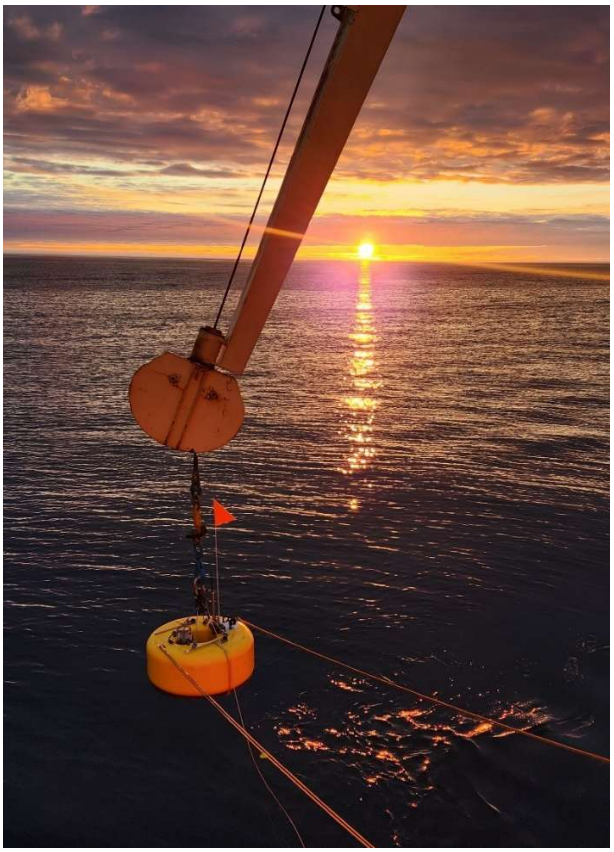
Baffin Island Broadband Offshore Seismology (BIBOS) OBS Deployment Cruise
NFSI-010-2024-04
FV Mersey Venture

September 9-26, 2024

National Facility for Seismological Investigations

Dalhousie University



Funding

Ship time for the NFSI-010-2024-04 cruise was funded by Defense Research & Development Canada (DRDC). NFSI personnel time, travel costs, and deployment consumables were funded through the Facility Verification allocation of NFSI's CFI grant.

Researchers listed below are engaged in the application process for an NSERC Alliance grant to continue work started in this deployment, along with DRDC staff scientists.

Name	Institution	Role
Mladen Nedimovic	Dalhousie University	Principal Investigator (PI)
Yajing Liu	McGill University	Co-PI
Miao Zhang	Dalhousie University	Co-PI

Acknowledgement

We thank Alexandre Plourde (NRCan/Dalhousie researcher) for his significant contributions in prioritizing the scientific goals and deployment configuration for this survey.

Cruise Identification

We are not aware of any other unique identifiers used to refer to this cruise at time of publication.

Organization	Cruise ID
NFSI	NFSI-010-2024-04

Revision History

Date	Version No.	Author(s)	Description
Feb 2025	1.0	K. Bosman, G. Cairns	Base document

Contents

Cruise Participants

Science Party

Name	Affiliation	Role
Graeme Cairns	NFSI	OBS Expedition Leader
Katherine Bosman	NFSI	OBS Technician/Watch Leader
John Thibodeau	NFSI	OBS Technician/Watch Leader
Andre Tremblay	DRDC	Instrument Technician

Ship's Crew

Name	Role
Quinten Roy	Captain
Brandon Clarke	1st Mate
Gabriel Lanteigne	2nd Mate
Shane Foxe	Chief Engineer
Justin Hearn	2nd Engineer
Gabe Bennet	3rd Engineer
Alan Cosby	Cook
Ron Jamieson	Crane Operator
Bryton Schrader	Crane Operator
Ted Hingley	Seaman
Curtis Savoury	Seaman
Chris Kaiser	Seaman
Darren Albert	Seaman
Danny Rowe	Leeway Marine Representative

Summary

Between September 9 and 26, 2024, the NFSI-010-2024-04 expedition aboard F/V Mersey Venture deployed 29 broadband ocean-bottom seismometers (BOBS) in northern Baffin Bay, as the first stage of a proposed 3- to 5-year project investigating Canada's eastern Arctic offshore region. The originally planned 30-station grid in northwestern Baffin Bay was reduced to 28 stations as one instrument malfunctioned shortly after deployment and had to be recovered, and another was reassigned to a co-deployment opportunity in northwestern Greenland. All instrument seafloor locations were determined by acoustic triangulation immediately after deployment. Recovery of the stations is planned for late summer 2025.

1.0 Introduction

The Baffin Island Broadband Offshore Seismology (BIBOS) deployment represents the first year of ICE-OBS (Investigating Canada's Eastern Offshore with Broadband Seismology), a multi-year proposed BOBS survey to investigate Canada's eastern Arctic offshore region. This project aims to develop improved understanding across a range of scientific objectives, including active seismic zones, lithospheric structure, baleen-whale habitat use, and the marine acoustic environment in Baffin Bay, the Davis Strait, and the western Labrador Sea. The output science products will benefit Canadians living in coastal Arctic communities through regionally improved earthquake and tsunami hazard assessment. They will also provide fundamental data to marine spatial planning efforts, including policies around marine mammal conservation and new seafloor infrastructure, that are needed due to the continued increase in commercial, tourist, and private vessel traffic crossing through the Northwest Passage resulting from a decrease in Arctic sea ice. Results of the proposed work will guide future policies designed to protect Canadian lives, onshore and offshore infrastructure, and conserve critical marine species.

1.1 Background

The Baffin-Labrador Seaway is the product of continental rifting and seafloor spreading between Greenland and the eastern Canadian Arctic. Although the rifting has ceased, it has left dense networks of faults that host abundant seismicity today. In northwestern Baffin Bay, ~1300 earthquakes of M>3 have been recorded over the past 30 years. Large historical earthquakes in this region include the 1933 Baffin Bay M7.3 earthquake, which is the largest earthquake recorded on the east coast of Canada and may be the largest earthquake recorded on a passive margin in the world. These earthquakes pose hazard to communities on the northeastern coast of Baffin Island. A similar zone of seismicity exists in the western Labrador Sea, posing hazard to Iqaluit and communities on the Labrador coast. Hazard stems in part from the direct shaking, but also the potential for triggered landslides – and subsequently triggered tsunamis. The remoteness and vast scale of this area has historically made it extremely challenging to survey with seismic or acoustic instruments, leaving it poorly characterized in many contexts.

Seismic hazard assessment for the eastern Arctic is challenging in part because it is unclear what geodynamic processes dominate the tectonic stress field in the region and there are large uncertainties in the locations/dimensions of potentially seismogenic faults, largely due to the lack of instrumentation in the northern and offshore regions. Recurrence intervals of the largest earthquakes are also poorly constrained, and it is unclear to what degree the current distribution of earthquakes can be used to predict the location of future mainshocks. The connection between intraplate earthquake recurrence and seismic hazard is further complicated by the fact that earthquakes can occur over multiple fault segments, often involving intersecting or "stepover" faults.

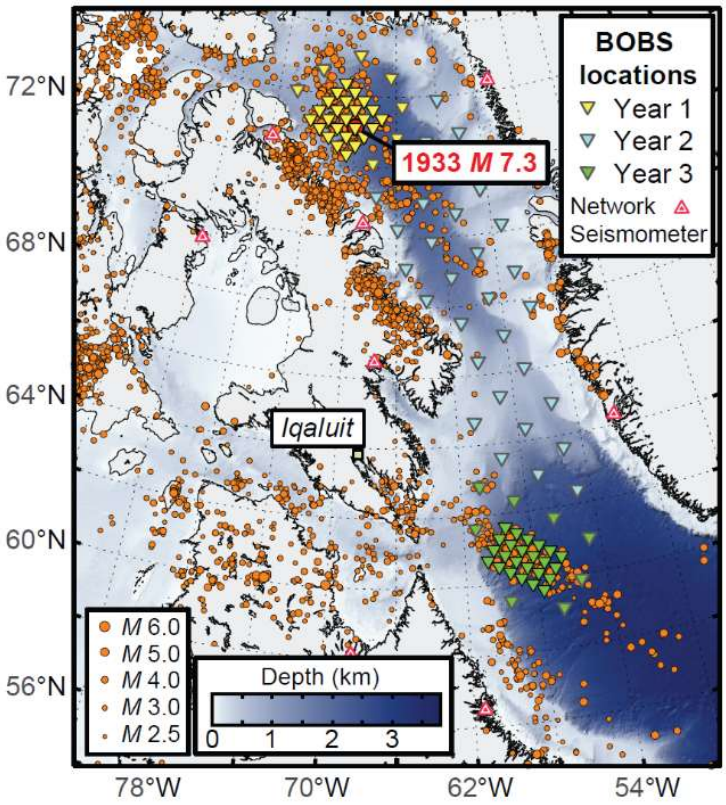


Figure 1-1: Proposed ICE-OBS multi-year BOBS experiment spanning northern Baffin Bay to the western Labrador Sea. Orange circles indicate earthquake locations from the Canadian National Earthquake Database. The existing land-based seismometer network (red triangles) provides sparse coverage over the study region. The BIBOS array is modified from the original "Year 1" proposed stations.

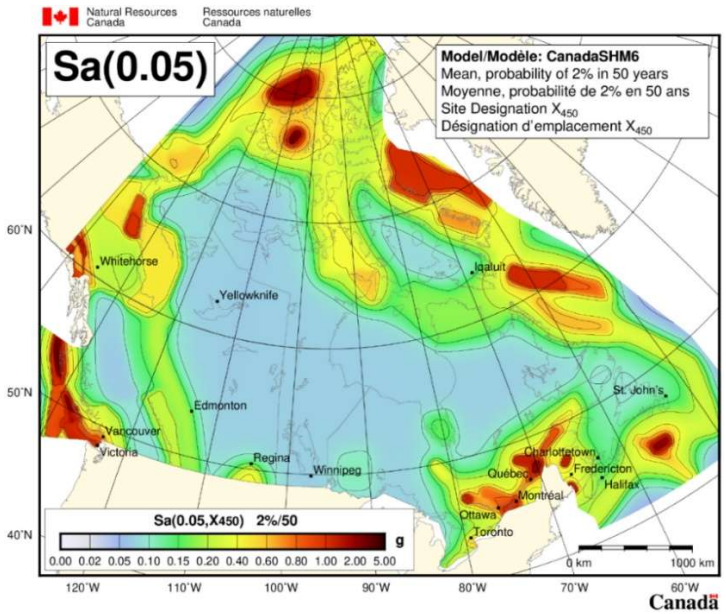


Figure 1-2: Seismic hazard map of Canada; specifically, the spectral acceleration at a 0.05 s period for which a 2% probability of exceedance per 50 years is expected, according to the 2020 National Building Code of Canada, from NRCan. The proposed multi-year project will focus on two zones of high seismic hazard (dark orange to red zones) in the eastern Arctic, one in northwestern Baffin Bay and one in the western Labrador Sea.

Considering its remote location, the shallow crust of the Baffin-Labrador Seaway is relatively well imaged, via seismic reflection, because of its extensive sedimentary basins that have potential to host oil-and-gas deposits. However, the deeper, igneous crust and underlying mantle layers remain poorly characterized in most regions, as they have been constrained by seismic refraction surveys which are relatively sparse. This has left major gaps in our understanding of the tectonic history of the area, including how the rifting between northeastern Canada and Greenland was initiated, what controls the variation from magma-rich to magma-poor spreading regions, and what role, if any, a proto-Iceland mantle plume had in the magmatism. Magnetic surveys lack the typical oceanic crustal "striping" signature and highlight variations in rifting style along the margin. Variations in deep lithospheric structure are hypothesized to be a major control of variations in the timing and character of rifting, but this has been impossible to investigate thus far given a lack of sufficient passive source seismic data. The BOBS survey will help address these questions by allowing deep seismic tomography, using distant earthquakes and/or ambient noise rather than an active-source survey, providing information on the entire lithosphere.

Acoustic waves propagate further underwater than electromagnetic waves, thus underwater communication systems usually rely on acoustic sensors. Underwater acoustic communication, and therefore knowledge of acoustic noise levels, in the ocean have long been critical for military submarines. In recent decades, it has also become increasingly important to civilian applications, including the development of seafloor infrastructure and oceanographic research. The data recovered from this experiment will allow us to characterize how factors such as wind speed, precipitation rate, marine traffic, and cracking in sea ice contribute to ocean noise in the Baffin-Labrador Seaway. A particular challenge posed by the Baffin-Labrador Seaway is the prevalence of intermediate water depths, i.e. those greater than the continental shelf (up to a few hundred meters) but not on the abyssal plain (a few kilometers and deeper) which are often the only depth ranges considered.

The eastern Arctic is thought to be an important summer feeding ground for several baleen whale species found in the broader North Atlantic. This includes fin whales and blue whales, two endangered species that are monitored in southern Canada by *Fisheries and Oceans Canada* (DFO) with passive acoustics, among other methods. Data on their distribution in the Arctic is extremely limited. Aerial surveys conducted off western Greenland within the last 20 years have provided estimates of a few thousand fin whales present in the area. Fin whales have also been acoustically monitored in the Davis Strait, indicating that they remain in the area as late as December, likely migrating south just ahead of sea-ice formation. There is very little information available on the abundance of blue whales, but their presence in the eastern Arctic has been noted. The habitat use of baleen whales, especially that of endangered species, is critical data for marine spatial planning efforts, including the creation of new Marine Protected Areas.

1.2 Mission Objectives

The objective of this cruise was to deploy an array of 30 broadband ocean-bottom seismometers (BOBS) in northwestern Baffin Bay. The original plan was for these to be deployed in a single array on a uniform 40km grid. Shortly before sailing it was agreed that, time permitting, one of the stations would be reassigned to a site near the mouth of Bylot Sound, western Greenland, to complement other instrumentation deployed near that location.

1.3 Maps

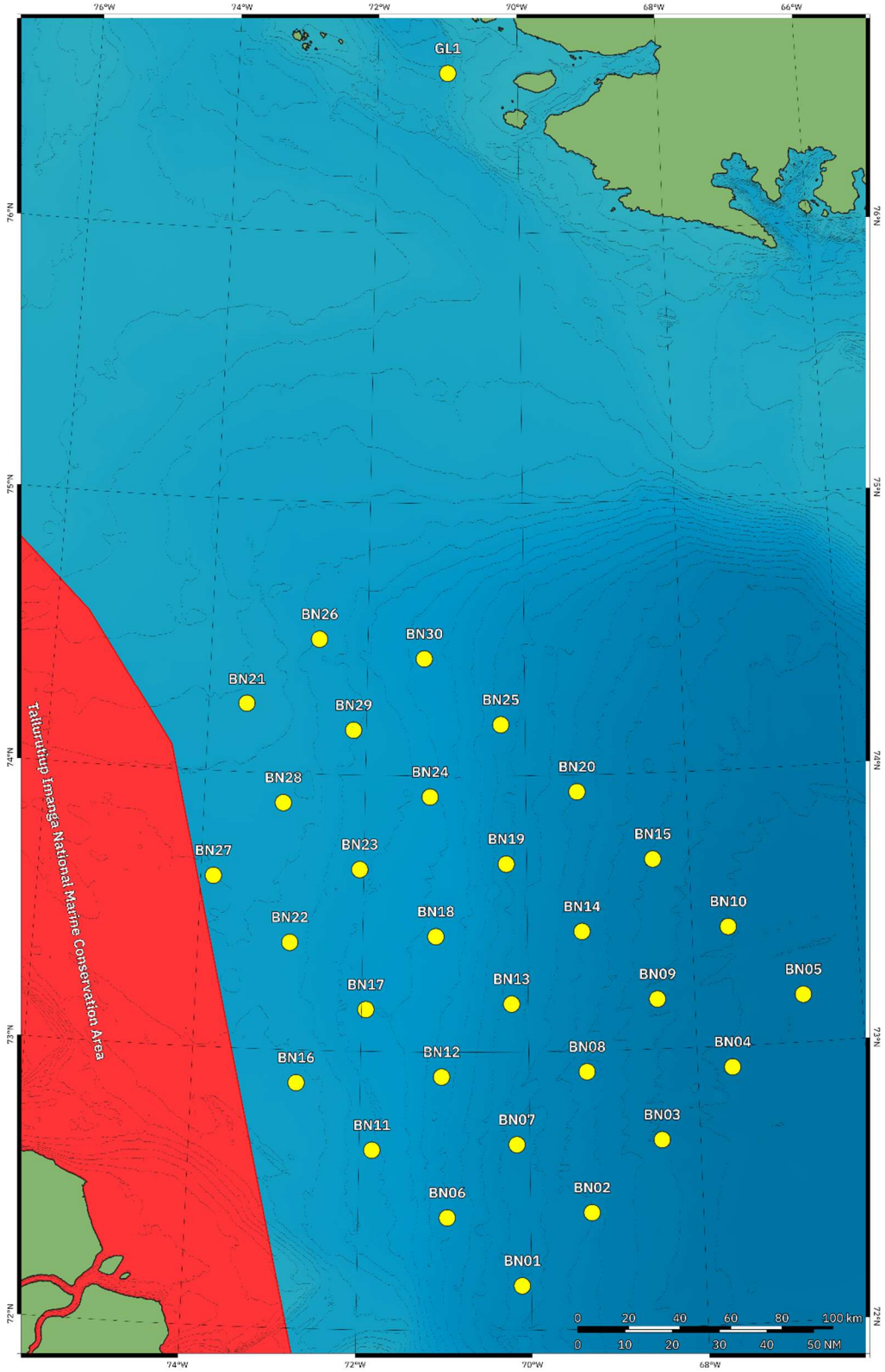


Figure 1-3: Planned BIBOS station locations as of the cruise start date, showing the full 30-station grid and an estimated target location near Bylot Sound. Red overlay lower left is the Tallurutiup Imanga National Marine Conservation Area.

2.0 Instrument Preparation

In preparation for deployment, all 30 OBS underwent test recording between late June and mid-August 2024 for varying lengths of time. Eleven instruments which had been subject to retrofit maintenance in mid-June were tested for approximately 6 weeks (late June through early August). A further 13 instruments were tested for approximately 1 week after being in storage since March 2024. The remaining 6 instruments were delivered to NFSI in early August following repairs performed by Güralp in the UK and were then tested for 48 hours to meet time constraints for mobilization. All test data showed nominal behaviour.

Most OBS had their batteries charged to full at NFSI facilities at Dalhousie University campus in Halifax and at the COVE facility in Dartmouth. Due to the relatively short timeframe available for preparation, three instruments could not be charged before mobilization. Charging for these instruments was performed on the ship during transit to the first deployment site. Electrical connectors and water seals (O-rings) were serviced by NFSI staff prior to mobilization.

All recovery beacons were assembled and tested in the NFSI laboratory space at Dalhousie prior to mobilization.

3.0 Field Operations

3.1 Operational Summary

Vessel	FV Mersey Venture
Cruise start date	9 September 2024
Cruise end date	26 September 2024
Onboarding port	Pond Inlet, NU, Canada
Offboarding port	Iqaluit, NU, Canada
OBS deployed	30
OBS positioned	30
OBS recovered	1
VHF beacon frequency	159.480 MHz
Long-term backup release date	15 July 2026 – 21 July 2026

3.2 Mobilization

All equipment was loaded onto the ship at Mersey Seafoods' facility in Liverpool, NS. Transport by truck from Halifax to Liverpool was arranged by Leeway Marine, with pickup of accessory equipment on August 19th by an enclosed box truck and the OBS instruments on August 21st by flatbed trailer. NFSI's equipment was stowed aboard the ship for transit to Baffin Bay and during an initial voyage leg for deployment of DRDC instrumentation. All accessory equipment was stored in a 10-foot container on the aft deck. The OBS instruments in stillage boxes were secured in a covered area at the front of the trawl deck, where they could be slid along rails to bring within reach of the crane when needed.

NFSI staff traveled from Halifax, NS to Pond Inlet, NU on September 8th-9th to board the ship following the completion of DRDC's initial science program. One technician from DRDC remained on board to assist NFSI staff with the OBS deployments.

Figure 3-1: Aquarius stillage boxes stowed forward on trawl deck. The box legs straddle two adjacent rails, providing some lateral constraint on movement, and slide relatively easily out from under cover to move instruments to the staging area. Extension cords can be run out from the workshop for power as needed (blue and green cables at lower right).

3.3 Accessory Equipment Setup

A small office room on the 1st forecastle (winch) deck was used for programming the OBS and other final pre-deployment preparations. This room is just inside from an open area under the crane on the starboard side, which was used for staging OBS a few at a time for deployment. A cable transit through the wall provided access for a GPS antenna (mounted to the railing on the bridge deck above), Aquarius data cables for programming the OBS, and a dunker cable for on-deck testing of the acoustic modems. It was possible to fit three OBS in the staging area at a time, refilling the space as necessary from the storage area on the trawl deck below. Rubber mats were used to protect the underside of the OBS while in the staging area, as well as a used truck tire which was left on board from a previous operation.

Figure 3-2: Deck unit and tools set up in ship's office for instrument preparation.

Figure 3-3: OBS staging area on starboard side of winch deck ahead of crane. Maximum of three Aquarius can be placed in this area and still allow unhindered foot traffic.

Figure 3-4: Lifting an Aquarius OBS from the trawl deck storage area to the staging area on the winch deck. Taglines were secured to either side of the buoyancy to control swing and passed up to the deck above as the lift progressed.

Figure 3-5: Deployment of Aquarius OBS using starboard deck crane. Two taglines were threaded through the loops on either side of the buoyancy and pulled out simultaneously to minimize twist immediately prior to release at the water line. The third line in the middle is the pull rope for the quick release mechanism.

Figure 3-6: Aquarius OBS near water level about to be released. Note the high angle of the taglines and release pull rope. Total height from the water line to the winch deck is approximately 7 meters.

A second deck unit was set up in a 10-foot powered container which had been placed on the port side of the aft trawl deck, near a door in the sidewall of the ship. The dunker was deployed through this door for in-water acoustic communication with the instruments. GPS position used for seafloor location surveys was obtained from a GPS antenna mounted on a railing directly above the container.

Figure 3-7: Dunker setup for in-water acoustic communication: (left) deckhands lowering the dunker on its cable through the door in the port side of the trawl deck, and (right) deck unit and NFSI technician Katie in powered container.

3.4 Cruise Narrative

NFSI staff boarded the *Mersey Venture* at Pond Inlet, NU on the evening of September 9th. The ship immediately began transit to the first deployment site. The initial transit was timed to arrive at the southwest corner of the planned grid at first light on September 11th, allowing a full day for equipment setup and discussion of operational procedures with the crew.

The first deployment occurred shortly before 08:00 ADT on September 11th. Deployments proceeded through the grid zig-zagging from south to north and finishing at the northeast corner. Operations averaged just over five deployments every 24 hours. Average transit speed was slightly slower than typical (7-8 knots) for fuel efficiency. Weather remained excellent throughout the cruise, with calm sea state and low winds. The ship's crew is very familiar with conditions in Baffin Bay, and all remarked that such a long stretch of good weather at this time of year is highly unusual.

Ship noise was a significant issue for in-water acoustic communication, especially at the deepest stations which were at up to 2.4km water depth. Generally, communication was reliable for stations at less than 2km depth, although bottom-side modem power levels had to be raised to their maximum setting to maintain reception. Below 2km, communications were challenging even at the highest power setting. As observed in some previous operations, the top-side dunker modem struggled to detect responses from the seafloor instrument due to noise from the ship's propulsion system.

The instrument initially deployed at station BN14 surfaced unexpectedly about 38 hours after launch, with only six stations remaining to deploy of the main grid. Due to the high volume of email notifications from GPS beacons during pre-deployment testing, the surfacing was not noticed for several hours. For

operational efficiency, the decision was made to complete deployment of the grid, reserving one OBS to replace the one that surfaced, and then return to retrieve the drifter and deploy its replacement. The drifter was recovered without incident, using one of the ship's zodiacs to attach the crane hook to the instrument's lifting frame. Debugging immediately after recovery revealed partial functionality for a few hours before the instrument stopped showing signs of life entirely. The OBS will be returned to Dalhousie for forensic investigation; water ingress is the suspected cause of malfunction based on experience with previous drifters.

Following completion of the main grid, the ship transited to the mouth of Bylot Sound in northwestern Greenland to deploy one OBS near some equipment operated by DRDC which had been deployed a few weeks earlier.

Some drop locations revisions were made about halfway through deployment of the main grid on September 14th. The 1st Mate noticed on approach to station BN15 that it and the other three stations remaining of the northeast edge of the grid (BN20, BN25 and BN30) were in fact located in Greenland national waters and would require permitting and notification to the Greenland government of our entrance into their boundaries. The permitting process for this would likely take months for approval, as it did for deployment of equipment in Bylot Sound in northern Greenland. Instead, we decided to move the stations 1-1.5 nm southwest of the boundary to remain in Canadian waters. Shifts for stations BN15 and BN20 were relatively small, with larger shifts for the more northern stations.

The cable used for deployment of the dunker began having reliability issues during the location survey for station BN15A. This cable has been damaged and repaired before, so there may be some issue with either the repair itself or handling of the cable since the repair. Fortunately, we had a second cable on board which was in use for on-deck testing and could be swapped to maintain reliable functionality for in-water communication.

One instrument showed a residual voltage on the pressure case during final pre-deployment checks. A similar, although much higher, voltage reading caused massive corrosion of the pressure case and battery drainage leading to early release for an OBS deployed offshore western Canada in Fall 2023. This instrument was held back from deployment initially. The ship's crew was able to provide us with a suitable chain hoist, vacuum pump and fittings to allow the OBS to be opened for investigation during transit to Greenland. A pinched low-voltage supply wire was found and repaired, and the instrument reassembled and tested. Following successful post-maintenance testing, the OBS was deployed at station BN30A to complete the main grid during the return transit from Greenland.

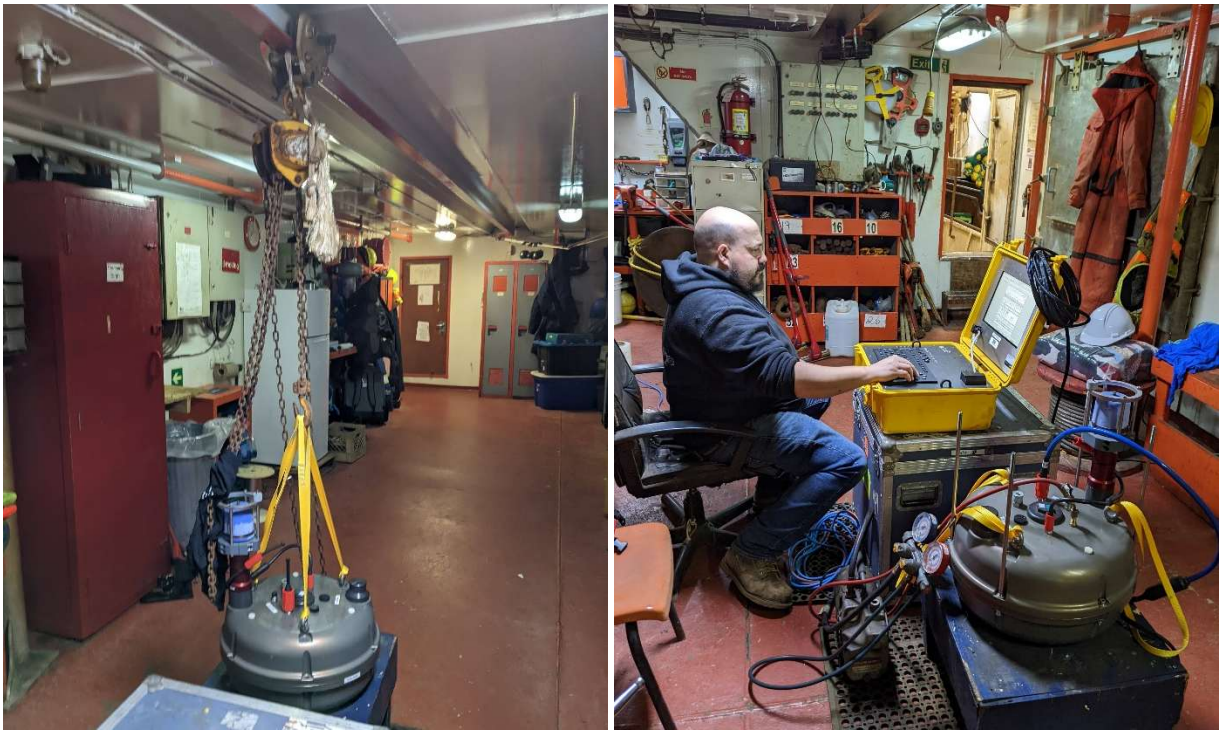


Figure 3-8: Workspace in rigging room on trawl deck during AQU-6366 repair: (left) OBS pressure case hooked up to manual chain hoist mounted on overhead beam, (right) NFSI technician John initiating test recording after reassembly, with vacuum pump connected to pressure case vent hole. The large sliding door at far right (behind orange cold-weather suit) leads to the covered area of the trawl deck (other side visible in Figure 3-1).

Figure 3-9: Aquarius OBS pressure case opened for repairs. All required maintenance was performed on the upper portion of the pressure case, which is tipped up at left.

After all deployments, the ship transited to Iqaluit, NU for offboarding of all NFSI and remaining DRDC staff on September 25th and 26th. The ship then transited to its home port in Liverpool, NS, arriving on October 3rd. All equipment was demobilized in Liverpool and transported by truck to Halifax, NS on October 7th.

3.5 Station Notes

The main array grid is numbered as "BNxx[a]" where 'xx' is a 2-digit number and 'a' is an optional uppercase letter modifier. Station numbers 21 and 26 are missing from the array. These stations were originally planned to fill out the northwest corner of the grid but had to be moved shortly before embarking on the cruise as they were located within the Tallurutiup Imanga National Marine Conservation Area. Due to instrument availability, the proposed alternate locations of these stations were later dropped during the cruise.

Original planned locations for four stations of the northeastern-most line of the array (BN15, BN20, BN25 and BN30) were found to be within Greenland's national waters during deployment operations. We had a very short timeline to modify the array design, as the permitting process required for the original sites would normally take months for approval. These stations were moved to 1-1.5 nautical miles southwest of the Greenland EEZ boundary to stay within Canadian waters. The new sites are denoted with an "A" suffix.

The OBS originally deployed at station BN14 (AQU-555C) surfaced unexpectedly approximately 38 hours after deployment. Only a few stations of the grid were remaining to be deployed at this time, so deployment operations were completed while tracking the instrument's position using the Apollo GPS/Iridium beacon installed on the OBS. The drifting instrument was then retrieved for diagnostics. In total, the OBS drifted for about 22 hours before recovery. An alternate instrument was then deployed as a replacement at the original planned location of BN14, denoted as BN14B.

Station GL1 is located near the mouth of Bylot Sound in northwestern Greenland. This station is a co-deployment with some equipment operated by DRDC which was deployed nearby a few weeks earlier. Remaining quantitative discussion in this report will focus on the main array grid.

Table 3-1: Planned locations and actual OBS drop locations for stations in the main grid.

Station	Launch Time	Planned Location		Actual Drop Location		Distance from Planned (km)
		Latitude	Longitude	Latitude	Longitude	
BN01	2024-09-11 10:52:00	72.1596	-70.1058	72.159317	-70.104717	0.049
BN02	2024-09-11 15:34:10	72.4181	-69.29	72.417990	-69.289637	0.017
BN03	2024-09-11 21:18:19	72.6731	-68.4507	72.672912	-68.450942	0.023
BN04	2024-09-12 03:28:03	72.9245	-67.5872	72.924650	-67.587383	0.018
BN05	2024-09-12 09:20:35	73.1722	-66.6988	73.172433	-66.698500	0.028
BN06	2024-09-13 09:34:24	72.4043	-70.966	72.404533	-70.965167	0.038
BN07	2024-09-13 05:28:56	72.6663	-70.1515	72.665750	-70.152450	0.069
BN08	2024-09-13 00:18:16	72.925	-69.3128	72.925607	-69.312948	0.068
BN09	2024-09-12 19:27:52	73.1801	-68.4493	73.180298	-68.449625	0.024
BN10	2024-09-12 14:09:23	73.4314	-67.5601	73.432067	-67.562650	0.110

BN11	2024-09-13 13:47:32	72.6451	-71.8496	72.645167	-71.849100	0.018
BN12	2024-09-13 17:37:41	72.9108	-71.037	72.910833	-71.037010	0.004
BN13	2024-09-13 21:38:17	73.1731	-70.1998	73.171705	-70.200822	0.159
BN14	2024-09-14 02:20:16	73.4319	-69.3369	73.431615	-69.336252	0.038
BN14B	2024-09-16 18:44:20	73.4319	-69.3369	73.431883	-69.335565	0.043
BN15A	2024-09-14 07:48:30	73.687	-68.4477	73.671917	-68.495917	2.263
BN16	2024-09-15 05:58:44	72.882	-72.7571	72.882138	-72.760518	0.113
BN17	2024-09-15 02:13:42	73.1513	-71.9474	73.151142	-71.947897	0.024
BN18	2024-09-14 22:06:46	73.4173	-71.1123	73.417220	-71.111528	0.026
BN19	2024-09-14 17:16:27	73.6798	-70.251	73.679798	-70.249747	0.039
BN20A	2024-09-14 12:33:36	73.9387	-69.3626	73.908667	-69.464800	4.607
BN22	2024-09-15 10:23:30	73.3876	-72.8831	73.38777	-72.881557	0.053
BN23	2024-09-15 21:37:52	73.6573	-72.0511	73.65749	-72.047902	0.103
BN24	2024-09-16 01:49:22	73.9237	-71.1922	73.922518	-71.190787	0.139
BN25A	2024-09-16 10:07:22	74.1865	-70.3054	74.145348	-70.43486	6.054
BN27	2024-09-15 14:33:19	73.6197	-73.8447	73.61956	-73.844023	0.026
BN28	2024-09-15 17:59:21	73.8931	-73.0167	73.893223	-73.014397	0.073
BN29	2024-09-16 06:18:29	74.1633	-72.1612	74.163312	-72.161023	0.006
BN30A	2024-09-18 10:54:21	74.43	-71.277	74.378413	-71.440343	7.563

Seafloor locations were surveyed for all stations by a triangulation method using a directional dunker for simple acoustic ranging. Several ranges were collected at each of 3 or 4 points distributed around the drop or presumed seafloor location. Resulting seafloor locations were determined using the ob_inst_survey[1] package developed by GNS Science with modifications by NFSI staff. Bearings of drift measurements are given in degrees clockwise from North.

Table 3-2: OBS drop locations and surveyed seafloor locations for stations in main grid.

Station	Drop Location		Surveyed Seafloor Location			Horizontal Drift	
	Latitude	Longitude	Latitude	Longitude	Depth (m)	Distance (m)	Bearing (°)
BN01	72.159317	-70.104717	72.157314	-70.105653	1756.0	225.7	188.2
BN02	72.417990	-69.289637	72.417122	-69.287110	2007.9	129.0	138.6
BN03	72.672912	-68.450942	72.671564	-68.450396	2234.6	151.5	173.1
BN04	72.924650	-67.587383	72.923557	-67.583068	2352.1	186.8	130.8
BN05	73.172433	-66.698500	73.171778	-66.695221	2398.2	128.8	124.6
BN06	72.404533	-70.965167	72.404189	-70.964986	1400.3	38.9	171.0
BN07	72.665750	-70.152450	72.664743	-70.149832	1770.5	142.1	142.2
BN08	72.925607	-69.312948	72.925648	-69.313872	1971.1	30.6	278.7
BN09	73.180298	-68.449625	73.179216	-68.451814	2217.8	140.0	210.3
BN10	73.432067	-67.562650	73.431955	-67.565770	2327.9	100.1	262.8
BN11	72.645167	-71.849100	72.645082	-71.848597	1086.0	19.2	119.5
BN12	72.910833	-71.037010	72.909530	-71.038852	1378.3	157.5	202.6

[1] Code originally developed by Neville Palmer of GNS Science (New Zealand), modified by NFSI staff. Github repository: https://github.com/nfsi-canada/ob_inst_survey

BN13	73.171705	-70.200822	73.172066	-70.204808	1666.6	135.0	287.4
BN14	73.431615	-69.336252	73.430827	-69.337411	1933.4	95.3	202.8
BN14B	73.431883	-69.335565	73.430459	-69.331763	1936.6	199.8	142.7
BN15A	73.671917	-68.495917	73.670221	-68.492360	2124.1	219.7	149.5
BN16	72.882138	-72.760518	72.879954	-72.765324	881.1	290.5	212.9
BN17	73.151142	-71.947897	73.149610	-71.947325	1168.7	171.9	173.8
BN18	73.417220	-71.111528	73.418263	-71.108575	1235.1	149.7	39.0
BN19	73.679798	-70.249747	73.677781	-70.248179	1587.1	230.4	167.7
BN20A	73.908667	-69.464800	73.908938	-69.464136	1799.7	36.6	34.2
BN22	73.38777	-72.881557	73.389047	-72.883416	945.1	154.3	337.4
BN23	73.65749	-72.047902	73.656704	-72.045407	1095.3	117.7	138.2
BN24	73.922518	-71.190787	73.923153	-71.191397	1165.0	73.3	345.1
BN25A	74.145348	-70.43486	74.146117	-70.433842	1512.7	91.2	19.9
BN27	73.61956	-73.844023	73.621041	-73.844181	901.6	165.4	358.3
BN28	73.893223	-73.014397	73.892243	-73.010335	867.4	166.7	131.0
BN29	74.163312	-72.161023	74.161647	-72.156562	996.9	230.2	143.8
BN30A	74.378413	-71.440343	74.378080	-71.438232	1206.3	73.6	120.3

Lateral drift during freefall shows significant scatter. Approximately half of all stations (17 of 30) show drift of less than 10% of water depth. Five stations have drift of greater than 15% of water depth, all of which are located at depths of less than 1000m, and two of which drifted further than 20% of water depth from their drop location. Station BN16 has particularly high lateral drift of 32.8% of water depth. Drift directions are predominantly NNW-SSE, with most stations drifting south from their drop location. This is consistent with the expected dominant current on the west side of Baffin Bay, which feeds into the Labrador Current further south. Significant tidal current was observed during the deployment operation, with the ship and nearby icebergs drifting at speeds of up to 2 knots at times.

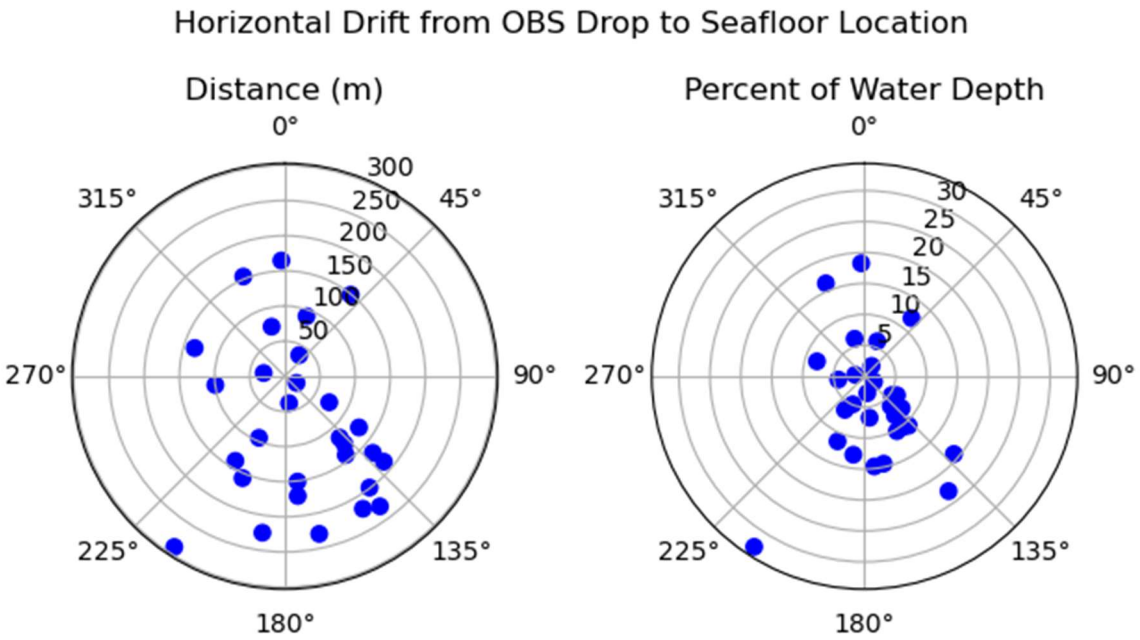


Figure 3-10: Horizontal drift measurements for stations in the main grid.

All instruments are fitted with an Apollo Mono Iridium GPS beacon and an XMB-11k VHF radio beacon. GPS position messages can be viewed through the XeosOnline portal or using the Hermes handheld receiver and are forwarded to an email alert list of key personnel. All VHF beacons are set to a frequency of 159.480 MHz. Each OBS includes an integrated Sonardyne acoustic transponder, for communication with surface vessels while deployed. The table below lists the instrument serial numbers, acoustic modem information and Apollo Mono GPS beacon serial numbers for the deployed stations present on the seafloor at the end of the cruise.

Table 3-3: List of OBS serial numbers, acoustic modem address and UID, and Apollo beacon serial number for all stations remaining on the seafloor.

Station	Serial Number	Modem Address	Modem UID	Apollo Mono S/N
BN01	AQU-FF61	5714	U007460	486
BN02	AQU-825E	5501	U0076A4	482
BN03	AQU-8559	5801	U007465	763
BN04	AQU-2164	5604	U0079CE	447
BN05	AQU-2A62	5505	U00730E	562
BN06	AQU-8363	5601	U0076A3	469
BN07	AQU-5461	5710	U0075FE	479
BN08	AQU-145A	5303	U00730A	451
BN09	AQU-F561	5513	U00730C	484
BN10	AQU-1B64	5103	U0079CB	480
BN11	AQU-195D	5803	U00730F	481
BN12	AQU-2964	5405	U007606	483
BN13	AQU-DB61	5411	U007311	628
BN14B	AQU-895A	5202	U006AEA	547
BN15A	AQU-2266	5704	U0076A7	545
BN16	AQU-0B62	5402	U0076A9	357
BN17	AQU-2564	5204	U0075F6	362
BN18	AQU-4561	5209	U006AD9	537
BN19	AQU-ED61	5213	U006AEB	364
BN20A	AQU-065D	5901	U007457	528
BN22	AQU-1764	5603	U006B02	557
BN23	AQU-BB5A	5207	U007467	532
BN24	AQU-1A62	5903	U00730D	418
BN25A	AQU-2D62	5805	U00730B	552
BN27	AQU-1F64	5404	U0076B5	415
BN28	AQU-D85B	5610	U007464	538
BN29	AQU-BA61	5306	U007469	541
BN30A	AQU-6366	5212	U0076A8	419
GL1	AQU-C260	5907	U0076A6	531

3.6 Vessel Track

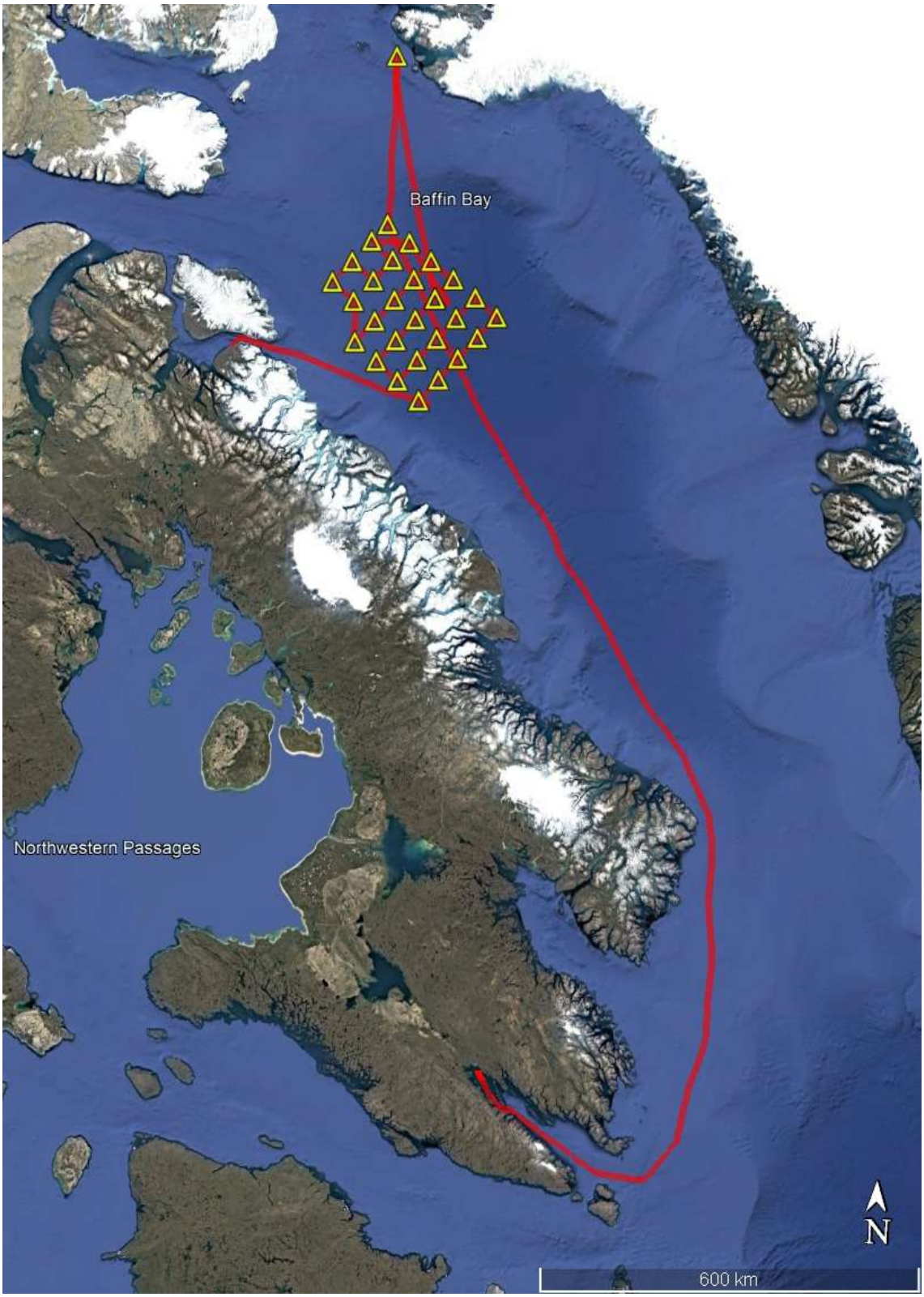


Figure 3-11: Full ship track (red). OBS locations are shown by yellow triangles.

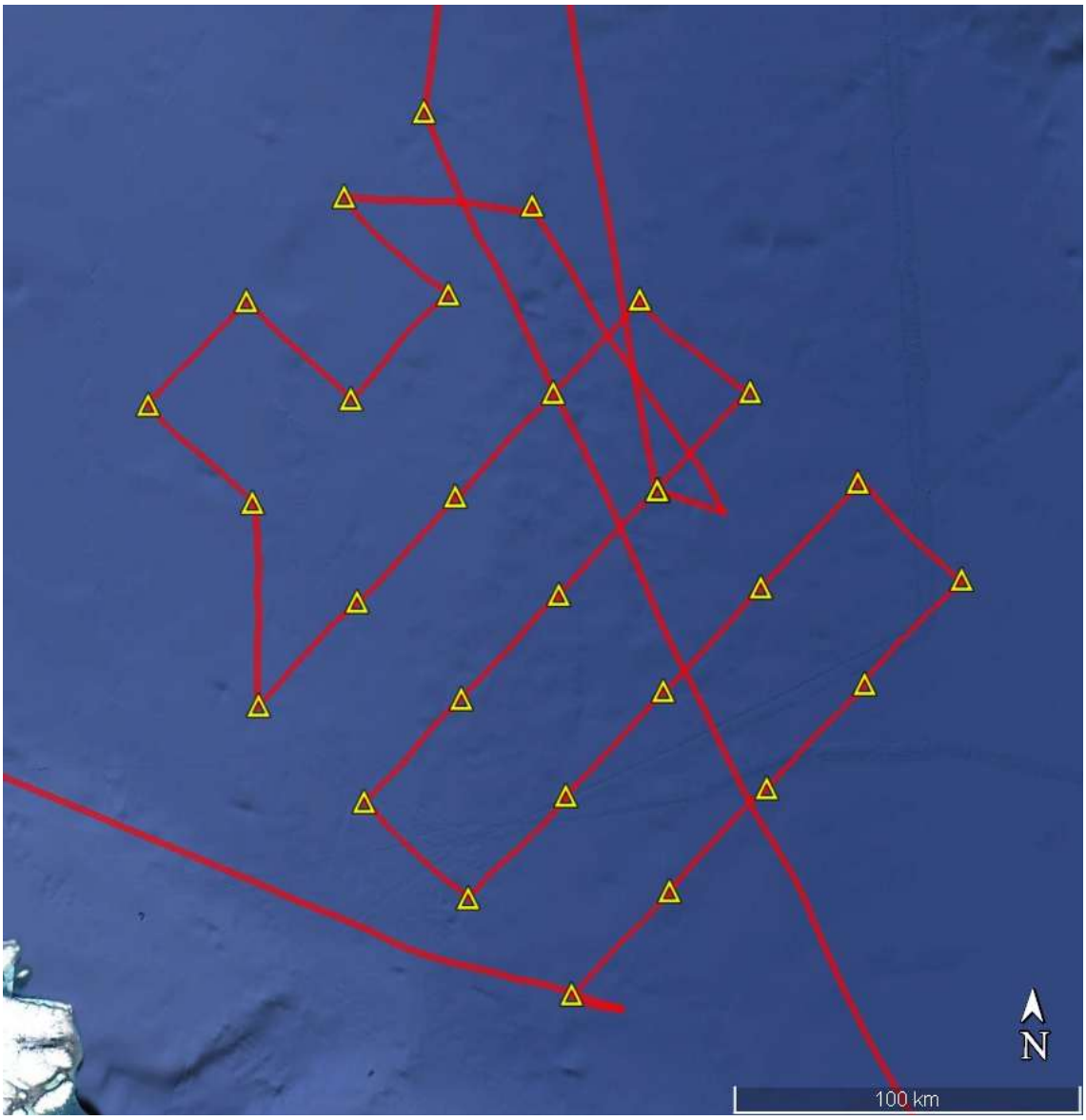


Figure 3-12: Detail view of ship track (red) through main grid of OBS locations (yellow triangles).

3.7 Demobilization

All NFSI equipment was offloaded from the ship by Mersey Seafoods staff and crew members in Liverpool, NS on October 3rd. Truck transport from Liverpool to Halifax was arranged by Leeway Marine on October 7th. Due to mechanical issues with the forklift at Mersey Seafoods, the truck did not arrive in Halifax until late afternoon. Accessory equipment was unloaded immediately at Dalhousie campus, but the empty stillage boxes from the OBS could not be unloaded at COVE on the same day due to unavailability of approved forklift operators after 4pm.

The truck arrived at COVE shortly before 8am on October 8th to unload all remaining equipment. During unloading, a wooden box containing spare ballasts was noticed to be missing. Follow up with Mersey

Seafoods located the box still aboard the ship. Alternate transport to return the box to Halifax was arranged by Mersey.

4.0 Discussion

Overall, this deployment operation was very successful. All 30 available BOBS were deployed, although one experienced a subsequent failure, for a total instrument utilization of 96.7%. Seafloor locations were surveyed for all stations immediately after deployment, obtaining good positional accuracy (<10m). The observed instrument failure appears to be related to an ongoing investigation by NFSI and the manufacturer of several other instrument failures during previous projects and will be thoroughly investigated.

The *Mersey Venture* proved to be well-equipped for BOBS deployment operations, with a highly experienced and professional crew. Recovery operations from this ship are likely to be more challenging, however, and may require the use of a zodiac as was done for the single recovery during this cruise. Acoustic noise was a significant challenge for the deepest stations. It may be possible to improve reception by moving the dunker forward (further from the ship's propeller), although this would require a significantly longer cable to account for higher freeboard.

We were very fortunate to have a long stretch of good weather for this operation. This is far from guaranteed or even expected in the Arctic, especially approaching the end of summer.

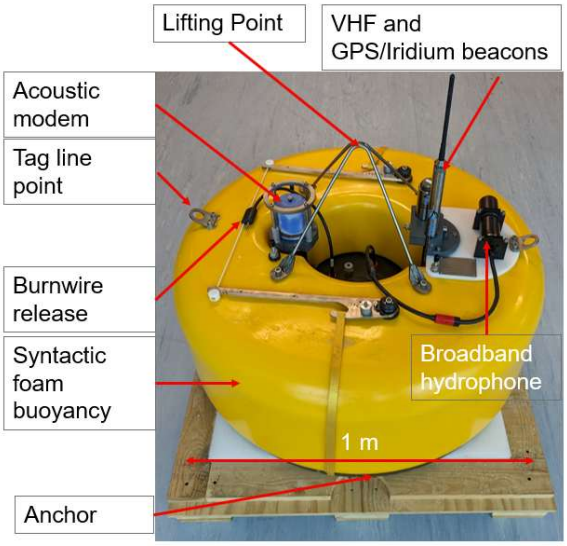
5.0 Lessons Learned & Best Practices

In two instances, station locations had to be moved after discovery of spatial restrictions for deployments, with too little time left to arrange appropriate permitting. Shortly before sailing, it was discovered that the northwest corner of the grid extended into a marine conservation area, requiring two stations to be relocated elsewhere. Then during deployment operations, it was found that the northeast edge of the grid crossed into Greenland national waters, affecting four stations. Such boundary issues should be thoroughly investigated during the scientific and operational planning process to avoid last-minute surprises.

Appendix A: Equipment Specifications

Aquarius Broadband Ocean Bottom Seismometers

The NFSI Aquarius Ocean Bottom Seismometers (OBS) are broadband devices made by Güralp Systems Ltd. The instruments are typically deployed in free fall mode, released from a surface vessel to sink to the seafloor under the weight of their detachable ballast, and return to the surface for recovery under their own buoyancy when the ballast is released via acoustic command.



Instrument weight 240kg + 90kg anchor
Sink rate ~0.6 m/s; Rise rate ~1.5 m/s

Specification	Number	Research Impact
Number of units	120+1	High resolution and coverage
Max deployment (months)	18	Allows long-term deployments needed for earthquake monitoring
Clock drift (us/day)	<30	Precise time-keeping over long deployments
Seismometer bandwidth	120s – 100Hz	Joint use for earthquake process and structure imaging studies
Dynamic range	24-bit	Able to record broad range of signal amplitudes
Hydrophone bandwidth	100s – 8kHz	Acoustic monitoring of microseismics and seafloor compliance
Communication	Acoustic Modem	Allows real time data to surface from SF instruments
Buyancy	Syntactic foam	Unsinkable once anchor is released

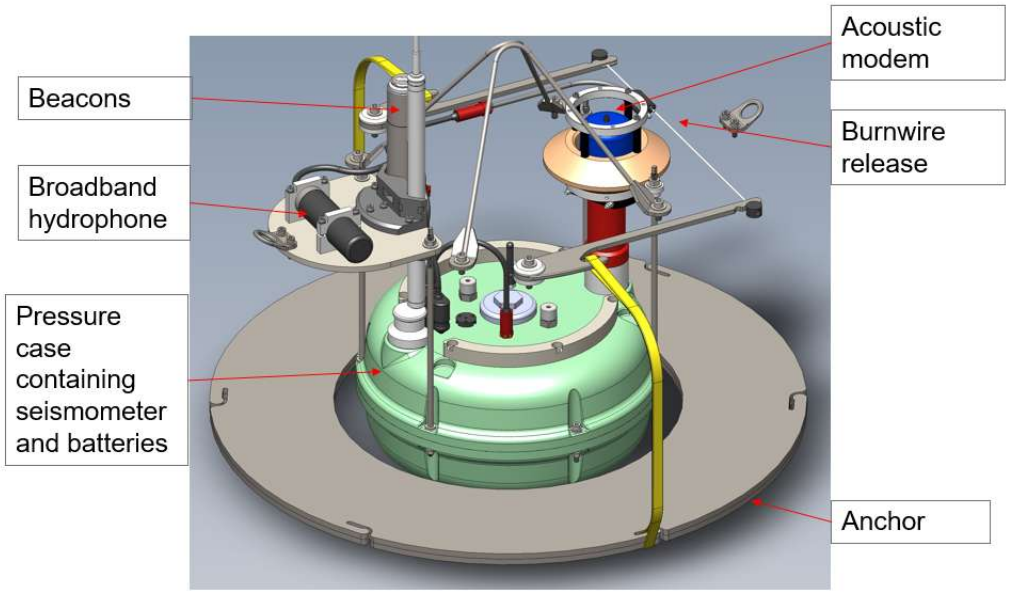


Table A-1: Güralp Aquarius OBS specifications, reflecting NFSI customizations.

Feature	Specification
Seismic sensor	• Broadband triaxial force-feedback sensor • Flat response from 120 s to 100 Hz • Nominal velocity response 2000 V/ms^{-1} • Tilt tolerance +/- 90 deg.
Absolute Pressure Gauge	• Keller PA-10L. Accuracy 0.25%
Hydrophone	• High Tech HTI-04-PCA/ULF • Passband 100 s to 8 kHz; Sensitivity -194 dB re: 1V/µPa. • NOT AVAILABLE FOR 2024 DEPLOYMENTS
Additional Channels & State of Health	• 3-comp digital compass composed of MEMS accelerometer and magnetometer • Temperature, humidity & supply voltage sensors
Data Logger	• Güralp Ultra-Low Power Digitizer board with Certimus computer.
Data Storage & Recording formats	• 128 GB dual redundant flash cards • Data stored in miniSEED format • Metadata stored in dataless SEED, RESP and StationXML format
ADC & Sample Rates	• 24-bit low-power 4 channel delta-sigma • Sample rate typically 250 Hz for seismic channels and 5 Hz for auxiliary sensors
Clock	• Double compensated microprocessor controlled TCXO • Locked to GPS time before each deployment • Uncorrected drift typically < 1 ms/day • Linear drift correction applied post-deployment
Power	• Lithium-Ion battery packs made up of 468 LG INR 18650 MJ1 cells • Total energy of 5954 Wh provides nominal autonomy of 15-18 months on seafloor, depending on application • Charge time approx. 1 hr/month of deployment
Acoustic Communication	• Sonardyne 6G LMF omnidirectional transceiver used for communication and positioning instruments on the seafloor • Used with surface transponder or USBL systems • Communication rates up to 9000 bps
Release Mechanism	• Burnwire triggered by acoustic command, timed release or critical battery level trigger
Recovery Tracking Beacons	• Xeos Apollo Mono Iridium GPS LED Flasher beacon • Xeos XMB-11K VHF beacon
Instrumentation Pressure Case	• 7000 series rolled aluminium, anodized • Pressure rated to 6000 m • Weight: 89 kg in air; 44.6 kg in seawater
Syntactic Foam Flotation	• Weight: 150 kg in air; 86 kg uplift in seawater
Ballast	• 10 mm + 15 mm steel plates • Weight: 89 kg in air, 77.4 kg in seawater
Full Instrument Weight/Buoyancy	• Air weight 239 kg instrument + 89 kg ballast = 328 kg • In-water weight: 44.6 + 77.4 – 86 = 36 kg • Buoyancy without ballast: 86 – 44.6 = 41.4 kg

Full Dimensions with Flotation and Ballast	• 1000 mm diameter cylinder • Height to top of buoyancy 459 mm • Height to top of lifting bar 725 mm
Sink/Rise Rate	• Sink rate 0.6 m/s, Ascent rate 1.5 m/s

Recovery Devices

The NFSI Aquarius OBS are equipped with recovery beacons made by Xeos Technologies Inc. These beacons are surface activated and autonomous, providing a margin of safety should the OBS batteries become depleted or the software malfunction. Two types of recovery beacons are used: an XMB-11k VHF beacon and an Apollo Mono Iridium GPS/LED Flasher beacon.

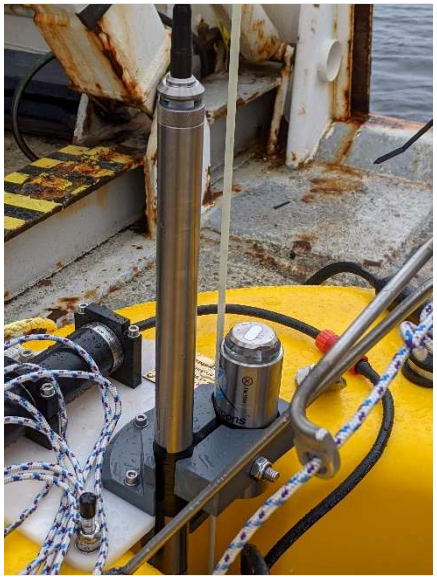


Figure A-1: Recovery devices mounted on OBS. XMB-11k VHF beacon on left, Apollo Mono GPS/LED/Iridium beacon on right.

The XMB-11k emits a VHF radio signal that can be localized using a receiver equipped with a directional Yagi antenna to ranges of up to 12 km for a duration of typically 5 days (dependent on pulse length and repetition frequency) after surfacing. For the OBS deployments discussed in this report, all XMB-11k's were configured to 159.480 MHz.

The Apollo Mono transmits its GPS position via the Iridium satellite network and has an LED flasher for visually locating the instrument at night. For the first hour after surfacing, the Apollo will send positional updates every 10 minutes, then switch to hourly updates. Instrument positions can be tracked via an online portal or with a handheld Xeos Hermes receiver. Positional update frequency and LED activation can be reconfigured remotely through the Iridium link to extend battery life. The Apollo is powered by a primary lithium battery. Communication longevity will depend on update frequency and sea conditions, but with daily updates for a drifting instrument will be more than 1 year.

Positioning Systems

NFSI brought a Sonardyne Modem 6 Mini-Dunker LMF LBL and Telemetry Transceiver System Type 8244-3156 on the NFSI-010-2024-04 cruise to communicate with OBS instruments and determine their position on the seafloor. This dunker model is directional for improved noise performance. An omni-directional Modem 6 Mini-Dunker (type 8244-3155) was used solely for on-deck testing of acoustic communication with each OBS during pre-deployment programming.

The dunker is operated by lowering it over the side on the end of a cable. It is nominally able to communicate with instruments to depths of 6000m. It works as an acoustic modem to communicate with instruments on the seafloor or in the water column and can provide range measurements but not direction. Ranging can be used to position instruments with acoustic triangulation by moving the ship to measurement points that provide geometric constraint.

Table A-2: Sonardyne Modem 6 Mini-Dunker Type 8244-3156 Telemetry Transceiver System Specifications

Feature[1]	
Transceiver depth rating	3,000 m
Operating Frequencies	LMF (14-19 kHz)
Transducer Beam Shape	Directional
Transmit Source Level (dB re 1 μPa @ 1 m)	190-196 dB
Tone Equivalent Energy (TEE)	196-202 dB
Range Precision	Better than 15 mm

As listed on Sonardyne datasheet

Appendix B: Vessel Technical Specifications

Vessel Name: FV Mersey Venture
Official Number: 8714358
MMSI: 316065000
Call Sign: CFD2073

General Operation	Specifications
Vessel Class: Fishing - Trawler Home Port: N.S. - Liverpool Owner: Mersey Seafoods Ltd Ice Class: 1B	Length (m): 63.0 Breadth (m): 14.2 Draft (m): 7.6 Freeboard (m): 7 from winch deck Gross Tonnage (t): 2337 Net Tonnage (t): 1216 Cruising Range (nm): 12,000 Endurance (d): 60-65 Cruising Speed (kts): 10 Maximum Speed (kts): 13.5 Main Hoist: ABAS Deck Crane SWL (t): 5
Crewing Regime Crew: 13-26 Berths Available: 35	

Appendix C: Cruise Log

Date	Time	Type	Comment
Sun. Sept 8th	1100	Travel	Katie, John & Graeme fly Air Canada to Ottawa, then Canadian North to Iqaluit
	1900	Travel	Overnight in Iqaluit hotels
Mon. Sept 9th	1100	Travel	K, J & G transit Iqaluit to Pond Inlet via Canadian North airline.
	1615	Travel	Arrive in Pond Inlet. Picked up after lengthy wait for driver who took us to pier where we were met by crew in zodiac. Shuttled to ship 2 at a time.
	1800	Planning	Discussion on bridge about trawler tracks showing in their nav software - difficult to tell whether these cross into grid and whether we need to move instruments accordingly. Emails to Alex and Mladen. Nav files exported but in proprietary format. John will try to parse out trawler tracks for import into OpenCPN. Decision to start at BN01 in southern corner, and work east to deep sites, giving time for decision about whether to relocate sites near trawler tracks. Begin transit immediately to BN01 at ~4.5knts. ETA 09-11 ~7am.
Tues. Sept 10th	0800	Navigation	Very slow transit to first station BN01, steaming at ~4.5 kts
	0900	Setup & Logistics	John running awk parsing program to extract trawler tracks from OLEX files, for importing into OpenCPN so we can plot with survey grid to see how much they overlay. Katie, John & Andre setting up lab in ship's office beside staging deck, and dunker bunker in container on main deck near access door from which dunker can be lowered. 3 OBS moved from lower deck to staging area, testing crane procedure. G mostly on emails, procurement, arrangements for recovery of 2 BC drifters.
	1230	Safety	Safety tour of vessel
	1700	Setup	Setup fairly complete. John continuing to parse OLEX tracks.
Wed. Sept 11th	0400	Navigation	Ship passed station BN01 a bit ago, transiting back and forth slowly until daylight for first deployment. Katie begin programming for first two OBS to prepare.
	0600	Weather	Beautiful - sunny, wind mild, sea calm.
	0600	Shift Change	Start OBS watches. On watch: Katie and Andre.
	0752	BN01	AQU-FF61 in water. NOTE case to ground recorded as 0.050V. Map depth 1737 m. First deployment of cruise. Good crane handling and release performance. Instrument needs to be submerged, taking weight off, for release to open.

	0936	BN01	Location survey complete. Low SNR due to ship noise (can't be declutched as generator is driven by shaft) but mostly ok.
	1200	Shift Change	K&A to J&G
	1200	Weather	Sunny, low wind, calm sea.
	1234	BN02	AQU-825E in water. Map depth 1905m
	1433	BN02	Location survey complete. Transit to BN03
	1818	BN03	AQU-8559 deployed. Map depth 2196m
	2104	BN03	Location survey completed. Low SNR, spotty comms. Ship drifting during survey, at one point dragging dunker under ship until repositioned. Transit to BN04
Thurs. Sept 12th	0000	Shift Change	J&G to K&A
	0028	BN04	AQU-2164 deployed. Map depth 2330 m.
	0256	BN04	Location survey complete. SNR low. Drifting quite a bit during survey. Only able to get 5-8 pings per location. Transit to BN05.
	0620	BN05	AQU-2A62 deployed. Map depth 2351 m (deepest site).
	0815	BN05	Location survey complete. Transit to BN10.
	1110	BN10	AQU-1B64 in water. Map depth 2293 m.
	1130	BN10/Tech Issue	Instrument in descent. Comms good but erratic clock reports from instrument with offsets of up to 45 mins. Backup release switched over to July 2026.
	1200	Shift Change	Katie & Andre to John & Graeme.
	1200	Weather	Overcast. Wind & waves have picked up. Wind ~17kts, waves ~1.5-2.0m. Some whitecaps.
	1230	BN10	Poor comms with SF instrument. Can't get status, only a few pings. Bridge reports that we've drifted ~1.2 nm from drop point, so probably outside acoustic cone. Repositioning ship to ~600m from drop pt.
	1300	BN10	Comms good at new location. Status update confirms backup time reset. SNR of 4.
	1337	BN10	Location survey complete.
	1340	Deck Logistics	Moving 2 instruments from storage area to level 2 deck staging area. Transiting to BN09. Speed 8.90 kts with wind on quarter. ETA 16:10.
	1627	BN09	AQU-F561 in water. Map depth 2183 m.
	1800	BN09	Location survey finished. Backup timer reset on descent.
	2118	BN08	AQU-145A in water. Map depth 1951 m.
	2145	Deck Logistics	Moving 2 more instruments from storage to staging area while instrument sinks.
	2324	BN08	Location survey finished.
Fri. Sept 13th	0000	Shift Change	John & Graeme to Katie & Andre.
	0000	Weather	Foggy but seas moderate.
	0228	BN07	Deployed AQU-5461. Map depth 1754m. (NOTE case to ground 0.09V)
	0308	BN07	OBS at seafloor. Ship drifted ~700m WSW during freefall, able to start survey immediately.

	0358	BN07	Location survey complete. Starting transit to BN06.
	0634	BN06	AQU-8363 in water. Map depth 1389m
	0705	BN06	OBS at seafloor. Ship drifted ~500m WSW during freefall, able to start survey immediately.
	0757	BN06	Location survey completed.
	0800	Deck Logistics	Moving 2 more OBS up to staging area before starting transit to BN11.
	1047	BN11	AQU-195D in water. Map depth 1078.
	1159	BN11	Location survey completed. Proceeding to BN12.
	1200	Shift Change	K&A to J&G.
	1200	Weather	Overcast and grey, but wind and seas have calmed since yesterday.
	1437	BN12	AQU-2964 in water. Map depth 1358 m.
	1552	BN12	Location survey completed.
	1600	Deck Logistics	Moving 2 more OBS from storage to staging. Transiting to BN13.
	1828	BN13	AQU-DB61 Deployed. NOTE case to ground 0.045V. One of the taglines got tangled when being pulled off, so instrument pulled up, tagline untangled, instrument re-lowered and released.
	1828	Weather	Getting colder, but wind & seas fairly calm.
	2021	BN13	Location survey completed. Transit to BN14.
	2320	BN14	AQU-555C deployed. Map depth 1889m.
Sat. Sept 14th	0000	Shift Change	John & Graeme to Katie & Andre.
	0000	Weather	Fairly calm. Ship drifting significantly due to tide.
	0015	BN14	Unable to get comms from current location (drifted ~700m from drop location during freefall). Try moving back to drop location to get seafloor status (should have landed around 0002).
	0034	BN14	Established comms near drop location. Very close, but drifting quickly to SE. Start survey and let it run out until we're far enough away or we lose comms.
	0150	BN14	Survey complete. Added a 4th point to even out geometry. All points are a little on the close side, but not bad. Pressure reading from seafloor 5700m, Keller sensor obviously acting up for this one so unreliable. Depth should be ~1930m based on survey result.
	0400	Site Change	1st Mate noticed the remaining stations of the NE line of the grid (BN15, 20, 25 and 30) are actually within Greenland national waters. We don't have permits to deploy there arranged (Andre says it took DRDC over 4 months to get the permit for the fjord instruments), so will have to shift all 4 stations to the SW. The shift for stations 15 and 20 (next 2 deployments) is only 1-1.5 nm, but the other stations are further. Moved targets for BN15 and BN20 to 1 nm SW of the national water boundary.
	0440	BN15A	Deployed AQU-2266. One tagline snagged on first deployment attempt. Brought the OBS back up to the rail to reset taglines. Second deployment attempt successful.

	0500	BN15A	Dunker not connecting to deck unit when first deployed for comms at BN15A. Pulled back on deck and checked cable, then working normally.
	0630?	BN15A	Location survey complete
	0700	Nav Tech Issue	GPS feed to Framework laptop cut out shortly before BN15A went in the water, wasn't noticed until back in the office after survey. Rebooted laptop to restart, but missing a section of the feed from the recording.
	0933	BN20A	Deployed AQU-065D. Map depth 1804m.
	0933	Weather	Fog coming up a bit, but otherwise weather still good.
	0945	Dunker Tech Issue	For comms, dunker got a few pings initially but then stopped connecting to deck unit before first status message obtained. Pulled up and checked cable, then working normally again for remainder of freefall and first survey point.
	1045	Dunker Tech Issue	Dunker not working at 2nd survey point, unable to connect to deck unit. After a few minutes of handling cable and unplugging/replugging connectors, swapped to other dunker cable (from omni). Working normally for remainder of survey with alternate cable.
	1148	BN20A	Location survey complete.
	1200	Shift Change	K&A to J&G.
	1200	Weather	Light fog, little wind and calm sea. Fog "rainbow" from light diffraction.
	1230	Deck Logistics	2 OBS being moved from storage to staging deck.
	1416	BN19	AQU-ED61 in water.
	1430	BN19	Ship drifted > 1km during OBS descent, dunker pulled under ship, lost comms. Repositioned, arriving at first survey point just before instrument reached bottom.
	1543	BN19	Location survey complete.
	1820	AQU-6366 Tech Issue	Arriving onsite BN18, during post-deploy software checks AQU-6366 showing 0.199V steady from anode centre to burnwire ground. Tried toggling burnwire acoustically, but no change. Disabled hydrophone power through console command. No change. Disconnected cable in case of power leakage from POE or ethernet. No change. Dropped slightly to 198.3 mV. Decided to hold back from deployment and switch to AQU-4561 which was on standby. Later tried using Andre's Fluke voltmeter and got 0.197V - voltage may be dropping with time or could be difference in voltmeters. Will try again later.
	1907	BN18	AQU-4561 in water.
	2000	AQU-6366 Tech Issue	AQU-6366 debugging: checked again with NFSI voltmeter: 0.198V. Took anode dummy out, still 0.198V. Put mag switch in, voltage immediately dropped to 0V once mag plug deep enough to toggle reed switch. Pulled plug slowly out, voltage jumped to 0.202 then stabilized at 0.198V. Repeated exercise with identical result. Left with mag plug inserted.

	2000	Planning	Will hold back AQU-6366 unless anomalous voltage resolved, removing northernmost station to accommodate. Must make sure before leaving main grid that instrument intended for Greenland Fjord is fully operational. Possibly open up AQU-6366 during transits to and from Greenland. If fixed, deploy at northernmost site of main grid during return trajectory.
	2045	Deck Logistics	Flag and move defective AQU-6366 back to storage area, accessible for further testing. Move 3 more OBS from storage to staging deck. AQU-2564, 0B62 & 1764.
	2200	Tech Issue	During tests of AQU-2564, having a lot of trouble getting omni to work with damaged cable. Problem seems to be in loop between strain relief and molded joint, but can be coaxed to work when bent to some angles. Improvised zip-ties to pull cable to angle where contact works, but it's a precarious fix.
	2300	Tech Issue	Arriving on BN17 site. GPS lockup in OpenCPN. Probably driver on laptop for John's adapter card. Reboot laptop. Still no feed. Reinsert USB and get feed but OpenCPN lockup on relaunch. Restart OpenCPN again and it's ok.
	2314	BN17	AQU-2564 in water (with RD's previously mounted on retired AQU-6366.)
Sun. Sept 15th	0000	Shift Change	J&G to K&A
	0000	Weather	Very calm seas, not much wind
	0023	BN17	Survey complete
	0245	BN16	Coming up on station, rigging up OBS. The current is very strong right now. There's a huge iceberg very close to us moving at about 2kts.
	0258	BN16	AQU-0B62 deployed, smooth release
	0316	BN16	Ship is drifting SW quite a bit during freefall, moved ~600m in first 13 minutes after release. Lost contact with OBS shortly before it should have hit bottom, at about 1km distance from drop point (likely outside directional dunker cone of reception).
	0412	BN16	Survey complete. OBS drifted ~250m SW from drop location.
	0420	Deck Logistics	Moving 2 OBS to staging area (replenish numbers). Waited for ship to turn around for transit before using crane.
	0450	Tech Check	Plug in to AQU-C260 for testing, check that OBS is fully functional in preparation for Greenland fjord deployment.
	0500	Planning	Rough estimation of timing for remaining 8 stations of the grid. Expecting to finish at either BN29 or BN25 around 1700 on Monday (tomorrow). Roughly 2 hour transit from BN29 to Greenland national waters. Andre needs to send first notification paperwork 24-36 hours before entering Greenland waters, so will send shortly after lunch today.
	0530	Weather	Current very strong this morning. Propeller blades at 0 degree pitch and traveling 10 kts. Brandon had minimal thrust at beginning of transit and got speed of ~12 kts.

	0610	Tech Check	Acoustic, burnwire and voltage checks for AQU-C260. All tests pass, verified for deployment in the fjord. Label and unplug, will move down to stillage box after next deployment.
	0723	BN22	AQU-1764 deployed. Map depth 951m.
	0730	BN22	Drifting at a decent clip during freefall, almost due North.
	0853	BN22	Survey complete. OBS drifted ~100m north from drop location.
	0900	Deck Logistics	Move AQU-C260 back down to trawl deck, secure in stillage. Move 2 more OBS up to staging area.
	1133	BN27	AQU-1F64 in water. Map depth 899m.
	1200	Shift Change	K&A to J&G
	1200	Weather	Seas almost flat calm, no wind. Can see mountains in distance. A few small icebergs scattered around.
	1233	BN27	Location survey complete. Ship drifted NW ~400m from drop location during freefall, so able to start survey right away.
	1459	BN28	AQU-D85B in water. Smooth release. Map depth 862m (2nd shallowest site). Large low iceberg off port side, the size of a small island.
	1820	BN28	Location survey complete.
	1600	Safety Drill	Testing fire pump on afterdeck (very noisy!). Also discussion with chief engineer about lift equipment to disassemble AQU-6366 and vacuum testing on reassembly. Aside: Engineer says ship's fuel consumption is ~7000 L/day of diesel at current speeds (~7.5 knts typical).
	1615	Deck Logistics	Moving 2 more OBS from storage to staging deck. AQU-BA61 and 1A62.
	1615	Weather	Flat calm, sunny, mild.
	1837	BN23	BB5A in water. Map depth 1083m. Tag line jammed during removal. Pulled back up, removed taglines, and re-lowered without taglines for release.
	1926	Tech Issue	GPS feed lockup to OpenCPN. Reboot laptop and it's back immediately.
	2006	BN23	Location survey complete.
	2024	Instrument Surfaced	Just noticed that AQU-555C Apollo 446 from station 30-14 surfaced at 1400 local time (1700 UTC) and is drifting. It has already moved 3.6 nm. This is the OBS that had a defective pressure gauge.
	2154	Planning	Decide that it's better to sacrifice instrument on corner of grid (#30) and use it to infill hole in grid created at #14. Therefore plan to skip #30, proceed straight to Greenland after deploying at #25, deploy in Greenland, then deploy at #14 and pick up drifter on way back in whichever order is most convenient. If drifter enters Greenland waters, we will stay in Greenland waters until we recover it to avoid exit/re-entry requirements. Email to Mladen & Alex to confirm this plan. Discussed with Captain, and later Danny. Both are fine with the plan. According to Windy, weather will pick up next Friday, but we should be up to Greenland and back well before then - probably Wed. to

			pickup/redeploy area. Captain prefers pickup at night if possible to see flasher, which we agree with. Discussed how to pick up - hooking from side door or using zodiac. Captain says no problem deploying zodiac at night - they do it all the time. Will probably try first from side door and use zodiac if necessary. Crew jokes that it's a good man overboard recovery exercise.
	2230	Deck Logistics	Moving one OBS from storage to staging. Setting aside the second that had been intended for the main grid to storage pending redeploy at BN14. Deck crew prefers this to keeping it in staging area for a few days in case we have rough weather in transit.
	2249	BN24	AQU-1A62 in water. Map depth 1178m.
	2324	Surfaced Instrument	Sent command to Apollo 446 (AQU-555C) to lower update rate from 1hr to 3hrs and turn flasher off to conserve batteries. Signal from L205 on R/V Atlantis shows it approaching San Diego.
	2400	BN24	First survey point complete. Shift change.
Mon. Sept 16th	0000	Shift Change	J&G to K&A
	0000	Weather	Sea flat calm, no significant wind.
	0032	BN24	Survey complete
	0130	Planning	Discussion of plan for recovery of AQU-555C. Distance from BN25 to latest position is ~50nm. The engineers would like to take the ship at full steam for a bit, which would make this a roughly 4 hour transit. Current estimate puts us at drifter location ~1330 today. Could drift a long way in the 26+ hours it would take to get to Greenland and back, so would be nice to recover sooner rather than later. We will plan to recover today, and likely deploy replacement OBS just after to avoid needing to come back later. Change position update frequency back to 1 hour at next contact (0300) and then up to 10-15 minutes when we start transit for recovery.
	0206	Surfaced Instrument	Sent command to Apollo #446 to update position at 1 hour interval. Should take effect at 0300 contact.
	0318	BN29	Deployed AQU-BA61. Flat calm, hardly any ripples in the water's surface.
	0340	BN29	OBS on bottom. Ship drifted 350-400m SSW during freefall, able to start survey immediately.
	0423	BN29	Survey complete. Ship will transit at close to full speed for ETA of 0700 at BN25A.
	0430	Deck Logistics	Move AQU-895A up to staging area to prep for replacement deployment at BN14.
	0520	Tech Issue	GPS feed to OpenCPN froze. Restarted Framework laptop and working again. Laptop seems to need full power down and then power back up (not Restart option) to detect external monitor.
	0707	BN25A	Deployed AQU-2D62. Beautiful sunrise backdrop. Had to dodge a big iceberg on the approach to drop location.

	0745	BN25A	Last status message during freefall at depth 1460m. Lost contact for a few minutes after, missed touchdown. Final status depth 1509m.
	0840	BN25A	Survey complete
	0920	Navigation	Gave newest position for 555C to bridge. Starting to move more East rather than SE. ETA 1400. Plan to increase update frequency to 10 or 15 minutes at 1100 or 1200, unless it starts moving more quickly or erratically.
	1137	Surfaced Instrument	Sent command to Apollo #446 to increase update position at 15 min interval. Should take effect at 1200 contact.
	1200	Shift Change	K&A to J&G nominally, but dropping watch schedule as we are no longer in 24 hr ops. K staying up for drifter recovery & to normalize schedule.
	1200	Weather	Steely grey sky and sea, but flat almost glassy calm. Calmest day so far.
	1353	Surfaced Instrument	Drifter spotted on radar in flat sea. Soon visible from bridge, framed by two background icebergs.
	1410	Surfaced Instrument	Drifter abeam. Zodiac in water.
	1418	Surfaced Instrument	Drifter on deck.
	1435	Surfaced Instrument	Connected to 555C through acoustic modem. Got status, all normal except pressure reading (which had gone defective during deployment descent). Power and voltage readings nominal, inconsistent with Phil's theory that wetting caused coulomb counter misreadings, triggering release.
	1445	Surfaced Instrument	Connected to 555C with cable. Serial communications garbled. Commands from deck unit through console partially garbled, although some able to get through. Comms back clear, but there's crosstalk between Femtomus response and Minimus messages. Want to offload data to check humidity channel, but not able to with serial comms problem.
		BN14B	Turning attention to redeployment at BN14 with AQU895A replacing 555C drifter.
	1544	BN14B	AQU-895A in water.
	1630	Planning	Discussed disassembly of 6366 with deck crew. Plan to use crane to remove buoyancy, then set up overhead lift in tool room beside storage area with either electric winch or chain lift.
	1715	Surfaced Instrument	Turning attention back to 555C briefly between location survey stations, now getting zero response from instrument through either console or acoustically. Will try mag switch reset once we are done with BN14B positioning, but instrument seems to be dead.
	1727	BN14B	Location survey completed
	1730	Planning	Heading for Greenland fjord. ETA ~1400 tomorrow. Plan to deploy ~1 nm NW of site where DRDC deployed another instrument, in deeper water. Andre says ~600m.

	1830	Tech Issue	Taking apart 6366 to investigate voltage between pressure case and ground.
	2400	Tech Issue	Used crane to lift off buoyancy, and then to move pressure case near workshop. Hand carried pressure case into workshop. Disassembled with use of overhead chain lift. On removing lid interface board, found nick in yellow wire going to pressure sensor where it had been pinched by lid screw. Some strands in the wire appear broken, but enough remain to keep wire. Isolated pinched section with shrink wrap, then very carefully reassembled. Connected deck unit and removed mag plug. Voltage to ground now seems ok (1-2 mV, bouncing around). Everything nominal. Opened up again, cleaned O-Ring surface and O-Rings, then closed. Set up pump borrowed from crew for vacuum test, however O-ring connector on vacuum system not a very good fit for our system. Ran vacuum to 40 Pa, and tightened clamshell connecting bolts with benefit of vacuum. Pressure slowly climbed, but we're confident the clamshell O-rings are good - we did them very carefully - and the leakage is due to the vacuum system, not the pressure case. Trying with Teflon tape added to threads of vacuum connector.
Tues. Sept 17th	0400	On Shift	Katie in office, calculating location survey results and checking test results for AQU-6366.
	0400	Weather	Wind and waves a bit more than previous days, but still fair. A few small whitecaps.
	0430	Tech Issue	AQU-6366 pressure test has been running since midnight. Trend looks normal, flattening off around 43 kPa.
	0800	Deck Logistics	Moving AQU-C260 up to staging area to prepare for Greenland fjord deployment. ETA 1230.
	0900	Weather	Very light snowfall. Mountains of Greenland in sight on the horizon.
	1000	Tech Issue	Partial run-through of post-maintenance checklist for AQU-6366. Passing tests so far.
	1252	GL1	AQU-C260 in water. Depth sounder depth ~505 m. 76 35.5379' N, 71 01.0537' W. Tidal current very strong (~10.5 kts, according to bridge).
	1304	GL1	Instrument on SF
	1339	GL1	Location survey complete. Heading back to BN30 location at 8-9 kts to deploy AQU-6366 after repair. ETA 0700.
	1400	Tech	Reassembling 6366, using crane to move pressure case and then mount buoyancy. Moved 6366 to staging deck in preparation for deployment tomorrow AM.
	1830	Planning	Meeting on bridge to discuss what to do about 3 trawlers on their way to around the survey area. Apparently between them they can tow a swath 450m wide going at about 3 knots, with which they can "mow the lawn" on the SF, and can apparently go to ~1400m, deeper than we expected. Question whether to send out a marine alert with rectangle denoting survey area,

			but this would cover a very large area. There are only about 4 instruments on the western side of the grid that are probably at risk. The first mate knows the captain of one of the boats. He will send them a snapshot of our survey grid and ask if that conflicts with their trawling plans. There are apparently no other ships that could do this sort of trawling in this area.
Wed. Sept 18th	0400	On Shift	K&A on shift to start setting up AQU-6366 for deployment
	0400	Weather	Calm seas and wind. Sky clear other than at the horizon, almost full moon shining brightly.
	0754	BN30A	Deployed AQU-6366
	0911	BN30A	Survey complete. Collected FFT noise info with dunker after done pinging at final point (every 3s for ~2 minutes).
	0915	Navigation	Start transit to Iqaluit. ETA Sept 24th.
	1245	Administration	Send NAVWARN request to Iqaluit MCTS office with all seafloor locations.
Thurs. Sept 19th	0600	Weather	Very calm. Looks as though the ship is not moving despite traveling at ~6kts.
	0630	Tech Issue	Found GPS feed on Framework laptop frozen. Had to restart laptop a few times to re-establish, working again ~0645. Approximately 36.5 nm of the track is missing, so was likely out for ~6 hours. Current position ~14.5 nm south of station BN03.
	0705	Administration	NAVWARN for array was issued yesterday afternoon, but the coordinates published for BN02 are incorrect. Sending a followup email to fix this with MCTS.
Fri. Sept 20th	0630	Demob	Katie cleaning and packing some cables no longer needed (Aquarius data cables, dunker setup from container).
	0900	Administration	Katie compiling cruise report draft.
Sat. Sept 21st	0630	Administration	Continue compiling cruise report draft.
	0830	Demob	Packing tools and supplies from ship's office.
Sun. Sept 22nd	0630	Demob	Packing some more equipment, move toolbox and extra flags from office down to rigging room.
	0830	Administration	Working on cruise report draft
Mon. Sept 23rd	0630	Demob	Pack most remaining equipment (leave office deck unit and GPS for recording ship track for now).
	1300	Administration	Working on cruise report
Tues. Sept 24th	0400	Navigation	Made the turn into Frobisher Bay, slowly approaching Iqaluit.
	0900	Administration	Contacted Xeos tech support to deactivate extra Apollo beacons and Hermes.
Wed. Sept 25th	0400	Navigation	Arrived near Iqaluit harbour. Too early to head in, transiting back and forth slowly.
	1300	Demob	Andre offboarding via zodiac.
	1300	Demob	Pack up remaining deck unit and field laptop. Load all accessory equipment into empty stillage boxes for transit and demobilization.

Thurs. Sept 26th	0700	Demob	Boarding zodiacs with luggage to go ashore. Unable to access downtown dock due to low tide, dropped off at government wharf on south side of harbour instead.
	1100	Travel	Katie, Graeme & John travel from Iqaluit to Ottawa via Canadian North airline. John continue on to Halifax via Air Canada.