and virtual and real communication ports.

4.4.2 Issues, Settings, Instruments

The Seawater Manifold was configured with four outlet arms. A numbered flowmeter was attached to each arm and was recorded in the data logger using a name:

- Arm 1: Flowmeter #1, ("TSG_1_Avg"), to de-bubbler and then TSG
- Arm 2: Flowmeter #2, ("EIMS_2_Avg"), Seapoint Chl-a Fluorometer w/ 30x gain and then to Wetlab FDOM fluorometer
- Arm 3: Flowmeter #3, ("PCO2_3_Avg"), to the pCO2 system
- Arm 4: Flowmeter #Spare, ("Fluorometer_4_Avg") position, USherbrooke's Wetlab FDOM sensor

Pump Settings and Flow Rate

Flow rate varied often due to sea-ice clogging the strainer at the ship's sea-water inlet, or pump malfunction. Sometimes the flow stopped altogether due to clogging and the pump would be turned off until conditions improved (less ice). The TSG data acquisition was typically left running however the periods of bad data will need to be identified and removed.

Flow rates were measured with bottle and timer and were found to be lower than the flowmeter's reading. Flowmeter data will need to be scaled down to reflect actual flow.

Typical flow rates

Instrument	Flowmeter L/min		Measured L/min
	Goal,	Typical	Typical
TSG	15 to 25	20	9
pCO2	1.5 to 2.0	1.8	1.2
Fluorometer pair	1.6 to 2.4	2.3	2.0
FDOM single (UdeS)	5.2 to 5.5	5.8	4.1

Water samples

Discrete water samples for Salinity, FDOM, DIC, Alkalinity (measured from the DIC bottle), Alkalinity only, Chlorophyll and d18O were collected from the fluorometer line. Samples were assigned a consecutive "Loop" number which was unique by time, i.e. if 4 different properties were measured at the same time they received the same Loop number.

Issues with Sea Water Pump and TSG data

On the whole, there were more issues with bubbly water and reduced flow, both due to the ice conditions over the pole and late season in the Beaufort.

TSG, Computer

- SBE21 SN 3312, “Nahidik”, was used this year instead of the typical LSSL TSG that is still out for repair.
- NMEA feed not part of first few data acquisition files. Fixed for file starting 22 Sep 2025 23:50 UTC.
- Chl-a and FDOM fluorometer repositioned at start of JOIS to prevent air bubbles from getting trapped in the sensors and potentially affecting the readings Fixed for data starting 22 Sep 2025 04:00 UTC.
- IOS FDOM fluorometer cleaned, changing value, with new file starting 23 Sep 2025 17:20 UTC.
- Computer froze and needed rebooting to restart data collection. ~ 4 hours of data may have been lost. During UNCLOS, after a reboot it was noticed GPS and intake temperature feeds were frozen (12 Aug 2025).
- SBE38: For the start of UNCLOS it was found flow was being diverted around the intake temperature sensor and the diversion valve not fully closed.

Flow meters

- Flow meter configured slightly differently this year than previous year. Flowmeter “4” was running a bit rough when air blown through so at start of cruise installed “Spare” for the UdeSherbrooke FDOM sensor, but did not adjust flowmeter calibration coefficients.
- For low-flow, the flowmeter appears to get stuck, unclear if this is the valve (real reduction of flow, something stuck in needle valve) or just the flowmeter. Turning the valve up and then back to original spot tends to fix this issue.
- Calibration of flowmeters has drifted/or is not necessarily correct. It is very useful to show stability, but flow checks are needed. The flowmeters over-report the actual flow.

Pump, Pump Transducer and Honeywell Control Box

- The pump burned out on crossing from Canada to Norway and the spare swapped in.
- Ongoing: The LED panel of the Honeywell Control Box has faded to the extent that its only readable when the lab lights are turned off. This needs to be repaired before the LED fades completely (Honeywell ST300 Smart Pressure Transducer).
- Low flow at start of UNCLOS was found to be that a diversion flow from the pump was sending most of the water out and not up to the lab.
- There were issues with low flow during UNCLOS with in (In effort to set the Honeywell controller to a higher process variable, the pressure transducer needed setting to a new range. The transducer couldn't be reset – unclear if it was a transducer problem or missing the external keypad for the transducer. It may be fixable, or a new transducer should be installed. Without this, the pump would need to be set to run at a fixed frequency.
- With the ice conditions for UNCLOS and JOIS this year (new snow, thin ice, new ice) the strainers were frequently clogging and the seabay freezing up requiring periods of bubbly, low flow and sometimes simply turning the pump off for a period.

4.4.3 TSG Configuration

TSG Seabird SBE21 SN 3312

Calibration and Accuracy Information, TSG							
Sensor		Accuracy	Pre-Cruise		Post Cruise		Comment
Name	S/N		Date	Location	Date	Location	
Seabird TSG SBE21	3312		16-Mar-2024	SeaBird Lab			
Seabird Temperatrue SBE-38 (Intake temperature)	0870		28 Jan 2023	SeaBird Lab			
Seapoint Chlorophyll Fluorometer	SCF4150 30x gain		3/6/2024	Seapoint 2pt health check at IOS (21-Feb- 2025)			30x gain cable (0 to 5V = 0 to 5mg/mL)
Wetlabs ECO CDOM Fluorometer	WSCD- 1281		17 Jun 2015	WETLabs			
Computer: laptop TP2023-02							Receives updates from timeserver

- In SEABIRD acquisition software: NMEA option has “Time Added” box checked
- SBE38 via internet sent out from computer using real Com # assigned by the USB to serial converter, then null modem to cable to TSG housing.
- Starting in 2023: Computer has time and date updated by timeserver.

4.5 Logging of Underway measurements with SCS

Paul Macoun, Sarah Zimmermann (DFO-IOS)

P.I.s: Bill Williams

This section gives the SCS string definitions, and lists the issues encountered this year.

These are the measurements taken at frequent regular intervals continuously throughout the cruise logged by “Shipboard Computer System” (SCS) software created by NOAA running on the science server.

These measurements are:

1. GPS from the ship’s Furuno GPS, using NMEA strings \$GPGGA and \$GPRMC. These GPS sentences are made available on the science VLAN, being used by CTD, XCTD, TSG and mapping programs.
2. AVOS weather observations of air temperature, humidity, wind speed and direction, and barometric pressure (\$AVRTE).
3. Sounder depth and the applied ship’s draft and sound speed.
4. Surface Photosynthetically Active Radiation (PAR).
5. Thermosalinograph (TSG), and the inlet sea surface temperature from the SBE38 that is also given in the TSG data stream.
6. Heading from the ship’s Gyro (\$HEHDT).
7. Data from the FDOM fluorometer in the seawater loop (FDOM).
8. Derived true wind speed calculated in SCS.

4.5.1 Issues with the underway system and data

General

Data gap 2025-09-24 from 14:30 to 17:56 UTC

Ships power went down 8:30 local (UTC is +6)

Feeds did not all come back up: Gyro, AVOS, SBE38, TSG, Sounder?, CDOM.

These were all corrected in GPSgate by closing and re-opening the instance.

Knudsen sounder software had sounder off. Restarted 12 kHz.

23 Oct 03:16 UTC Stopped SCS data acquisition. We've been at anchor for last ~24 hours with a couple hours trying to enter Cambridge Bay before turning around and heading back out.

Position, Time, Date, Speed and Course over ground - \$GPRMC

Started 21 Sep 2025 02:41

Position - \$GPGGA

Started 21 Sep 2025 02:41

Depth – “Sunder”

Started for first cast at AG5.

4 Oct 00:00 Ship's skipper had been on. I asked them to turn it off to see if it improves the Knudsen reading. The skipper is at a different frequency but I wonder if its causing the Knudsen to perform less well. In ice, while underway, the bottom is not detected.

Note – the Knudsen reading is displayed to the ships radar navigation computer (both the skipper and the Knudsen).

Meteorological data from AVOS (Automatic Voluntary Observing Ships System) - \$AVRTE

Started 21 Sep 2025 02:41

Seawater Loop (TSG)

TSG pump started 21 Sep 2025 00:30 UTC.

Seawater Intake Temperature (SBE38)

TSG pump started 21 Sep 2025 00:30 UTC.

Surface PAR

The sensor logged data files independently and also reported data to the NOAA Server for logging through the SCS system (given here).

The continuous logging Biospherical Scalar PAR Sensor QSR2150A (S/N 50228, calibration date 31 Mar 2025, Calibration Scale Factor 9.286E-04 V/(uE/m2sec)).

Initially, 20 Sep 2025 01:40 UTC, the sensor was mounted above the CTD operation area and next to the CTD surface reference PAR located mid-ship, starboard side, on railing two decks above the CTD (boat) deck with an unobstructed view over approximately 220deg. The blocked area is due mostly to the ship's crane and smoke stack which are approximately 50 feet inboard, aft and forward of the sensor.

Starting 22 Sep 2025 0046 UTC, this was changed to a higher position, aft on the same deck, mounted on top of the wood dock which was on top of the back portside container. The CTD's SPAR was moved with it.

30 Sep 22:21 to 04 Oct 00:21 data gap in SCS – see standalone files for data.

Cast 15, CB6. SPAR cleaned while CTD SPAR remounted aft above wood dock before station.

Cast 36, ICE-2. SPARs cleaned.

20 Oct 01:48 Last data to SCS. SPAR logging computer was rebooted. The software was restarted but it looks like the science server didn't pick up the feed again. Need to double check when we came on anchor, so maybe no important data missing from SCS. Data do exist in stand alone files in folder S:\ScienceNet\2025-010 JOIS\Data\SPAR

FDOM (CDOM)

First record 2025-09-21 01:39 UTC

11 Oct 04:20 to 15:24 Data gap.

Heading - \$HEHDT from Gyro

First file started 2025-09-23 23:53. Needed to change data routing from a digiport to a VLINX box, changed the server's GPSgate and SCS to match ports.

GPSGATE instance Gyro2025

Input 10.1.20.3:4000 (Vlinx box – note we found that only one computer at a time can connect to this ip address)

Output Com 23 with HEHDT NMEA filter

Com 25 with HEHDT NMEA 1 sec filter

TCP Server 20179

Updated SCS Sensor Configuration Editor to input Com25, validated, saved, and published.

SCS Device Configuration XML Release 2025-09-23 23:50:52

True Wind

Running once gyro started. First record 2025-09-23 23:50

4.5.2 SCS Data Strings Defined

This system takes data arriving via the ship's science network (a VLAN) in variable formats and time intervals and stores it in a uniform ASCII format that includes a time stamp.

Note the AVOS, TSG, FDOM and PAR data are also logged through their own acquisition software, and are provided in the cruise's Data folder.

The SCS system, running on a shipboard computer called the "NOAA server" or "science server" collects *.Raw files. The files are restarted periodically so they do not get too large. Each sentence logged in a .Raw file is also parsed for data fields of interest, and the values extracted, labelled and stored in the SCS database. The compress utility can be used on these extracted data to create files from a single data file for one sentence for the entire cruise.

The list of *.Raw files and fields within the data string are given below for 2020 but are similar for 2025:

Position, Time, Date, Speed and Course over ground - \$GPRMC

File: RMC_*.Raw

Time interval 1 second

Description of *.Raw file string , example file: RMC_20200910-214857.Raw
 09/10/2020,21:48:58.578,\$GPRMC,214427.00,A,7238.52537,N,07151.97735,W,15.051,
 310.9,100920,999.9,E,D*10
 09/10/2020,21:48:59.999,\$GPRMC,214428.00,A,7238.52807,N,07151.98798,W,15.050,
 310.2,100920,999.9,E,D*13

Sentence fields:

Date MM/DD/YYYY (timestamp from SCS)

Time HH:MM:SS.SSS (timestamp from SCS)

"\$GPRMC"

Time HHMMSS.SS

Status A= Active, V=Navigation receiver warning

Latitude DDMM.MMMM

Latitude N or S

Longitude DDDMM.MMM

Longitude E or W

Speed over ground in knots

Course over ground in degrees (True)

Date DDMMYY

Magnetic variation in degrees (999.9 = not valid)
 Variation E or W
 Mode indicator: A=Autonomous, D=Differential
 No comma before this field – checksum starting with *

Extracted and stored in the Database:

RMC-Time UTC
 RMC-Latitude
 RMC-Longitude
 RMC-SOG
 RMC-COG
 RMC-Date

Position - \$GPGGA

File: GGA_*.Raw
 Time interval 10 second

Description of *.Raw file string , example file: GGA_20200909-160350.Raw

09/09/2020,16:03:52.027,\$GPGGA,155920.0,6642.04389,N,06103.44820,W,2,08,1.0,16.8,M,18.5,M,7.0,0138*50
 09/09/2020,16:04:02.996,\$GPGGA,155931.0,6642.08959,N,06103.44817,W,2,08,1.0,16.9,M,18.5,M,6.0,0138*5F

Sentence fields:

Date MM/DD/YYYY (timestamp from SCS)
 Time HH:MM:SS.SSS (timestamp from SCS)
 "\$GPGGA"
 Time HHMMSS.S
 Latitude DDMM.MMM
 Latitude N or S
 Longitude DDDMM.MMM
 Longitude E or W
 Fix type: 0=invalid position, 1=autonomous GPS,2=DGPS
 Number of satellites used
 Horizontal dilution of precision
 Height of the geoid
 M (units of height)
 Age of correction data for DGPS in seconds
 Correction station ID number
 No comma before this field – checksum starting with *

Extracted and stored in the Database:

GGA-Quality (#9 above)

GGA-Satellite Count

GGA-Age of data

Depth – “Sounder”

Depth is measured using the 3.5, 12 or 30kHz transducers using a new for 2018 Knudsen CHIRP 3260 Echosounder, labeled “Science”. The depth value has been increased by the ship’s draft for each transducer. The depth is calculated using a specified sound speed. Both the draft and nominal sound speed variables are set by the user in the Knudsen software. Nominal sound speed is the average of the water column sound speed. To improve accuracy post-cruise, a new sound speed based on the CTD data could be applied. The currently applied draft and sound speed are given in the data string.

Time interval depends on ping rate, but in practice is between 5 and 10 seconds.

It was determined in past years that if the ship’s “fish finder” is on, there is interference with the 12kHz system.

Sounder data are more problematic than other types collected by SCS. 0.0 values are reported when the sounder does not detect bottom. It will report values that to the eye judging the visual echogram are clearly incorrect; any values less than 35m or values that either double or halve those nearby should likely be discarded. In areas with steep bathymetry the sounder will often report incorrect values from side reflections of deeper or shallower water – these artefacts can be difficult to filter out.

File: Knudsen-Sounder_*.Raw

Description of *.Raw file string

Knudsen-Sounder_20200921-001000.Raw

09/21/2020,00:11:32.929,Sounder,21092020,001435,,12.0kHz,3750.71,9.00,,1479

09/21/2020,00:11:43.929,Sounder,21092020,001448,,12.0kHz,3750.84,9.00,,1479

Sentence fields:

Date MM/DD/YYYY (timestamp from SCS)

Time HH:MM:SS.SSS (timestamp from SCS)

“Sounder”

Date UTC: DDMMYYYY

Time UTC: hhmmss

Sounder frequency (3.5kHz)

Depth (3.5kHz)

Applied draft (3.5kHz)

Sounder frequency (12kHz)
 Depth (12kHz)
 Applied draft (12kHz)
 Sounder frequency (30kHz)
 Depth (30kHz)
 Applied draft (30kHz)
 Soundspeed m/s

Extracted and stored in the Database:

Knudsen-Sounder-3.5kHzDepth
 Knudsen-Sounder-3.5kHzTD
 Knudsen-Sounder-12kHzDepth
 Knudsen-Sounder-12kHzTD
 Knudsen-Sounder-30kHzDepth
 Knudsen-Sounder-30kHzTD
 Knudsen-Sounder-NominalSoundSpeed

Meteorological data from AVOS (Automatic Voluntary Observing Ships System) - \$AVRTE

The AVOS system is mounted above the bridge and is operated and serviced annually by Environment Canada. The temperature/relative humidity sensor and The RM Young mechanical anemometer are mounted on the starboard side, about 4m above the bridge-top (approx. 25m above sea-level).

Note that the ship's gyro feed is not connected to AVOS so the compass being used for relative to apparent calculation is the AVOS fluxgate compass and should thus be avoided if possible. SCS does a relative to true wind calculation, using the gyro heading and SOG and this is described below.

Barometer – not sure where this is mounted.

Time interval is 10 sec

File: AVOS-serial-AVRTE_*.Raw

Description of *.Raw file string

AVOS-serial-AVRTE_20200915-001000.Raw

09/15/2020,00:10:10.605,\$AVRTE,200915,001014,00840,CGBN,24.9,322,181,,,,1018.60,-1.9,60,,,,5.0,,,141.7,13.3*45

09/15/2020,00:10:21.199,\$AVRTE,200915,001024,00840,CGBN,24.4,321,181,,,,1018.84,-2.0,60,,,,24.7,,,140.8,13.4*75

Sentence fields:

Date MM/DD/YYYY (timestamp from SCS)
 Time HH:MM:SS.SSS (timestamp from SCS)
 "\$AVRTE"
 Date UTC: YYMMDD
 Time UTC: hhmmss
 Region?
 Ship's Call Sign
 Relative wind speed, knots
 Apparent wind direction, degrees true north
 Relative wind direction, degrees where ship's bow is "North"
 Space for 2nd wind sensor, not installed
 Space for 2nd wind sensor, not installed
 Space for 2nd wind sensor, not installed
 Barometric pressure, Mbar (same as mmhg)
 Space for 2nd barometer, not installed
 Air temperature, degrees C
 Relative Humidity, %
 Space for 2nd temperature sensor
 Space for 2nd humidity sensor
 Space for Sea Surface Temperature, degrees C (this is NOT the same as the sea water loop TSG intake reading – different source)
 Wind gusts, knots
 Blank space for 2nd wind sensor gust
 Heading (\$HEHDT) direction, "Compass 1", degrees (not active)
 AVOS fluxgate compass direction, "Compass 2", degrees
 AVOS battery voltage
 No comma before this field – checksum starting with *

Extracted and stored in the Database:

AVOS-serial-AVRTE-date
 AVOS-serial-AVRTE-time
 AVOS-serial-AVRTE-wind speed
 AVOS-serial-AVRTE-apparent wind
 AVOS-serial-AVRTE-relative wind
 AVOS-serial-AVRTE-barometric pressure
 AVOS-serial-AVRTE-air temperature
 AVOS-serial-AVRTE-relative humidity

Seawater Loop (TSG)

Sea surface properties from sea water loop. Intake is ~9m below waterline. Please see separate TSG report section for description of TSG sensors.

Time interval is 5 seconds.

File: TSG-serial-*.Raw

Description of *.Raw file string

TSG-serial-_20200911-193215.Raw

09/11/2020,19:32:33.321, 1.58 1.36 30.741 27.035 0.380

0.37973 0.07204 255.811262

09/11/2020,19:32:38.321, 1.57 1.36 30.736 27.027 0.369

0.36874 0.07082 255.811319

Sentence fields:

Date MM/DD/YYYY (timestamp from SCS)

Time HH:MM:SS.SSS (timestamp from SCS)

Sea Surface Temperature in lab, Deg C

Sea Surface Temperature at intake, Deg C

Sea Surface Salinity, PSU

Sea Surface Conductivity in lab, mS/cm

Sea Surface Fluorescence (Chlorophyll-a), ug/L

Sea Surface Fluorescence (Chlorophyll-a) voltage, V

Sea Surface Wetlabs ECO CDOM Fluorometer voltage, V

Julian Day

Extracted and stored in the Database:

TSG-serial--T1

TSG-serial--T2

TSG-serial—Salinity

TSG-serial—Conductivity

TSG-serial—ChlFluorescence

TSG-serial--V0

TSG-serial--V1

TSG-serial--JulianDay

Seawater Intake Temperature (SBE38)

Sea surface temperature from sea water loop. Note this is the same temperature that appears in the TSG record. Intake is ~9m below waterline. Please see separate report for description of TSG sensors.

File: SBE-38-serialport-*.Raw
Time interval is about 1 second.

Description of *.Raw file string
SBE-38-serialport-_20201005-001000.Raw
10/05/2020,00:10:03.877, 3.3221
10/05/2020,00:10:14.343, 3.3265

Sentence fields:

Date MM/DD/YYYY (timestamp from SCS)
Time HH:MM:SS.SSS (timestamp from SCS)
Sea Surface Temperature at intake, Deg C

Extracted and stored in the Database:

TSG-serial--T1

Surface PAR

The continuous logging Biospherical Scalar PAR Sensor QSR2150A (S/N 50228, calibration date 31 Mar 2025, Calibration Scale Factor $9.286E-04$ V/(uE/m²sec)).

Initially, 20 Sep 2025 01:40 UTC, the sensor was mounted above the CTD operation area and next to the CTD surface reference PAR located mid-ship, starboard side, on railing two decks above the CTD (boat) deck with an unobstructed view over approximately 220deg. The blocked area is due mostly to the ship's crane and smoke stack which are approximately 50 feet inboard, aft and forward of the sensor.

Starting 22 Sep 2025 0046 UTC, this was changed to a higher position, aft on the same deck, mounted on top of the wood dock which was on top of the back portside container. The CTD's SPAR was moved with it.

The sensor logged data files independently and also reported data to the NOAA Server for logging through the SCS system (given here).

File: ASCII-PAR-serialport-*.Raw
Time interval is 10 second.

Description of *.RAW file string
 ASCII-PAR-serialport-_20200912-001000.Raw
 09/12/2020,00:11:41.768,D|35.813,1.54,7.451
 09/12/2020,00:11:52.143,D|35.439,1.54,7.43

Sentence fields:

Date MM/DD/YYYY (timestamp from SCS)
 Time HH:MM:SS.SSS (timestamp from SCS)
 “D|” - not sure what this is, ignored
 Surface PAR, V (need to be scaled with Calibration Scale Factor)
 Air temperature C
 unknown

Note that typically (not for 2025) we have:

Surface PAR, uE/m2/sec (same units as in CTD data)

Extracted and stored in the Database:

ASCII-PAR-serialport-PAR

FDOM (CDOM)

File: CDOM*.Raw
 Time interval is 30 second.

Description of *.RAW file string
 CDOM-_20251009-000000.Raw

10/09/2025,00:00:18.772,99/99/99	99:99:99	460	67	532
10/09/2025,00:00:48.536,99/99/99	99:99:99	460	74	532

Sentence fields:

Date MM/DD/YYYY (timestamp from SCS)
 Time HH:MM:SS.SSS (timestamp from SCS)
 Empty time field HH:MM:SS - ignore
 Value – 1 Unknown
 Value – 2 This is FDOM value
 Value – 3 Unknown

Heading - \$HEHDT from Gyro

File: HDT-Gyro_*.Raw
 Time interval 10 second

Description of *.Raw file string , example file HDT-Gyro_20251009-000000.Raw

10/09/2025,00:01:16.161,\$HEHDT,128.11,T*14
 10/09/2025,00:01:27.138,\$HEHDT,128.11,T*14

Sentence fields:

Date MM/DD/YYYY (timestamp from SCS)
 Time HH:MM:SS.SSS (timestamp from SCS)
 "\$HEHDT"
 Heading in degrees Direction
 T: Indicates heading relative to True North
 Checksum data, begins with *

Extracted and stored in the Database:

True Wind

File: True-Wind-DRV_*.Raw
 Time interval 1 second

Description of *.Raw file string , example file True-Wind-DRV_20251009-000000.Raw

10/09/2025,00:00:16.226,TrueWind,12,95.04,11.7,327,0.3,272.3,128.11,
 10/09/2025,00:00:17.231,TrueWind,10,92.11,9.7,324,0.3,272,128.11,

Sentence Fields:

Date MM/DD/YYYY (timestamp from SCS)
 Time HH:MM:SS.SSS (timestamp from SCS)
 "TrueWind"
 Wind speed, knots (true)
 Wind direction, degrees (true)
 For calculation:

Relative wind speed, knots (AVOS, \$AVRTE)
 Relative wind direction, degrees where ship's bow is "North" (AVOS,\$AVRTE)
 Speed over ground in knots (\$GPRMC)
 Course over ground in degrees (True) (\$GPRMC)
 Heading from Gyro (\$HEHDT)