CRUISE REPORT

RRS Discovery Cruise DY182

OSNAP Program
August 02 - Aug. 27, 2024
Reykjavik, Iceland to Reykjavik, Iceland

1. Introduction, Objectives, and Outcomes

The Overturning in the Subpolar North Atlantic Program (OSNAP) is an international program designed to provide a continuous record of the full-water column, trans-basin fluxes of heat, mass and freshwater in the subpolar North Atlantic. It is a collaborative program among science teams from several nations, including the U.S., U.K., the Netherlands, Germany, Canada, and France. The OSNAP observing system consists of two legs: one extending from southern Labrador to the southwestern tip of Greenland across the entrance of the Labrador Sea (OSNAP West), and the second from the southeastern tip of Greenland to Scotland (OSNAP East). The observing system also includes subsurface floats in order to trace the pathways of overflow waters in the basin and to assess the connectivity of currents crossing the OSNAP line. Cruise DY182 was the third Netherlands-sponsored cruise working along the OSNAP East line onboard of the Natural Environment Research Council (NERC)'s RRS Discovery. Scientists from the U.S. (University of Miami) and the Netherlands (NIOZ and Utrecht University) participated in this cruise.

DY182 objectives:

1. To perform mooring operations along the OSNAP East line between the Iceland and Irminger basins, including recovery of 12 currentmeter/hydrographic moorings and redeployment of 9 moorings.
2. To conduct standard CTD (Conductivity-Temperature-Depth) and Lowered ADCP (Acoustic Doppler Current Profiler) stations at approximately 42 sites along the same mooring line.
3. To acquire continuous underway data (vessel-mounted ADCP data, meteorological data, and surface temperature and salinity data) along the cruise track, and to perform selected additional CTD stations along the cruise track for instrument testing and calibration.

DY182 outcomes:

1. Successful mooring operations along the OSNAP East line between the Iceland and Irminger basins, which included the recovery of 11 currentmeter/hydrographic moorings and redeployment of 9 moorings.
2. A total of 40 standard CTD (Conductivity-Temperature-Depth) and Lowered ADCP (Acoustic Doppler Current Profiler) stations were obtained along the same

mooring line, and 20 extra stations were performed farther north along the Reykjanes Ridge (referred to as the "RR North Section").

3. Continuous underway data (vessel-mounted ADCP data, meteorological data, and surface temperature and salinity data) along the cruise track, and 4 additional CTD stations were performed for instrument testing and calibration totaling 64 CTD-LADCP stations throughout the cruise.

2. Cruise Synopsis

The cruise departed from Reykjavik harbor at 1000 UTC on August 2nd and the ship got underway toward the first planned CTD station along the OSNAP line. (All times listed in the remainder of this report are in UTC, which was also the time zone used for local time onboard the ship for the duration of the cruise.) At 2132 UTC on August 2nd the ship stopped in the northern Iceland Basin once we crossed the 1000 m isobath to perform a test cast for the CTD/LADCP profiling system (CTD001). 13 U. Miami SeaBird microcat (SBE37) instruments and one EdgeTech acoustic releaser were attached to the CTD-LADCP-Rosette system for testing of the effect of antifouling plugs leakage in the conductivity cell and acoustics communications, respectively (Figure 1). The CTD was lowered to 1005 m and the 12 Niskin bottles were all fired near the bottom. Once retrieved, the rosette was secured inside the CTD hangar, the Niskin bottles were inspected for leaks, bottle salinity samples were drawn for demonstration for all the shift supervisors and watch standers that were not feeling seasick, and the CTD sensors and LADCP were checked for functionality.

The work along the OSNAP line started at 0510 UTC on August 04th with CTD 001 in the central Iceland Basin, which was one of several calibration-dip casts (hereafter "caldip" casts) done on the cruise for the numerous SeaBird microcat (SBE37) instruments that were to be deployed on the moorings. On these casts, microcats were mounted on the CTD frame using custom made microcat clamps that can be used to easily replace a Niskin bottle position on the frame. In addition, these CTD casts were performed in normal fashion except that the bottle stops on the upcast were approximately 10 minutes long, with 6 such bottle stops done on each caldip cast. The temperature, conductivity and pressure measurements from the microcats and the SBE911+ CTD were then compared during the bottle stops to check the calibration of the microcats. As many as 24 microcats were mounted on the CTD frame for these casts.

The strategy for the mooring operations was to start in the central Iceland Basin with the most eastward of the University of Miami moorings and work westward across the Reykjanes Ridge to the NIOZ Irminger Sea moorings. In between the mooring operations, which were conducted in daylight hours, CTD/LADCP stations would be acquired along the OSNAP mooring line, mainly during the evening and early morning hours.

CTD001 marked the eastern end of the CTD/LDCP section that was to be occupied during the cruise, extending from the central Iceland Basin across the Reykjanes Ridge into the central Irminger Basin. On August 04th at 1725 UTC, we made the first attempt to recover U. Miami mooring D5. Acoustic communications with both mooring EdgeTech releases failed. After a few hours testing several different set ups for acoustic communications, which included sending acoustic signals from different angles towards the releases, we decided to move forward along the OSNAP line with plans to come back for a second recovery attempt. From the beginning of the cruise, the U. Miami team faced difficulties with acoustic communications using multiple Teledyne Benthos deck boxes connected to the RRS Discovery's 12 kHz IXIBlue hull-mounted transducer due to incompatible deck box connectors and software. The solution was to deploy U. Miam's smaller Teledyne transducer over the starboard side every time acoustic communications were necessary.

For calibration purposes, we performed CTD casts near each mooring site before every mooring recovery. This gave us an opportunity to successfully communicate with acoustic releases on mooring D4 using output power levels between -9 dB, and up to 0 dB on the Teledyne transducer over starboard rail of the ship. Due to bad weather conditions along the OSNAP line, we managed to obtain a second attempt to recover D5 on August 06th. Again, communication failed with releases using different deck boxes and power levels. As a final attempt, U. Miami team tried using the hull mounted transducer on the ship's Drop Keel (~5 m below the hull, when lowered) to send releases signals every 5 minutes or so along a circular path around the mooring location (~0.5 nm radius). The hypothesis was that acoustic communications might be tenuous and that firing multiple release commands from several different angles around to the mooring site might be successful. However, after circling the mooring site for a few hours, D5 did not release from the bottom, forcing us to move forward with the OSNAP cruise. At this stage, we planned to perform a D5 dragging operation at the end of the cruise if time allowed.

After continuing CTDs through the night and performing plankton net vertical tows at selected CTD locations approximately once a day, U. Miami successfully recovered the remaining six moorings and redeployed the planned four of them. The general strategy for the nighttime CTD/LADCP work during the cruise was to try to work ahead of the mooring operations to the extent possible, so that comparison CTD and LADCP profiles could be acquired at the stations nearest the moorings before the mooring recoveries were accomplished. Following this operational plan, the U. Miami team recovered and redeployed D4 on August 07th, M2 on August 08th, D3 on August 08th (deployment only), D2 on August 10th, and D1 on August 11th (deployment only).

The science party broke this operational pattern after the D1 recovery for efficiency purposes. The proximity of U. Miami's M1 to NIOZ's IC4 and IC3, combined with the necessity of extra time to redeploy NIOZ's moorings, required the NIOZ team to recover moorings IC4 and IC3 on August 12th. Then, they used the transit time from IC4 to M1 and the time required to recover and redeploy M1 to prepare the redeployment of the IC4 and IC3 moorings (i.e., data download, post-deployment caldip, and servicing). M1 recovery and deployment was accomplished on August 13th. During transit between D1 and IC4 locations on August 12th, the RRS Discovery crossed paths with the R/V Neil Armstrong (led by Dr. Leah McRaven and Dr. James Holte). R/V Armstrong had finished the OSNAP mooring servicing operations in the Labrador Sea and Western Irminger Sea. The good ocean conditions in that area allowed RV Armstrong to perform CTD casts between the east Greenlandic coast to the top of the Reykjanes Ridge near M1 along the OSNAP line. Therefore, we no longer needed to complete the CTD line between IC0 and East Greenland for the benefit of the program. The extra time was used to reassess our CTD sampling plans and plan for a mooring dragging operation to recover D5 at the end of the cruise. As a result, we performed an additional 20-station section farther north in the Iceland Basin across the Reykjanes Ridge near 60°N after NIOZ finished their mooring work. The purpose of this section was to: (1) observe the Irminger Current farther downstream (northward) along the western flank of the Reykjanes Ridge where one of its cores is believed to branch offshore into the Irminger Basin, (2) along the eastern side of the Ridge, to observe the deep flow and property structure of the Iceland-Scotland Overflow plume farther upstream in the Iceland Basin, prior to the point where models and our OSNAP observations suggest that it bifurcates into two branches as it crosses the OSNAP line, (3) move the ship eastward closer to D5 mooring, and (4) plan and assess the risks of a D5 dragging operation. This new section (CTD's 41-60) constituted the third repetition of the so-called "RR North" section, which will shed further light on the variability of the currents in the region.

After completing M1 operations we performed several more CTD stations westward along the CTD line that night, and proceeded with the deployment of NIOZ moorings IC4 and IC3 on the following day (August 14th). The NIOZ moorings used dyneema line instead of plastic-coated steel cable. The shackles used to connect line pieces are quite large and some care must be taken that the paid-out line does not get caught behind them as it comes off the spool. It is worth mentioning that the exact target position of the deployed NIOZ moorings were only decided during the cruise based on the Multibeam topographic data collected. The moorings were deployed along the line at the location with the target depth the mooring was designed to be in.

CTD's were continued during the afternoon and night of August 14th. Recurrent strong and persistent Tip Jet winds near Cape Farewell and the passage of atmospheric low-pressure system over the Irminger Sea constantly generated rough sea conditions that forced us stop our operations for several hours. On August 15th we managed to continue the CTD line during the afternoon before the weather conditions forced us to stop operating for the night.

In the morning of August 16th, NIOZ's IC2 was successfully recovered. Later that morning we decided to steam approximately 100 km north of the OSNAP line so we could wait out the rough sea conditions in the area (i.e., waves height reached up to 10 m near NIOZ's remanning moorings). While we waited, NIOZ performed a Caldip CTD cast (NL Caldip) of the microcats recovered from IC2 and remaining instruments from IC3 and IC4 that would be re-deployed on other sites. IC2 was successfully deployed on the afternoon of August 17th.

During that same night and first hours of August 18th we completed CTD's west of IC2 and past IC1. IC1 was recovered that same morning. Again, we repeated the strategy and finished the OSNAP CTD line near the IC0 site. Once IC0 was fully recovered on the morning of August 19th, we performed two Caldip CTD casts of recovered U. Miami and

NIOZ microcats before deploying IC0 on that same afternoon. The final NIOZ mooring operation (IC1 deployment) happened on the following morning (August 20th). During the following days August 21st to August 23th, we transited towards U. Miami site D5 along the "RR North" section performing CTD/LADCP casts (CTD's 041-060), and planned the dragging operation to recover D5. The secondary temperature and conductivity sensors on the CTD package were swapped out after CTD 040 (prior to starting the RR-North section) because we had found that those sensors presented larger than normal differences with the primary set of sensors. In addition, a high precision thermometer SBE35 was added to the system so we could evaluate the primary temperature sensor.

Given the depth of D5 (~2700 m) and after several interactions with the RRS Discovery's crew and marine technicians, it was decided the dragging operation would consist of "lassoing" D5 using approximately 1 km of wire attached to weights at its extremities. This wire would be then lowered to the desired depths by several kilometers of trawl wire connected to one of the ship's winches through the A-Frame in the back deck. The strategy was to use the 1 km of dragging wire, also known as ground line, to either cut the mooring wire or grapnel onto the mooring wire using the so-called Rennie grapnel hooks positioned approximately half-way along the ground line. The position and depth of the ground line would be monitored using a Sonardyne USBL beacon attached to the trawl wire approximately 100 m above the leading end of the ground line. To test the RRS Discovery USBL system (i.e., depth measurements accuracy), the beacon was strapped to the CTD-Rosette frame during three different CTD casts. The final test happened in the morning of the dragging the operation on August 24th (CTD USBL test).

After completing 18 out of the 20 stations along "RR North" section, we arrived at D5 around 2300 UTC of August 24th. During that night, we tried communicating with D5's acoustic releases without success from five different locations. First on top of the mooring, and four additional points (North, South, East, and West) approximately 2.5 nm miles away from the mooring in case volcanic activity, turbidity currents, or finishing vessels moved the mooring a few kilometers away from the last known position. After failed communications with the releases, on August 24th, we performed an 11-hour long dragging operation to recover D5. Although the USBL and trawl wire tension data suggested we successfully lassoed D5 and possibly cut the mooring wire, the mooring was not located at the surface nor hooked by the Rennie hooks. After the dragging operation we performed a search survey a few miles away from the mooring site. However, we did not sight the mooring strobe flashing lights nor hear its VHF radio signal. Due to time constrains, on August 24th 2330 UTC, we decided to cancel the search and complete the missing two stations along the "RR North" section on the way back to Reykjavik. Those two stations were performed on the morning of August 25th.

This concluded the science operations for cruise DY-182. The ship then steamed toward Rejkjavik, arriving off Rekjavik harbor at approximately 1800 UTC on August 26th, and completed docking by about 1940 UTC. Except for the failed D5 recovery, the cruise was successful, and additional objectives were accomplished due to the efficiency of our operations, adaptative operational strategy while experiencing bad weather conditions, and extra CTD stations performed by the RV Armstrong along our planned CTD line. The planned and performed activities and the full ship track for the cruise is shown in Figure 1.

3. Scientific Personnel

Name	Position	Organization
Tiago Bilo	Ch. Sci.	RSMAES/ U. Miami
Bill Johns	Senior Sci.	RSMAES/ U. Miami
Eduardo Jardim	Technician	RSMAES/ U. Miami
Joseph Bretl	Technician	RSMAES/ U. Miami
Cedric Guigand	Technician	RSMAES/ U. Miami
Houraa Daher	Scientist	RSMAES/ U. Miami
Dave Huisman	Technician	NIOZ
Aleksandr Fedorov	Scientist	NIOZ
Emma Daniels	Scientist	Utrecht University
Claudia Weiners	Scientist	Utrecht University
Ann Ouseph	Student	Utrecht University
Femke de Ouden	Student	Utrecht University
Josefine Dounders	Student	Utrecht University
Aart Stuurman	Student	Utrecht University
Laura Bergshoef	Journalist	NRC

4. Cruise Operations

4.1 Mooring Operations

The moorings were mostly deployed and recovered using a Lebus double-capstan winch system that was provided by NERC. This system allows separate wire reels to be loaded on an auxiliary spooler and fed into the main double capstan winch without having to pre-spool all the wire reels onto a traction winch before deployment, such as is required with commonly-used mooring winches such as the TSE winch. This saves considerable time in on-deck preparation for new mooring deployments and was an extremely valuable asset on the cruise.

All of the taut-wire moorings were deployed in traditional fashion by laying out the mooring components from top to bottom while steaming into the wind at, tentatively, 1.0 - 1.5 kts through the water and dropping the anchors at selected "fallback" distances from the target site depending on the length of the moorings and observed ocean currents at the deployment sites. The marine technicians working on the back deck often asked to adjust the ship speed to increase or reduce the wire tension during deployment. While U. Miami moorings were deployed as close as possible to the pre-selected target locations for the moorings determined during the early days of OSNAP, the NIOZ moorings' target locations were selected during the cruise based on current RSS Discovery Multibeam data. Each NIOZ mooring target location must present a specific target depth within an acceptable deployment area.

Moorings were recovered by grapneling onto pickup lines at the tops of the moorings, usually from the starboard side of the vessel, and hauling in and sequentially removing mooring components from the top to the bottom of the moorings. Most of the U. Miami moorings came with tangles, some of which were severe and required extra time to stop off extra multiple wire segments streaming aft and safely bring them aboard. This has been common in the mooring recoveries during OSNAP, where the moorings often come up in a tight cluster due to relatively weak currents, and the mooring elements begin to tangle with each other before we can get hooked onto the mooring and straighten it out. Swivels were added to the deployed U. Miami moorings to hopefully reduce this problem. The NIOZ moorings, owing to their design - which relies mainly on one large float for buoyancy rather than the distributed flotation used on the U. Miami moorings, and also includes swivels on the moorings - came up with no tangles.

Mooring Recoveries

A total of 11 moorings were recovered on the cruise, at the locations listed in Tables 1 and 2 and shown in Figure 1a.

Table 1. U.S. Mooring Recoveries (U. Miami)

Mooring Site	Mooring Number	Latitude (ºN)	Longitude (ºW)	Depth (m)	Date of Recovery
M1	M497	58° 52.30'	30° 31.77'	1710	13/08/2024
M2	M498	58° 02.20'	28° 01.14'	2370	08/08/2024
D1	M492	58° 44.81'	30° 07.06'	1740	11/08/2024
D2	M493	58° 32.00'	29° 27.59'	2513	10/08/2024
D3	M494	58° 18.37'	28° 49.08'	2180	09/08/2024
D4	M495	58° 00.56'	26° 58.25'	2680	07/08/2024
D5	M489	58° 00.24'	25° 40.49'	2705	NOT RECOVERED

Table 2. NIOZ Mooring Recoveries

Mooring Site	Mooring Number	Latitude (ºN)	Longitude (ºW)	Depth (m)	Date of Recovery
IC0	IC0-6	59° 13.19'	35° 07.32'	2948	19/08/2024
IC1	IC1-6	59° 06.20'	33° 41.09'	2505	18/08/2024
IC2	IC2-6	59° 01.30'	32° 43.61'	1879	16/08/2024
IC3	IC3-6	58° 57.44'	31° 57.08'	1637	12/08/2024
IC4	IC4-6	58° 53.47'	31° 17.86’	1470	12/08/2024

Mooring Deployments

A total of 9 moorings were deployed at the locations listed in Tables 3 and 4 and shown in Figure 1b. Acoustic surveying of the on-bottom position of the moorings was successfully completed after each mooring deployment.

Table 3. U.S. Mooring Deployments (U. Miami).

Mooring Site	Mooring Number	Latitude (ºN)	Longitude (ºW)	Depth (m)	Date of Deployment
M1	M501	58° 52.27'	30° 31.85'	1710	13/08/2024
M2	M502	58° 02.19'	28° 01.24'	2370	08/08/2024
D2	M499	58° 31.04'	29° 27.51'	2461	10/08/2024
D4	M500	58° 00.42'	26° 58.06'	2676	07/08/2024

Table 4. NIOZ Mooring Deployments

Mooring Site	Mooring Number	Latitude (ºN)	Longitude (ºW)	Depth (m)	Date of Deployment
IC0	IC0-7	59° 13.04'	35° 07.75'	2956	19/08/2024
IC1	IC1-7	59° 06.18'	33° 41.29'	2505	20/08/2024
IC2	IC2-7	59° 01.33'	32° 43.55'	1877	17/08/2024
IC3	IC3-7	58° 57.45'	31° 57.00'	1641	14/08/2024
IC4	IC4-7	58° 53.44'	31° 18.02’	1476	14/08/2024

4.2 CTD/LADCP Stations, Water Sampling, Plankton Net Tows

A total of 64 CTD/LADCP stations were conducted during the cruise (Table 5, Figure 1b). At each station, profiles of temperature, salinity (conductivity), and dissolved oxygen were collected from the surface to within approximately 10 m of the bottom, using a Sea-Bird SBE-911plus CTD system. A Valeport underwater altimeter was used to detect the bottom and worked very reliably throughout the cruise with a typical range of acquisition of the bottom of 90-100 m. Seven of the CTD stations were "caldip" casts to provide calibration data for SBE micro-cat instruments to be deployed on, and recovered from, the moorings. During these casts, microcats were securely attached to the CTD frame and the CTD package was lowered to its target depth, with 6 10-minute-long bottle stops during the package retrieval. ***On RSS Discovery, it is costumery to serially number the CTD casts to avoid the usage of names such as Test Cast or NL Caldip (see Table 5)***. ***All CTD and LADCP data files are named after the cruise's serial cast numbers. In contrast the Bridge***

and Science party followed the cruise plan using Table 5. Therefore, CTD Test Cast in Table 5 corresponds to cast CTD001. The CTD package included dual temperature, conductivity, and dissolved oxygen sensors located at different position on the Rosette system. While primary sensors were located in the center of the system, the secondary sensors were placed on a side wing (Figure 2).

Water samples for calibration of the salinity were collected using a 24-bottle Rosette system containing 12 liter Niskin bottles. For stations where water samples were drawn (see Table 5), 12 bottle samples were collected. As the cruise progressed, and a base calibration for the CTD salinity sensors was established using the already measured bottle samples, bottles were typically fired only on every other cast to save time and lessen the load of running the salinity samples on the ship's Guildline Autosal Salinometer.

The salinity bottles were UK style with disposable cap inserts, that were not re-used between samples (new inserts were used for each new bottle drawn). Salinities from the autosal runs were very solid and stable, which led the Autosal operators to not re-calibrate the autosal throughout the cruise. As a result, the standard checks at the beginning and end of each autosal run (which usually consisted of one 24-bottle crate, covering two casts) showed a slight updrift over the early to middle part of the cruise which then went back to near zero by the end of the cruise.

The autosal drift was corrected on a station-by-station basis. After accounting for the "slow" drift of the autosal, some individual standard checks that showed differences from the standard water salinity seemed to present slightly erroneous readings. Therefore, applying this correction may have caused the calibration for those stations to be off compared to the others. In those cases, the standard checks were set to be equal to the actual standard water salinity (34.997) so that no correction was applied to the autosal salinities. This made everything look reasonable in the preliminary calibration.

We changed the secondary temperature and conductivity sensors after CTD 040, because the secondary salinity appeared to be off by ~0.005 psu from the bottles, and because the secondary salinity offsets were also weakly pressure dependent. We had also noticed a ~0.0015 temperature difference between the primary and secondary sensors, which we suspected was an issue with the secondary temperature sensor at first due to salinities of the primary sensors (which depend on an accurate temperature) were comparing well with bottle readings. To confirm this hypothesis, when we swapped out the secondary sensors, we also added a high precision SBE-35 thermistor to the CTD package. After several stations worth of data we determined that in fact the primary temperature sensor was reading high by 0.0015°C relative to the SBE-35, suggesting that the primary-secondary temperature difference we had seen earlier was actually due to an offset of the primary sensor. Therefore, prior to doing the conductivity calibration for the primary conductivity sensor, we subtracted 0.0015°C from the primary temperature sensor values.

For the final calibrated temperature and salinity files, we will use the primary sensor values as the best set of sensors, where the primary temperature is corrected in the Seabird processing by subtracting a constant offset of 0.0015°C, and where the primary conductivity sensor is corrected using the slope (0.99987179) and offset (0.0002964 mS/cm) determined from bottle calibration routine, having used the corrected primary temperature (i.e reduced by 0.0015°C from the original values). There was no indicated pressure dependence of the conductivity calibration (Figures 3-5).

A final calibration will only be done for the primary CTD sensors, since the secondary sensors were changed partway through the cruise and the first set of secondary sensors also showed poor salinity values with a pressure dependent offset. The second set of secondary C and T sensors also showed pressure dependent offsets in both temperature and salinity with respect to the primary sensors. Therefore, only the primary T, C, and S values should be used for scientific analysis.

Finally, the dual oxygen sensors (which remained the same throughout the cruise) agreed very well with each other, and therefore may be used with some confidence even though not calibrated on this cruise. However, these were the same oxygen sensors used on the previous cruise DY 181, and therefore the oxygen calibration performed on that cruise can be used to adjust the sensor values. The differences between the two sensors during DY 182 were within about 3-4 micromoles/kg (or about 0.1 ml/l), where the secondary oxygen was higher than the primary, and the sensors and their differences were stable throughout the cruise.

Current profiles were measured at the stations using a dual (paired upward and downward-looking) 300 kHz TRDI Workhorse Acoustic Doppler Current Profiling system (LADCP). With the exception of CTD018 (i.e., Cast CTD019) when the upward looking ADCP did not record data, both 300 kHz ADCPs worked very reliably throughout the cruise. The LADCP data was preliminarily processed using version IX_13 of the LDEO LADCP MATLAB processing toolbox maintained by M. Visbeck & A. Thurnherr. The preliminary processing procedure included corrections of the Rosette horizontal drift using GPS data, sound speed and Rosette vertical velocity using 1 Hz CTD T, S, and P profiles, and bottom tracking corrections. No SADCP data was included in the processing of the preliminary calibrated casts.

Finally, throughout the cruise vertical plankton net tows were performed as part of fieldwork training of students and a study at Ultrecht University about the dominant plankton species in the pelagic and sympagic regions of the water column between Greenland and Iceland, and potential influences of climate change, non-indigenous species, and contaminants on the pelagic and sympagic systems. Plankton net towns were carried approximately at least once a day before or after selected CTD stations (see Table 5) and at selected mooring locations where the ship stayed stationary (D5, M1, IC0, and 1.4 nm NE of IC1). Using a small conned-shaped plankton net with a collection contained at the bottom end, the Dutch scientist and student team hauled the net from 20-50 m depth to the surface. The net had wights to ensure the vertical position of net during the tow. After the tow, the plankton samples trapped in the collection container were transferred to labeled 50 ml plastic tubes and frozen in a -20°C freezer for posterior DNA metabarcoding ashore.

Table 5. CTD/LADCP Station Information

CTD Number	Date time	Latitude N		Longitude W		Max Press.	Depth
	UTC	deg	min	deg	min	dbar	m
Test Cast+	Aug 2 2024 21:32:00	62	55.93	22	57.67	1018	1026
001*	Aug 4 2024 05:10:00	57	57.60	24	29.46	2816	2833
003†	Aug 4 2024 13:37:00	57	57.64	25	44.88	2763	2710
002*	Aug 4 2024 22:48:00	57	57.50	25	07.18	2773	2718
004†	Aug 5 2024 06:21:00	57	57.53	26	04.36	2826	2781
005	Aug 5 2024 11:25:00	57	57.55	26	22.64	2859	2800
006	Aug 5 2024 20:23:00	57	57.58	26	42.26	2782	2735
007	Aug 6 2024 00:57:00	57	57.59	27	00.45	2700	2658
008	Aug 7 2024 00:51:00	57	58.02	27	17.81	2428	2392
009†	Aug 7 2024 17:28:00	57	58.70	27	33.90	2275	2240
010	Aug 7 2024 20:45:00	57	59.32	27	50.46	2404	2365
011	Aug 8 2024 00:12:00	57	59.73	28	04.42	2436	2399
012	Aug 8 2024 03:52:00	58	05.07	28	20.32	2426	2289
013†	Aug 8 2024 22:39:00	58	10.46	28	37.12	2326	2292
014	Aug 9 2024 02:30:00	58	15.76	28	53.19	2212	2180
015	Aug 9 2024 05:46:00	58	20.11	29	05.38	2188	2156
016†	Aug 9 2024 14:12:00	58	24.73	29	19.07	1975	1948
017*	Aug 9 2024 17:35:00	58	29.36	29	32.17	2546	2505
018	Aug 9 2024 21:44:00	58	33.39	29	44.07	2010	1982
019	Aug 9 2024 00:54:00	58	37.68	29	56.87	2012	1984
020	Aug 10 2024 04:02:00	58	41.97	30	10.23	1727	1704
021†	Aug 10 2024 20:30:00	58	45.76	30	21.95	1644	1622
022	Aug 10 2024 23:31:00	58	49.86	30	34.63	1636	1614
023	Aug 11 2024 02:10:00	58	50.22	30	48.23	1470	1452
024†	Aug 11 2024 13:43:00	58	50.56	31	02.20	1551	1540
025	Aug 11 2024 16:54:00	58	53.32	31	17.91	1485	1478
026+	Aug 11 2024 19:30:00	58	54.76	31	30.96	1608	1587
027	Aug 11 2024 21:46:00	58	56.07	31	43.98	1782	1760
028+	Aug 12 2024 01:30:00	58	57.30	31	57.10	1651	1629
029*†	Aug 12 2024 19:10:00	58	58.32	32	05.79	1715	1695
030+†	Aug 14 2024 19:10:00	58	58.70	32	12.54	1536	1516
031†	Aug 15 2024 13:34:00	59	00.02	32	28.06	1879	1854
032+	Aug 15 2024 18:03:00	59	01.48	32	42.99	1875	1849
033	Aug 15 2024 21:33:00	59	02.94	33	02.74	2404	2400
NL Caldip*†	Aug 16 2024 18:55:00	60	51.09	33	27.55	2901	2851

034[+]	Aug 17 2024 18:08:00	59	04.69	33	32.11	2276	2242
035	Aug 17 2024 21:13:00	59	06.48	33	41.24	2501	2460
036[+]	Aug 18 2024 01:31:00	59	07.92	34	02.67	2870	2824
037[†]	Aug 18 2024 14:03:00	59	09.74	34	24.29	2468	2431
038[+]	Aug 18 2024 18:04:00	59	11.33	34	45.67	2473	2436
039*	Aug 18 2024 21:21:00	59	12.72	35	06.96	2993	2930
040*[†]	Aug 19 2024 10:37:00	59	15.76	35	27.81	3060	3010
NL Caldip2*[†]	Aug 19 2024 19:50:00	59	11.84	35	05.49	2861	2815
041	Aug 21 2024 02:12:00	61	08.24	32	20.94	2588	2548
042[+]	Aug 21 2024 02:12:00	61	05.01	31	57.05	2444	2406
043	Aug 21 2024 09:38:00	61	01.61	31	33.34	2469	2440
044[+]	Aug 21 2024 13:43:00	60	58.42	31	09.79	2216	2180
045[+]	Aug 21 2024 17:15:00	60	55.31	30	45.97	2047	2015
046	Aug 21 2024 20:25:00	60	52.10	30	22.28	1711	1694
047[+]	Aug 22 2024 00:09:00	60	48.88	29	58.67	1704	1681
048[+]	Aug 22 2024 03:19:00	60	45.63	29	34.74	1540	1521
049	Aug 22 2024 06:08:00	60	42.38	29	11.43	1298	1285
050[+]	Aug 22 2024 09:03:00	60	39.19	28	47.66	1061	1048
051[+]	Aug 22 2024 11:39:00	60	35.86	28	23.99	1011	1008
052[†]	Aug 22 2024 13:54:00	60	29.46	28	06.63	1491	1470
053[+]	Aug 22 2024 17:15:00	60	23.14	27	48.77	1380	1360
054[+]	Aug 22 2024 19:47:00	60	17.22	27	31.60	1959	1644
055	Aug 22 2024 22:56:00	60	10.92	27	14.54	1747	1720
056[+]	Aug 23 2024 02:26:00	60	04.90	26	58.03	2055	2025
057[+]	Aug 23 2024 05:28:00	59	59.16	26	41.86	2013	1984
058[†]	Aug 23 2024 08:30:00	59	53.66	26	26.97	2320	2285
USBL Test[+]	Aug 24 2024 03:03:00	57	57.97	25	40.57	2744	2701
059[†]	Aug 25 2024 12:40:00	59	46.28	26	08.23	2122	2092
060[+]	Aug 25 2024 09:38:00	59	39.67	25	49.77	2429	2402

* Instrument calibration casts

[†] Plankton net tows

[+] No water samples drawn from Niskin bottles

4.3 Underway Measurements

Thermosalinograph

Values of surface temperature, salinity, and fluorescence were continuously monitored using a Sea-Bird TSG system installed in the ship's seawater intake line, and logged by the vessel's underway recording system. Fluorescence sensor started presenting indications of biofouling on August 16^{th}. The system was cleaned on August 18^{th} morning at 10:00 GMT and the water intake flow rate and fluorescence measurements were back to the expected values.

Shipboard Acoustic Doppler Current Profiler

Upper ocean currents were continuously measured with the double ship-mounted Acoustic Doppler Current Profiler (SADCP) system installed on the RRS Discovery, consisting of a 150 kHz Workhorse and 75 kHz SADCP system. Both systems provided good data to their nominal working depths being minimally impacted by rough seas. Data were first-pass processed onboard in real time using the UHDAS acquisition system. Gyrocompass data were continuously corrected by a POS-MV inertial navigation system. On August 17^{th} morning (around 10:00 UTC), the C-NAV correction system stopped working due to hardware problems probably damaged during bad weather, which decreased the GPS's accuracy from 0.1 m to approximately 2 m. C-NAV was fixed on August 19^{th} at 13:00 UTC and stopped working again two days later.

Acoustic Multibeam topographic data

Real time Multibeam topographic data were obtained along the ship track. Often, mooring operations required the Multibeam system to be turned off. If the system was off for longer than 10 minutes one member of the Dutch scientist team (usually Emma Daniels) or the ships IT and instrumentation officer Zoltan Nemeth performed Marine Mammal Observation surveys. If a marine mammal was not observed in the ship's vicinity for approximately 1 hour or longer, the Multibeam was turned on again.

5. Preliminary Results

The CTD/LADCP section across the OSNAP line displays deep reaching banded circulation patterns from the eastern end of the section in the Iceland Basin to the eastern flank of the Reykjanes Ridge (Figure 6). In the Iceland Basin, upper ocean temperature and salinity observations above 500 m are relatively warmer and saltier than the rest of the section. Note that over the eastern flank of the Reykjanes Ridge, the flow is mostly southward (i.e., negative values) which is probably due to the East Reykjanes Ridge Current recirculating modified subtropical waters brought by the North Atlantic Current to the Subpolar Gyre. At mid-depths (1000-1600 m) in the Iceland Basin we observe cold, fresh Labrador Sea Water that diminishes along the eastern flank of the ridge. Both SADCP measurements (Figure 8) and the banded velocity observations in this region suggest that eddy activity or meandering flow may be dominating during the observation period.

On the western side of the ridge the upper ocean is notably colder and fresher than the eastern side (Figure 6). The area around IC2 is marked by an abrupt change between salty/warm waters to the east and fresh/cold waters to the west, suggesting a oceanic front is present. The interior here also shows a thick layer of cold, fresh mid-depth waters, similar to the Iceland Basin, characteristic of Labrador Sea Water and Irminger Sea Intermediate Waters. Immediately west of the ridge axis we observe northward flow associated with the Irminger Current (Figures 6 and 8).

In the deep layers on the eastern flank of the ridge (i.e., potential density higher than 27.80 kg/m^3), the Iceland Scotland Overflow Water (ISOW) layer is clearly shown with its characteristic bottom intensified salinity signal. The ISOW salinities are highest along the ridge flank and weaken slightly towards the interior of the basin. Bottom enhanced south-westward flow in the ISOW layer is observed primarily in 3 cores: one at the base of the ridge flank near 26°W, one within the rift valley where the D2 mooring is located (29.5°W), and one higher up along the flank near 30°W. The flow at near the ridge crest is the strongest ISOW flow observed in this section. This flow appears linked to the locally strong southward upper ocean flow associated with the East Reykjanes Ridge Current.

On the western side of the ridge, bottom salinity in the ISOW layer is also elevated but to a lesser degree than on the eastern flank. This indicates that ISOW has likely become more diluted and as it crossed through gaps in the ridge. Bottom velocities here do not show a strong ISOW flow. Instead, we observe upper ocean velocities diminishing with depth and no clear bottom enhanced branches of ISOW.

The northern section completed across the Reykjanes Ridge shows similar hydrographic structure to that of the main OSNAP section (Figure 7). Warmer, saltier upper ocean waters are found on the eastern flank and colder, fresher waters along the western flank. The ISOW salinity signal is also stronger on the eastern flank than the western flank. In contrast, the Irminger Current flow is significantly weaker than what is observed along the OSNAP lines. Near bottom velocities on the eastern flank clearly show three bottom enhanced branches of ISOW flow with the strongest velocities found near the ridge crest.

6. Compliance with consent to perform research in foreign waters

In accordance with the provisions specified in the cruise prospectus and application for Icelandic and Greenlandic research clearance, this report summarizing the results of the research conducted on cruise DY182 will be provided to the proper authorities within 6 months of the termination of the cruise.

7. Acknowledgements

The support and able assistance provided by the captain and crew of the RRS Discovery is gratefully acknowledged. Support for the scientific research was provided by the U.S.

National Science Foundation under grants OCE1756231 and OCE1948198. The NIOZ contribution to OSNAP is financially supported by the Innovational Research Incentives Scheme of the Netherlands Organization for Scientific Research (NWO) under grant agreement nos. 016.Vidi.189.130 "From ice to ocean; where does the freshwater go" and by UU-NIOZ grant "The Impact of atmospheric noise on the Atlantic Meridional Overturning Circulation".

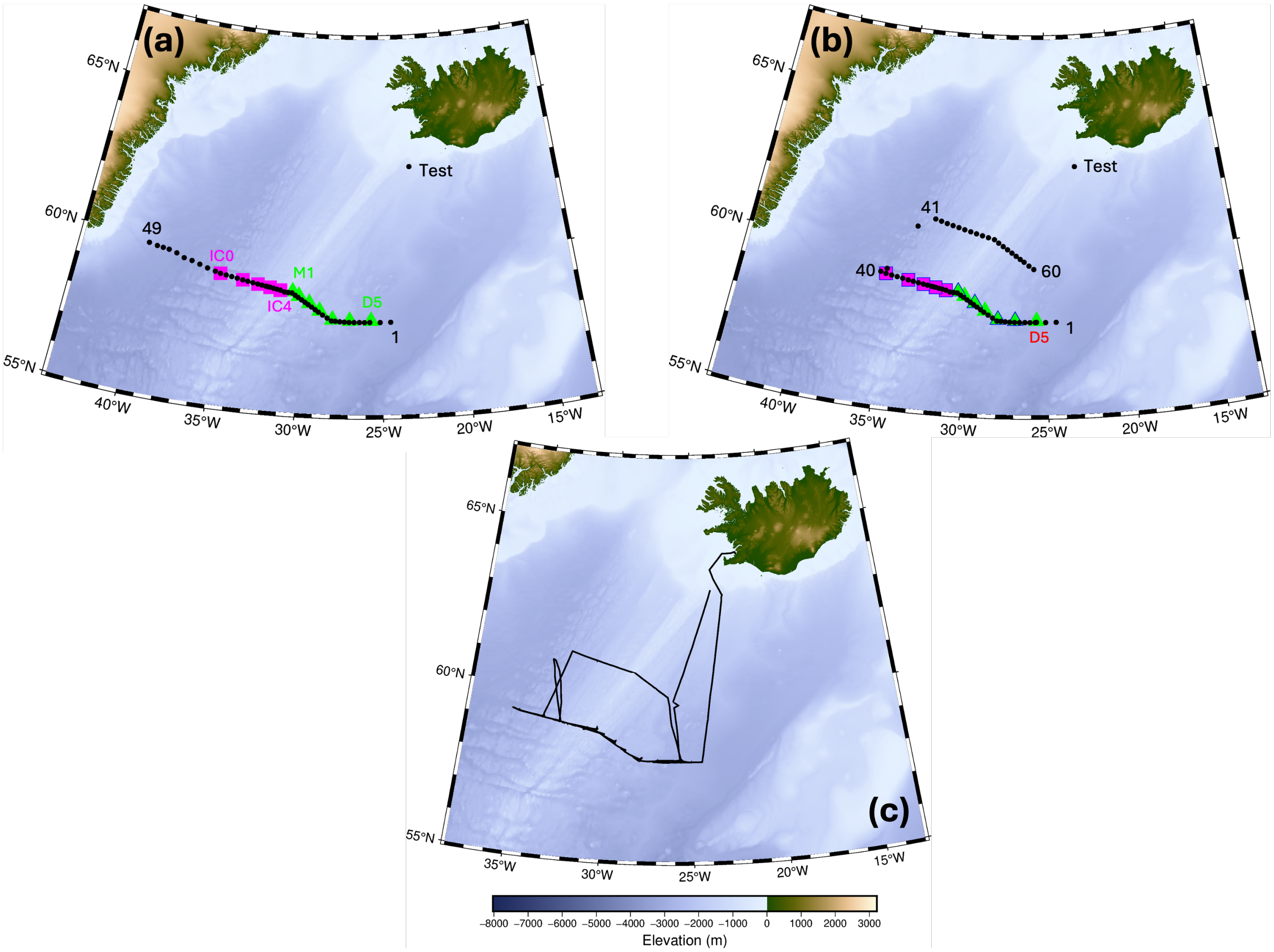

Figure 1. DY-182 cruise science activities and ship track. (a) Planned CTD casts (black dots) and UM (green triangles) and NIOZ (magenta squares) OSNAP moorings deployed in 2022. (b) Obtained CTD casts and OSNAP moorings. All moorings locations depicted in (a) and (b) were recovered, except for D5. Redeployed moorings are depicted as markers with blue edge on (b). (c) Final RRS Discovery ship track.

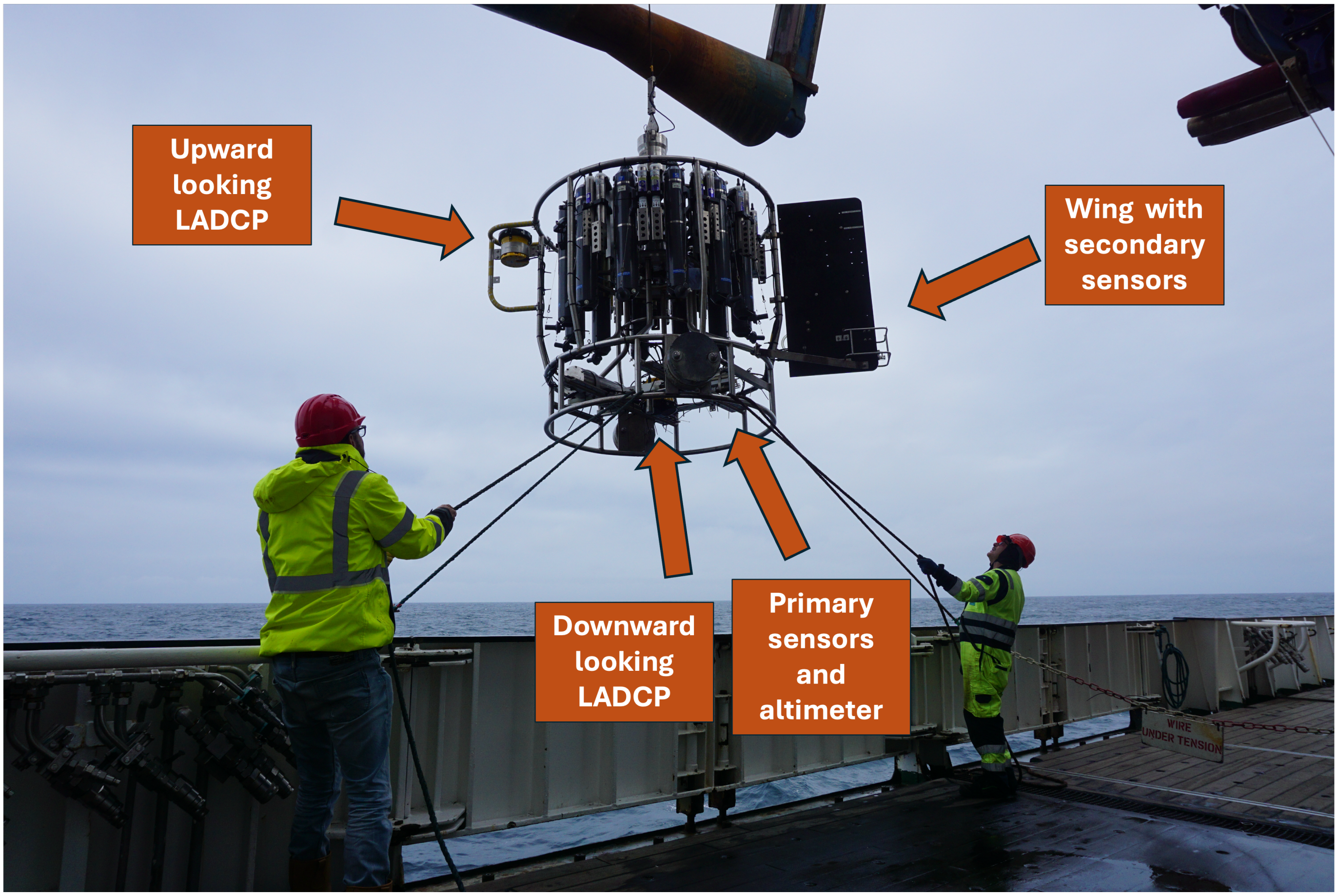

Figure 2. Deployment of the CTD-Rosette system used during DY 182 during first final caldip station.

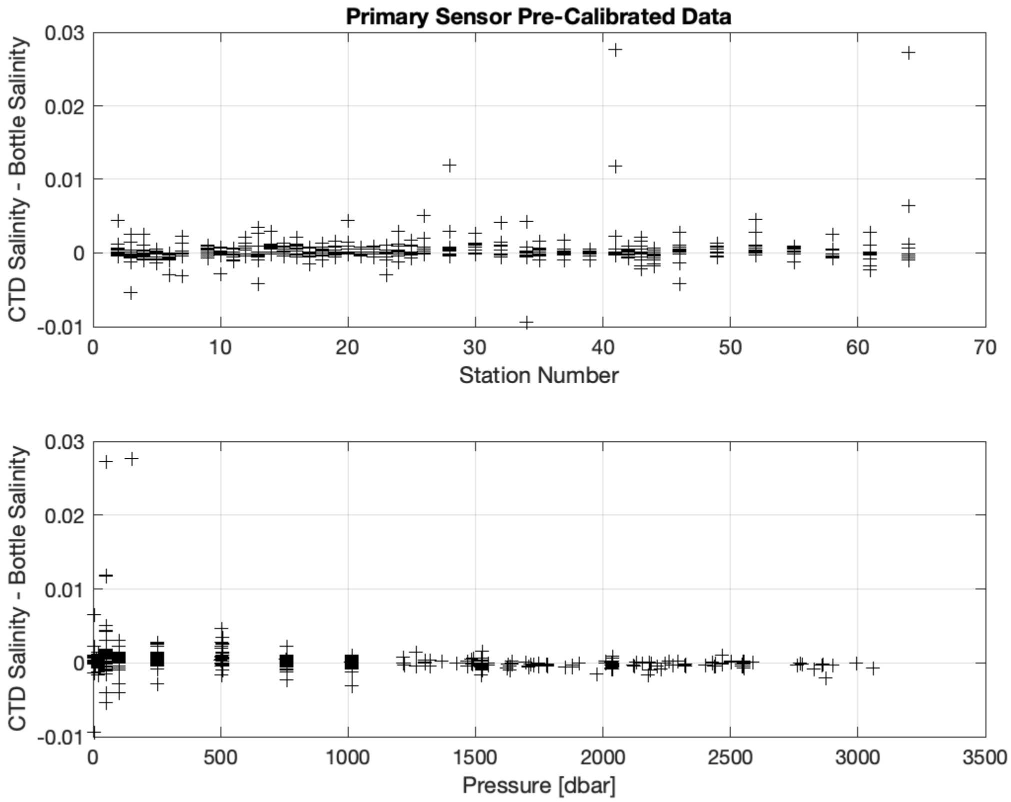

Figure 3. Pre-calibration CTD's primary sensor derived salinity minus bottle-derived salinity as function of station number and pressure.

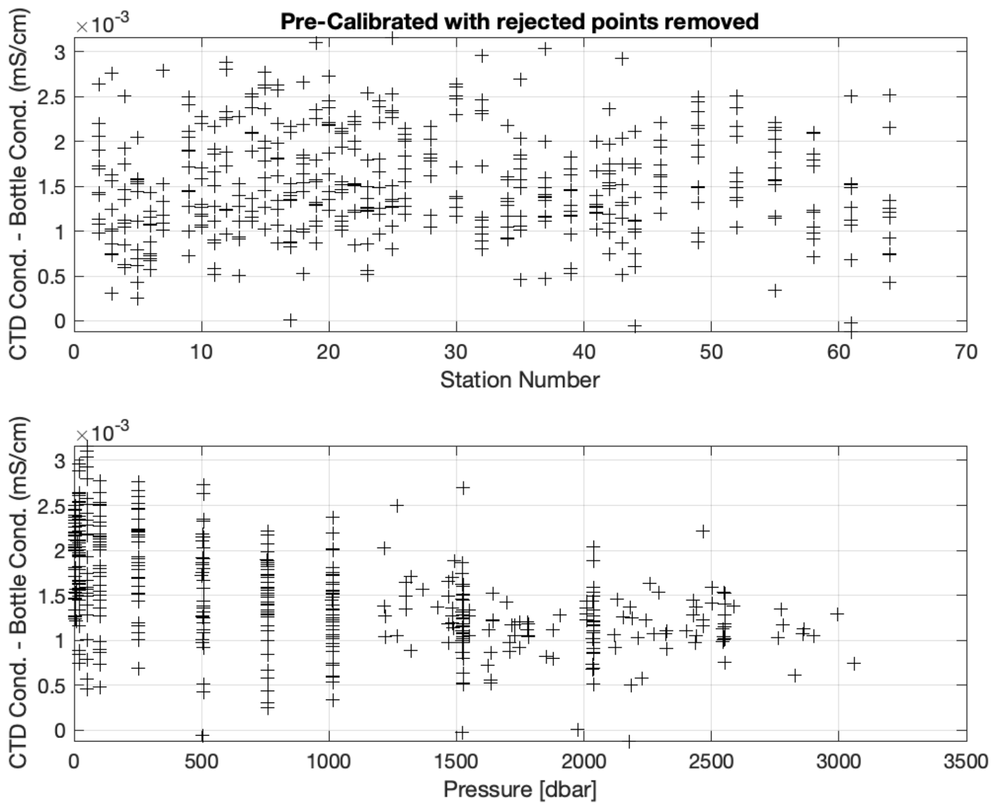

Figure 4. Pre-calibration CTD's primary sensor derived salinity minus bottle-derived salinity as function of station number and pressure without bottle salinity outliers.

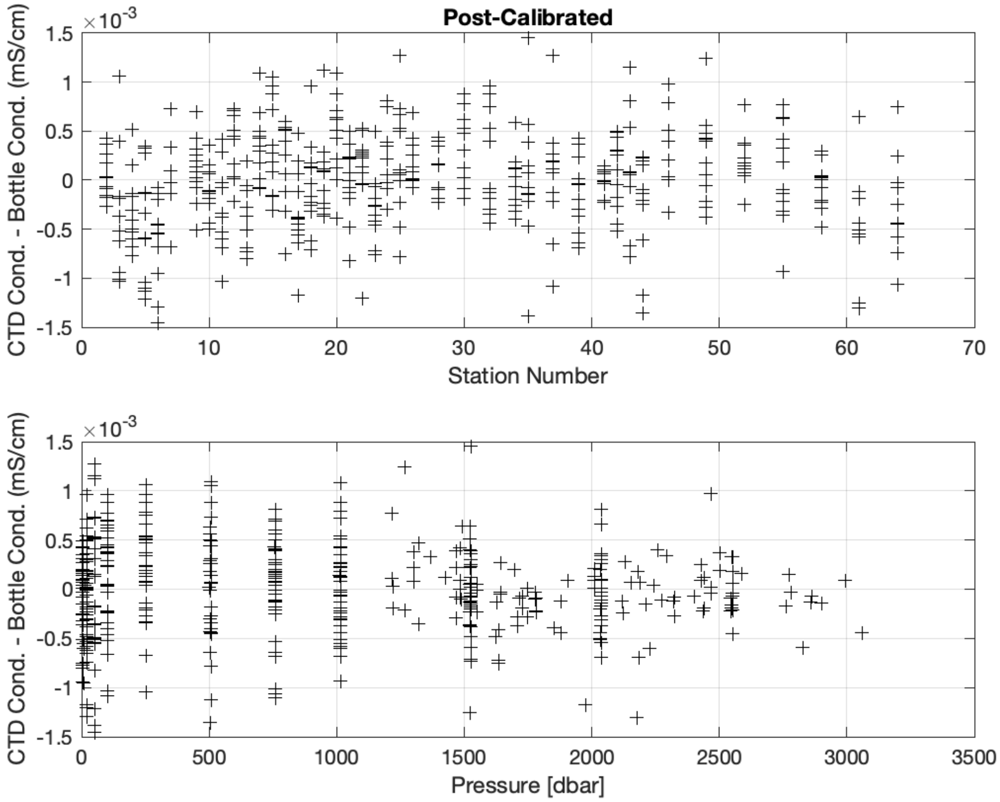

Figure 5. Final calibrated CTD's primary sensor derived salinity minus bottle-derived salinity as function of station number and pressure without bottle salinity outliers.

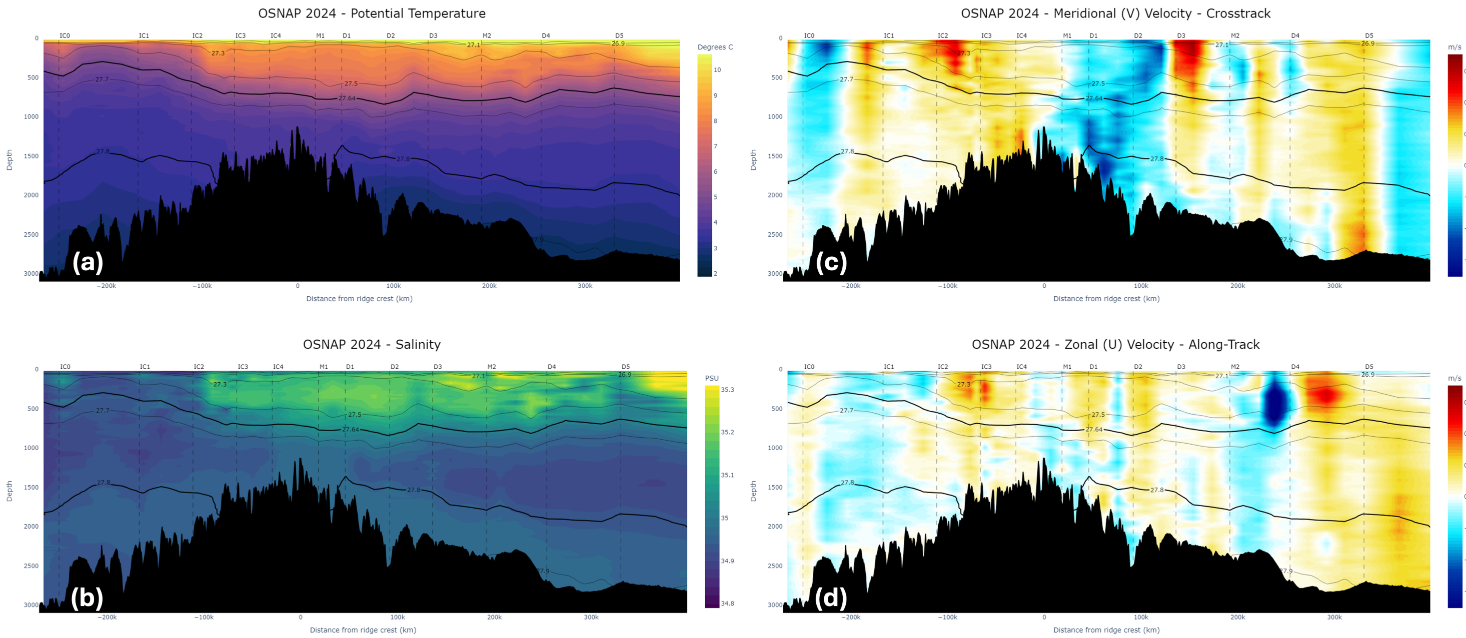

Figure 6. Sections of (a) potential temperature, (b) practical salinity, (c) meridional velocity, and (d) zonal velocity measurements along the OSNAP made with CTD (a, b) and LADCP (c, d). Solid lines are potential density surfaces. Vertical dashed lines represent the mooring locations.

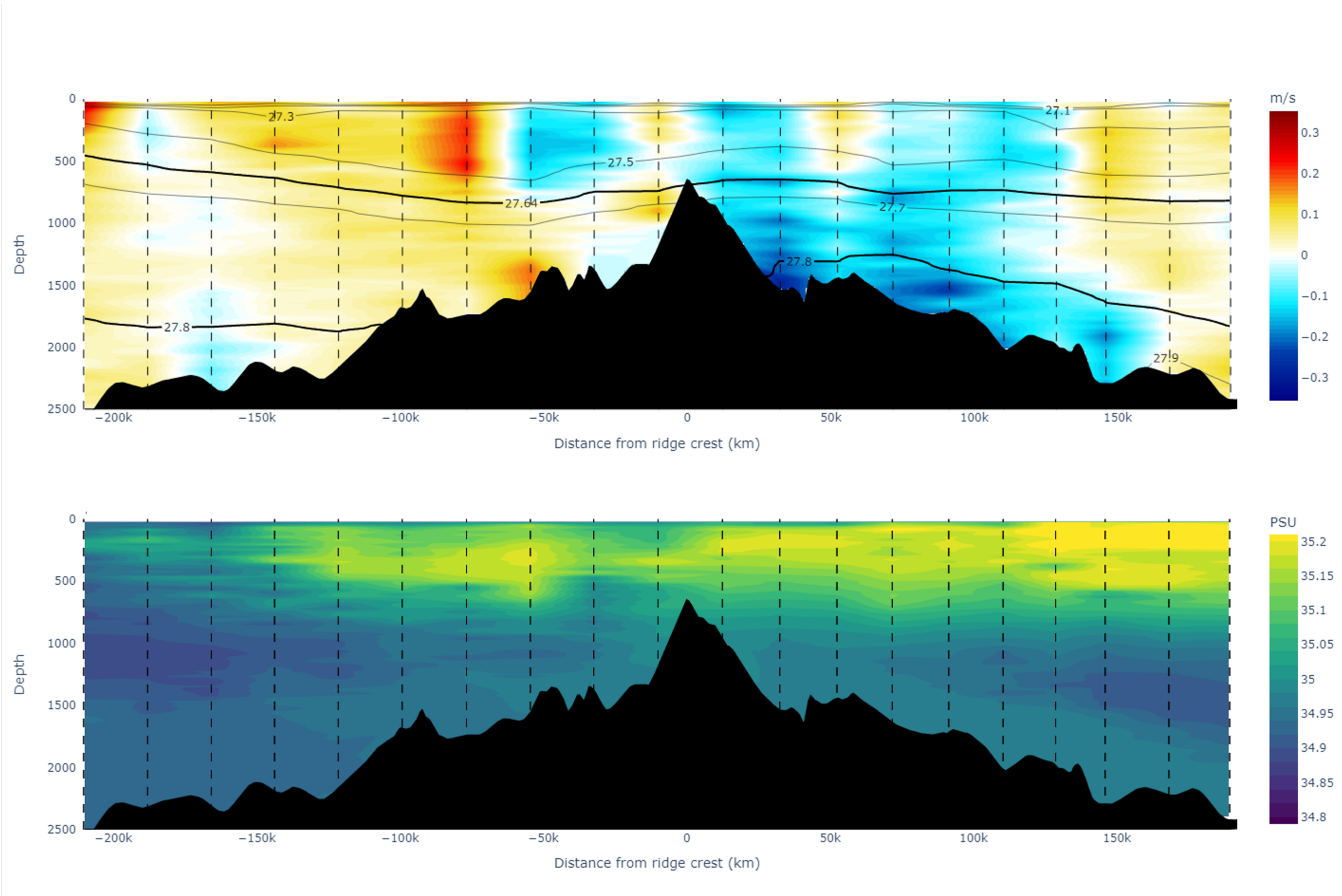

Figure 7. Sections of (a) meridional velocity and (b) practical salinity measurements along the RR North Section made with LADCP and CTD, respectively. Solid lines are potential density surfaces. Dashed vertical lines are the locations of the CTD/LADCP casts.

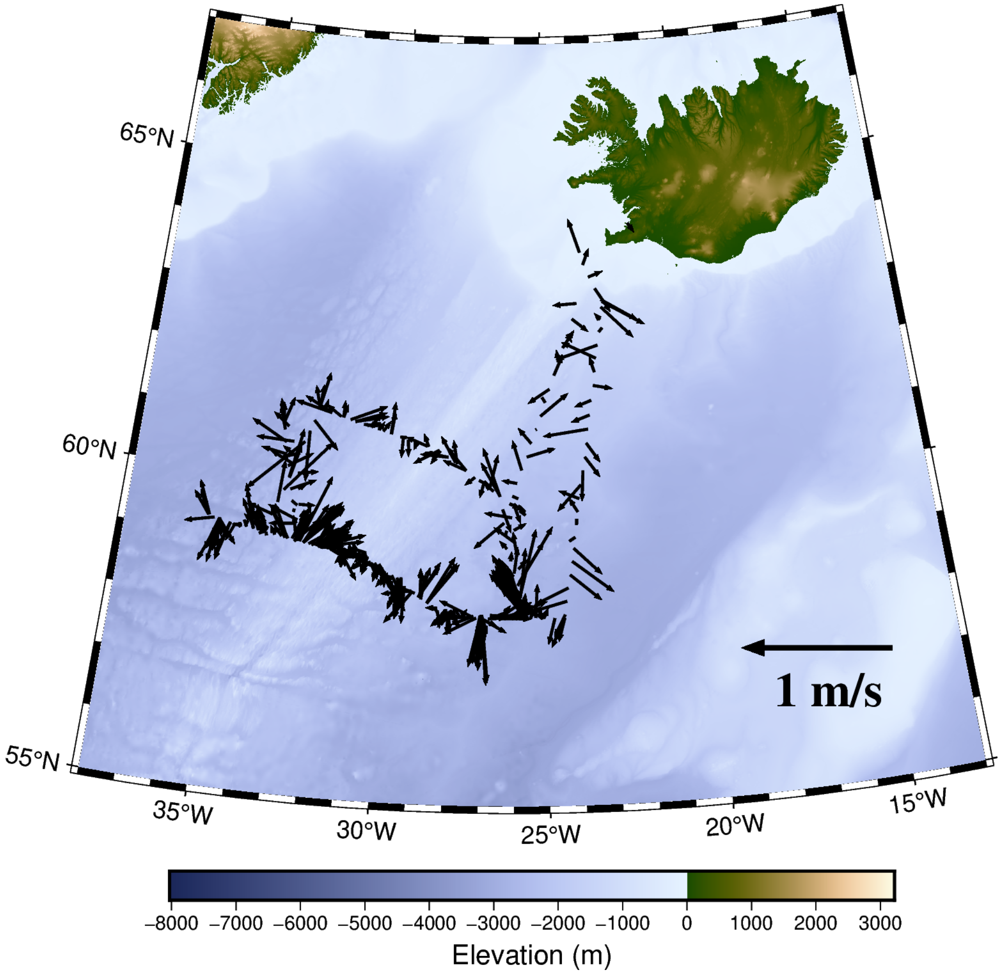

Figure 8. Shipboard ADCP measurements obtained along the RRS Discovery path during the DY 182 cruise at approximately 100 m depth.