OSNAP GDWBC Cruise Report

R/V Neil Armstrong, AR69-01
20 June – 17 July 2022
Woods Hole to Reykjavik

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Abstract

This cruise report documents the fifth recovery and sixth deployment of the Greenland Deep Western Boundary Current (GDWBC) array off the east coast of Greenland as part of the Overturning in the Subpolar North Atlantic Program (OSNAP). This is the second time this array has been both recovered and deployed by the BowerLab at the Woods Hole Oceanographic Institution. In earlier years (2014, 2015, 2016), the array was deployed by P. Holliday at the National Oceanography Center in Southampton, UK. The initial deployment by WHOI took place in 2018 on the R/V Armstrong cruise AR30, and a WHOI-led turnaround happened in 2020, cruise AR46.

In addition to the four GDWBC mooring recoveries and deployments, we completed a set of CTD casts to measure water properties at the mooring sites prior to mooring recovery, and to test acoustic releases and calibrate the mooring microcats and optodes. This was the second time that this array included optodes, which were calibrated and deployed for Isabela Le Bras, WHOI. Water sampling of salt and oxygen were performed to calibrate CTD cast data and moored instruments.

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1. Science Personnel

Sheri White, WHOI, Chief Scientist, Lead OOI scientist
Jennifer Batryn, WHOI, OOI technician
Daniel Bogorff, WHOI, OOI technician
Irene Duran, WHOI, OOI technician
Sawyer Newman, WHOI, OOI technician
Matt Latvis, WHOI, OOI technician
Leah Houghton, WHOI, OOI hydrographer
John Kemp, WHOI, CRL lead mooring technician
Chris Basque, WHOI, CRL mooring technician
John Jordan, WHOI, CRL mooring technician
Peter Dooley, NOAA, Marine Mammal Survey
Heather Furey, WHOI, Lead OSNAP scientist
Adam Houk, WHOI, OSNAP technician
Ellen Park, WHOI Joint Program Student, OSNAP Water sampling and CTD
Croy Carlin, WHOI, SSSG
Sonya Brugger, WHOI, SSSG

2. Overview of OOI and OSNAP work

The R/V Armstrong left Woods Hole, Massachusetts on 20 June 2022 and steamed to the OOI Irminger Sea array area. OSNAP personnel H. Furey, A. Houk, worked on OSNAP instrument preparation, including optode and microcat pre-deploy calibration dips and acoustic release tests. We then proceeded to do a pre-recovery CTD cast, recover and deploy four OSNAP moorings in the east Greenland Deep Western Boundary Current region. After the OSNAP recoveries, we did a post-calibration cast for all recovered microcats and optodes. Due to time constraints, we did not plan to do, or do, post-deployment CTD casts. During OSNAP-GDWBC2022, we targeted identical mooring sites as in 2020. Figure 1 shows the overall station locations and cruise track.

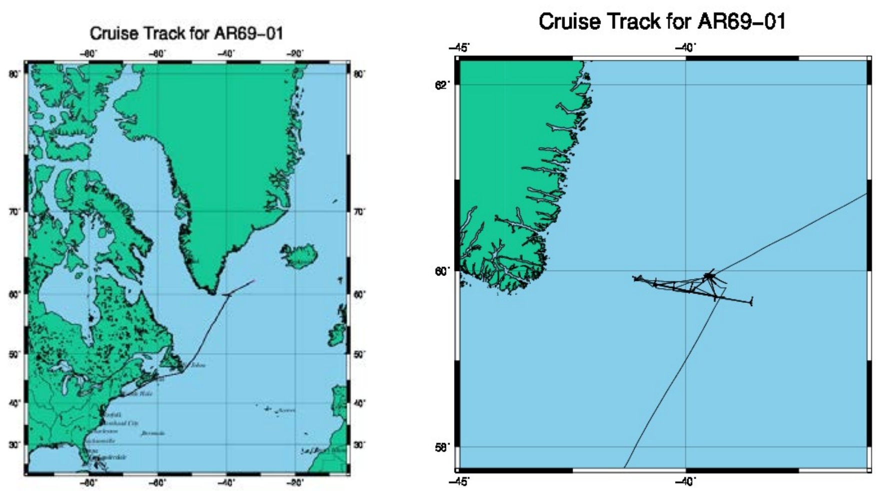
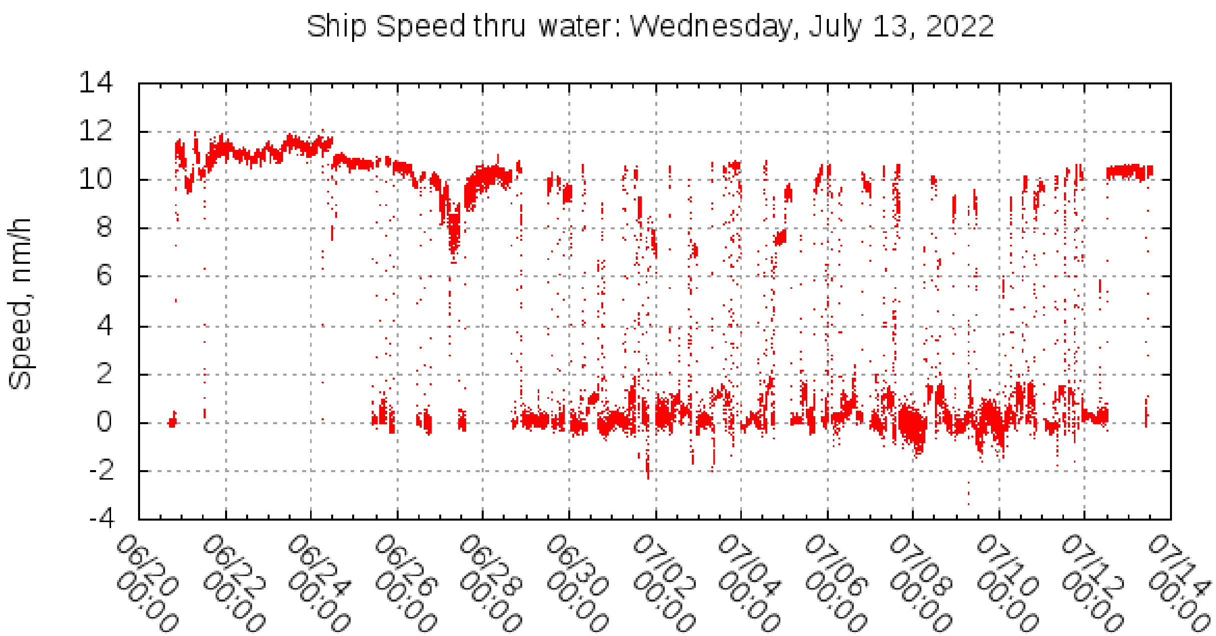
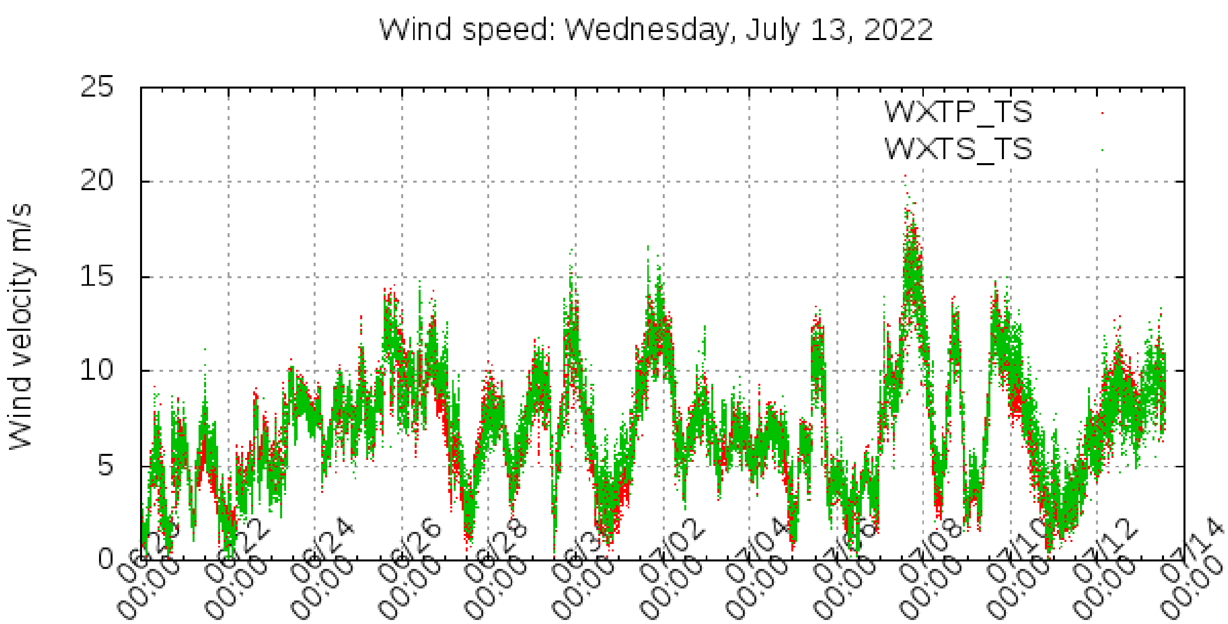
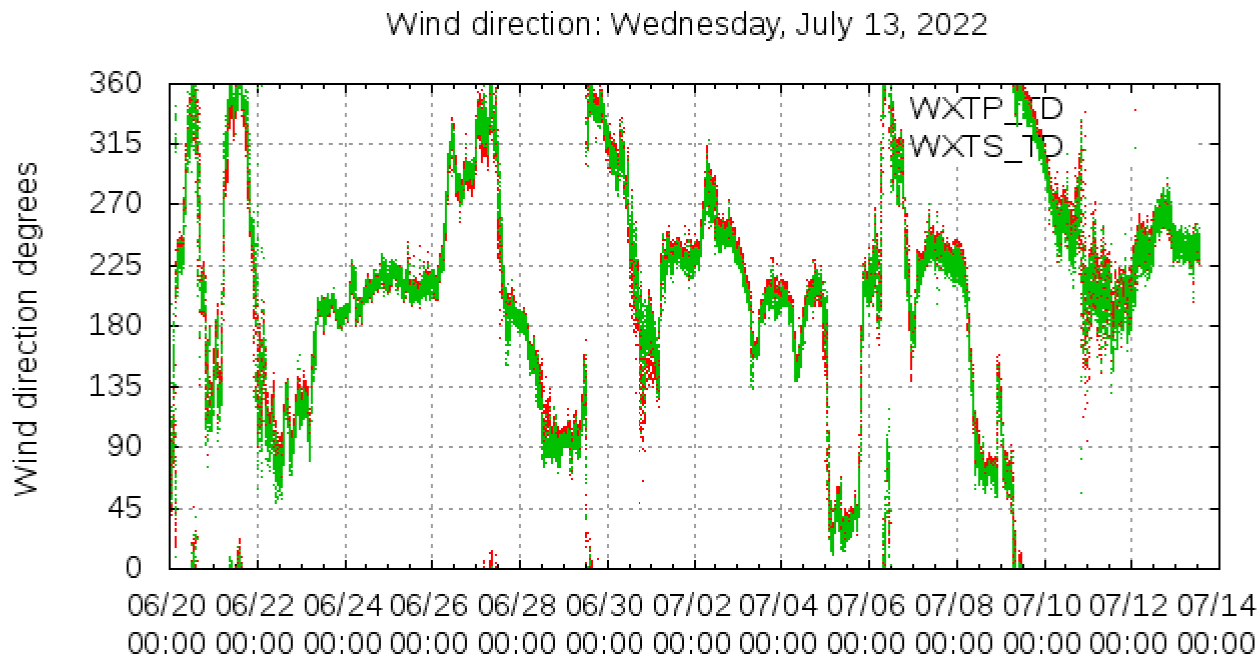


Figure 1. Overall cruise track for AR69-01, and zoom-in on study region, Woods Hole to Reykjavik, 20 June- 17 July 2022.

Once arriving at the work site, the weather was at first not favorable to mooring deployments, and we often had daily, or sometimes hourly changes in work plans. During rough weather periods we relied on getting releases tested and instruments calibrated during CTD casts. Figure 2 shows ship's speed through water, wind speed, wind direction, air temperature, barometric pressure, humidity, rain intensity, and sea-surface temperature during the cruise time period.






Wind direction: Wednesday, July 13, 2022
Wind direction degrees
360
315
270
225
180
135
90
45
0
WXTP_TD
WXTS_TD
06/20 00:00
06/22 00:00
06/24 00:00
06/26 00:00
06/28 00:00
06/30 00:00
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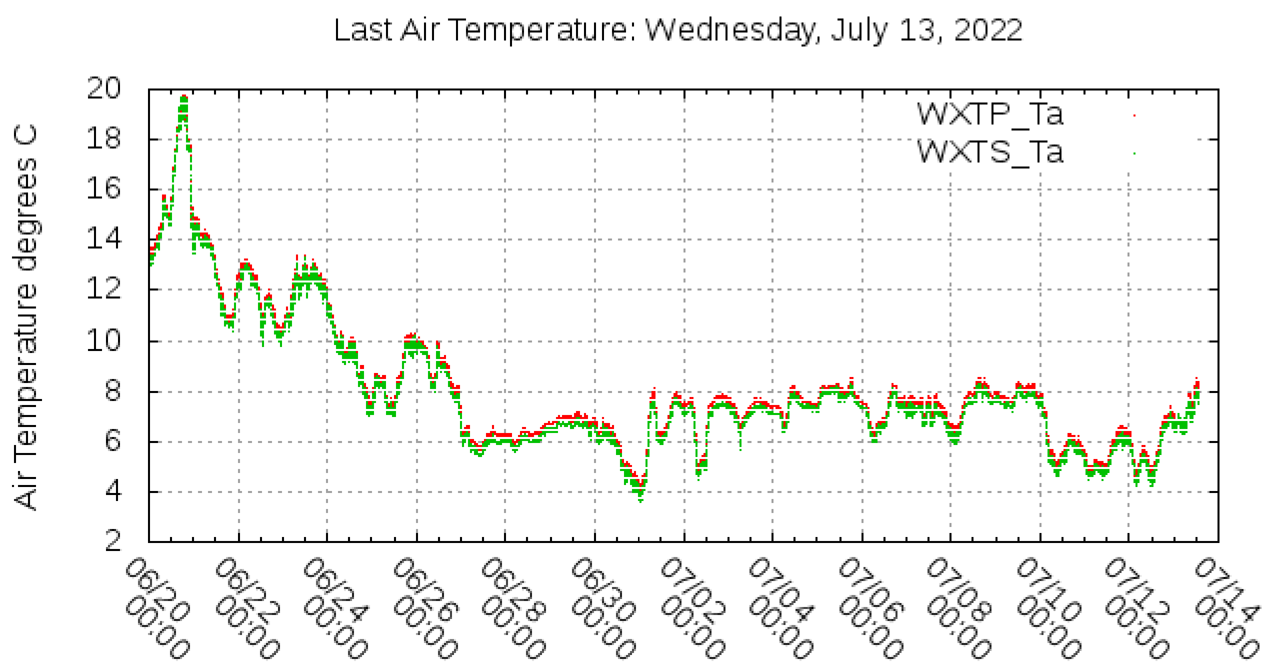
07/12 00:00
07/14 00:00


Last Air Temperature: Wednesday, July 13, 2022
Air Temperature degrees C
20
18
16
14
12
10
8
6
4
2
WXTP_Ta
WXTS_Ta
06/20 00:00
06/22 00:00
06/24 00:00
06/26 00:00
06/28 00:00
06/30 00:00
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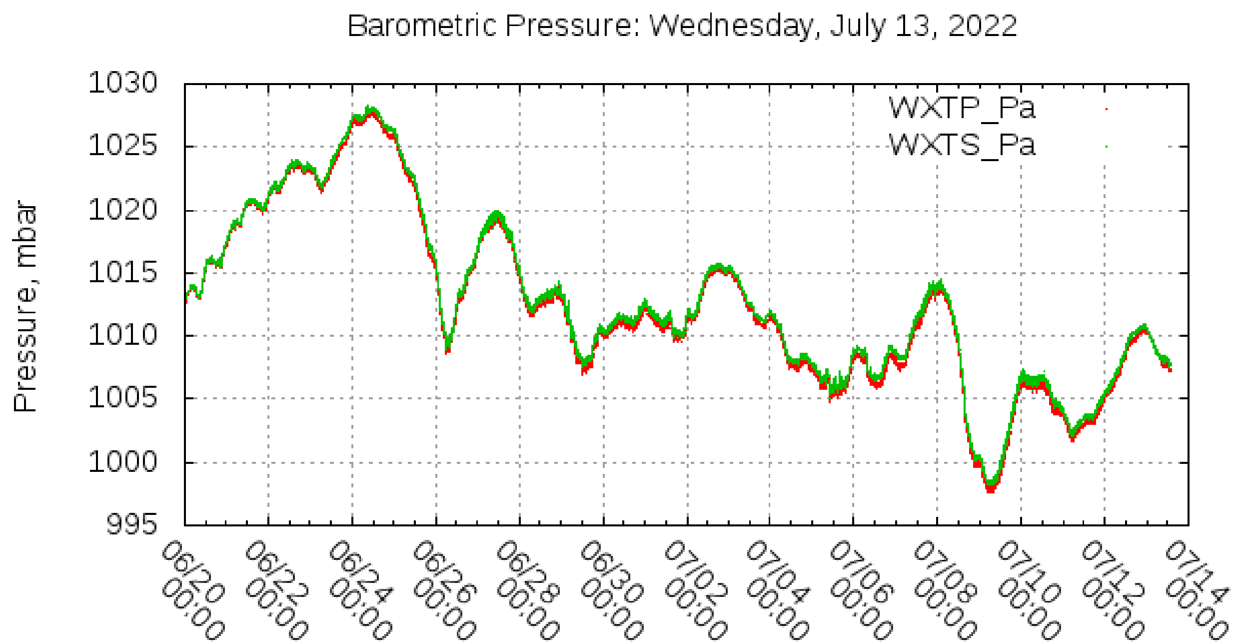
07/12 00:00
07/14 00:00


Barometric Pressure: Wednesday, July 13, 2022
Pressure, mbar
1030
1025
1020
1015
1010
1005
1000
995
WXTP_Pa
WXTS_Pa
06/20 00:00
06/22 00:00
06/24 00:00
06/26 00:00
06/28 00:00
06/30 00:00
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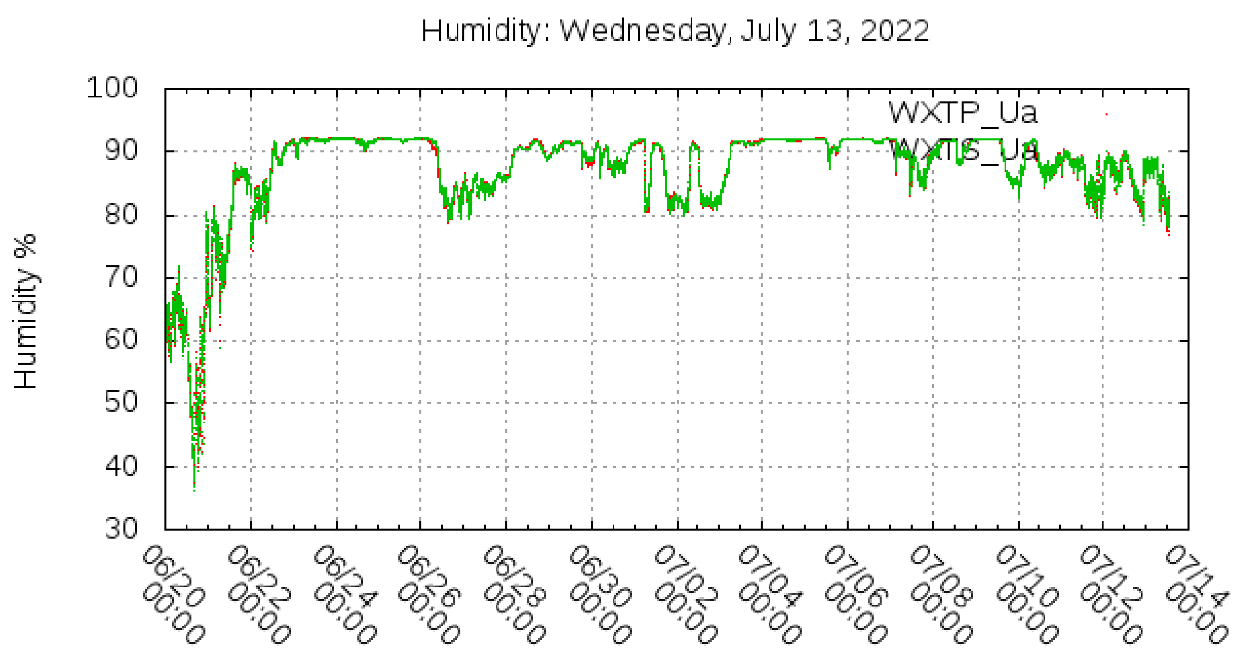
07/12 00:00
07/14 00:00


Humidity: Wednesday, July 13, 2022
Humidity %
100
90
80
70
60
50
40
30
WXTP_Ua
WXTS_Ua
06/20 00:00
06/22 00:00
06/24 00:00
06/26 00:00
06/28 00:00
06/30 00:00
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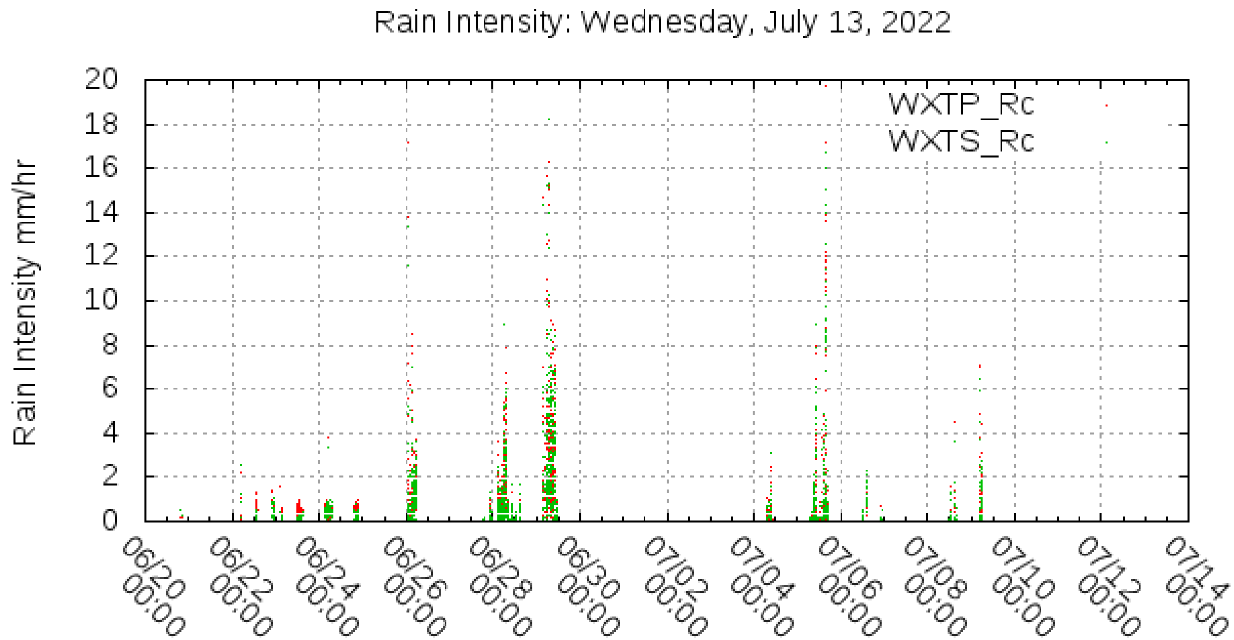
07/12 00:00
07/14 00:00



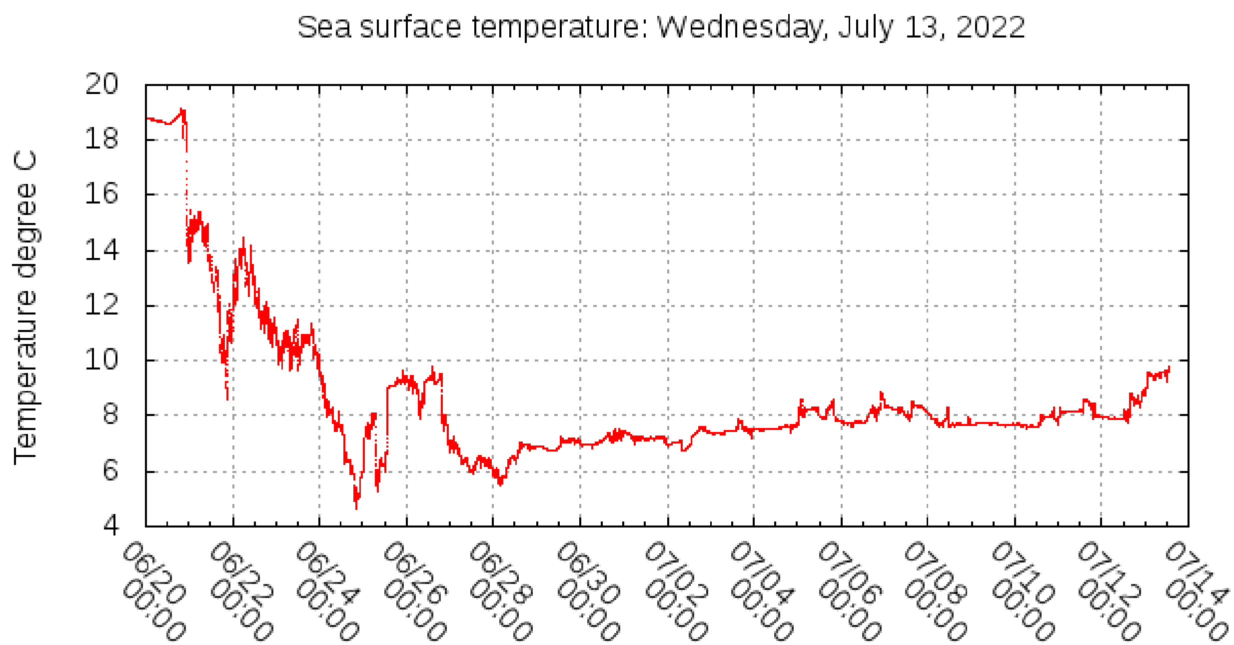


Figure 2. Weather conditions measured on the bow mast of the R/V *Armstrong* during AR69-01. Shown are ship's speed through water, wind speed, wind direction, air temperature, barometric pressure, humidity, rain intensity, and sea-surface temperature for the cruise period.

3. Cruise Narrative relevant to OSNAP Operations

Below is a summary of CTD and mooring operations performed that were directly relevant to the OSNAP objectives. Work flow for OOI and for OSNAP were different due to mooring placement. For OOI, with two sites to toggle between, we were able to deploy before recovering. For OSNAP, due to co-location of deploy and recover sites, we were required to recover before deploying the new mooring. Additional considerations were that (1) the OSNAP mooring calibration casts had to be performed before recovery, (2) instruments to be deployed needed to be 'caldipped' prior to deployment, (3) optodes needed to be turned-around (recovered, then caldipped, then re-deployed), and (4) recovered microcats needed to be caldipped. The general plan was to deployed all OOI moorings, turned around all OSNAP moorings, and then recovered all OOI moorings. In this way, we would clear the deck of all new mooring components before pulling onboard the old mooring components. We were able to get all OOI moorings deployed before this plan became obsolete. Due to weather, we ended up pulling onboard OOI moorings and recovering and deploying OSNAP moorings in a patchwork. Appendix A show cruise plan for all mooring and CTD operations performed on AR69-01 (OOI and OSNAP).

Table 1. CTD and mooring operation relevant to OSNAP GDWBC.

Date	Day	Summary of OSNAP activities	Details
20 June 2022	MON	Move on board R/V Armstrong, depart.	Refuel, move onboard, safety and fire drills. Depart. Ted Lasso: tried & failed.
21 June 2022	TUE	Transit. Get workflow in order; write and send blog; test casts CTD#001 and CTD#002.	Test casts to 50m depths – no sampling – testing and replacing altimeter; Day-to-day timeline review and rework; Mooring diagram annotation; Sampling review; sampling plan. OSNAP blog #1 completed and sent. Cruise report work.
22 June 2022	WED	Transit.	Transit to deep water / OOI work site. Hashed out sampling plan. Adam got out microcats to prep for calibration.
23 June 2022	THU	Time change from GMT-5hrs to GM - 4hrs. Transit.	Transit to deep water / OOI work site. Buffed sampling plan. Got CTD data plotting w/ LTM's diagnostics. Thought perhaps left top sphere of M1 on the dock, found out it is being turned-around. Ugh.
24 June 2022	FRI	Transit.	Final hydrography mtng. Transit to deep water / OOI work site. Make mooring recovery logs. Check recovery release sheets. Copy deploy release sheets. Roe v. Wade overturned.
25 June 2022	SAT	Time change from GMT-4hrs to GM - 3hrs. Transit; CTD#003, 3 OOI releases. CTD#004, CTD#004b 8 OOI & 10 OSNAP mcats. CTD#005, 3 OOI	Transit to deep water / OOI work site. CTD with 3 OOI releases. CTD for OOI and OSNAP microcats. CTD crapped the bed – did soaks for microcats despite no data. CTD resumed comms ~450m did second '004b'

		releases. Note CTD#005 is 'old fish' with not recent calibration.	cast and lowered to 600m to get singles oak and salts to make at least one pin point of sample to CTD to instrument. Replaced 'fish' while SSSGs played 'The Final Countdown' for a test cast #005. That kind of day. Now they are playing 'Living on a Prayer'. The 'Under Pressure'. Then 'Celebrate Good Times'. So, it worked out.
26 June 2022	SUN	Transit; CTD#006, 3 acoustic releases; CTD#007 OSNAP mcats (16) and spare optodes (5).	Transit to OOI work site. CTD with acoustic releases, test of fixed CTD fish. CTD for OSNAP microcats and optodes, some repeat work from failed cast #004.
27 June 2022	MON	Transit. CTD#008 16 OSNAP microcats.	Transit to OOI work site. CTD for OSNAP microcats.
28 June 2022	TUE	Time change from GMT-3hrs to GM -2hrs. Transit; arrive glider box; deploy gliders; CTD#009@gliders w OOI releases.	Transit to OOI work site. Arrive ~1800. Glider CTD w/ acoustic releases.
29 June 2022	WED	SUMO deployment aborted at 1100; transit to M3, cast #010@M3, ping on releases; transit to M2, cast#011@M2, ping on M2 releases.	Winds over 20 knots made us delay this deployment. Squirrely sea state.
30 June 2022	THU	SUMO deployment. Anchor survey. CTD#012@SUMO.	Wind ~12 knots, seas a bit quieter, good day for deployment.
01 July 2022	FRI	Deploy HYPM. Glider recovery. CTD#013@HYPM w OOI releases. Anchor survey.	Good solid day. Made cups.
02 July 2022	SAT	Deploy FLMB. CTD#014@FLMB w OSNAP releases. Second CTD#015 to 1000m to retest 2 OSNAP releases and test a fourth. Anchor survey.	All good, productive day, decent end time.
03 July 2022	SUN	Deploy FLMA. Recover M3. FLMA anchor survey.	Did second mooring op (recover M3) to 'make hay while the making is good'. Flat water, possible weather in a few days, FLMA CTD cast can wait.
04 July 2022	MON	CTD#016@M4 w OSNAP releases [31335 32479]. Recover M4. Deploy M4. Anchor survey.	Long OSNAP day. Calibration cast at M4 mostly bad data. Anchor survey – the acoustics were not good, and difficult to get a good reading on surveyed position. HHF mis-communicated to bridge surveyed position, new working w/ AH. Bridge found problem. Resolved on 10 July; reworked survey with Art Newhall code to verify surveyed location. Adam's code was in agreement. Surveyed results confirmed and good.

05 July 2022	TUE	CTD#017@M1 w OSNAP releases. Recovered M1. Caldip CTD#018 near M1 w/ OSNAP 12 microcats and 8 optodes. CTD#019@FLMA site.	Nutty day, with winnowing time window making for a crunch of work trying to turn around optodes from a morning recover, including caldip, and putting on an afternoon deployment. Weather closed in and all mooring work cancelled.
06 July 2022	WED	Recovered SUMO. Caldip CTD#020 near SUMO w/ remaining 13 OSNAP microcats.	Successful recovery, calm day. Going slow after chaos/swirl of the previous day.
07 July 2022	THU	Deploy M1. Anchor survey.	Productive, good, unhurried.
08 July 2022	FRI	Recover M2. Recover top part FLMA. Recover bottom part of FLMA. CTD#021 caldip of M2 instruments, optodes and microcats.	Productive, good, unhurried.
09 July 2022	SAT	Recover FLMB, upper portion.	Weather closed in and all mooring work cancelled.
10 July 2022	SUN	Recover HYPM-8. Recover FLMB, lower half.	Seas chaotic after yesterday's storm. Work successful, but cold on deck – colder by ~6C. Folks tired after stormy night.
11 July 2022	MON	Deploy M2. Anchor survey. Deploy M3. Anchor survey.	Calm seas, no rain, sun peaked out for just about 5 glorious minutes. Good long day, no muss.
12 July 2022	TUE	Calibration cast CTD#022 for OOI microcats. Leave study area. Transit.	We are all ready to go! A good cruise.
13 July 2022	WED	CTD#023 to test LADCP. Transit.	Good! Folks packing up. Cruise report.
14 July 2022	THU	Transit.	Cruise report / data download.
15 July 2022	FRI	Transit.	Cruise report / data download.
16 July 2022	SAT	Transit. Arrive Reykjavik.	Permission granted to arrive one day early.

4. GDWBC Mooring Operations

Four OSNAP GDWBC moorings were recovered and deployed. The mooring team was led by John Kemp of CRL, with Chris Basque and John Jordan, working with Adam Houk. OOI's Dan Bogorff assisted for all OSNAP mooring deployments. Adam Houk was OSNAP instrument lead, with Ellen Park assisting in securing instruments to wire, and scrubbing them when they came off the water. OOI team member Matt Latvis assisted on deck as needed. The remaining science party, Jennifer Batryn, Sawyer Newman, Irene Duran, Sheri White and H. Furey worked on instrument serial number and position verification, photographing operations, working the clipboard, as well as other deployment tasks. A similar configuration of people was used during the OOI mooring operations. Figure 3 shows the locations of the GDWBC moorings, with the OOI mooring sites and CTD locations. The OSNAP GDWBC moorings M1-

M4 were deployed on the same line as two of the OOI moorings, FLMA and FLMB. OSNAP target positions are those provided in P. Holliday 2016 cruise report. Details of mooring deployments and recoveries may be found in Tables 2, 3, and 4.

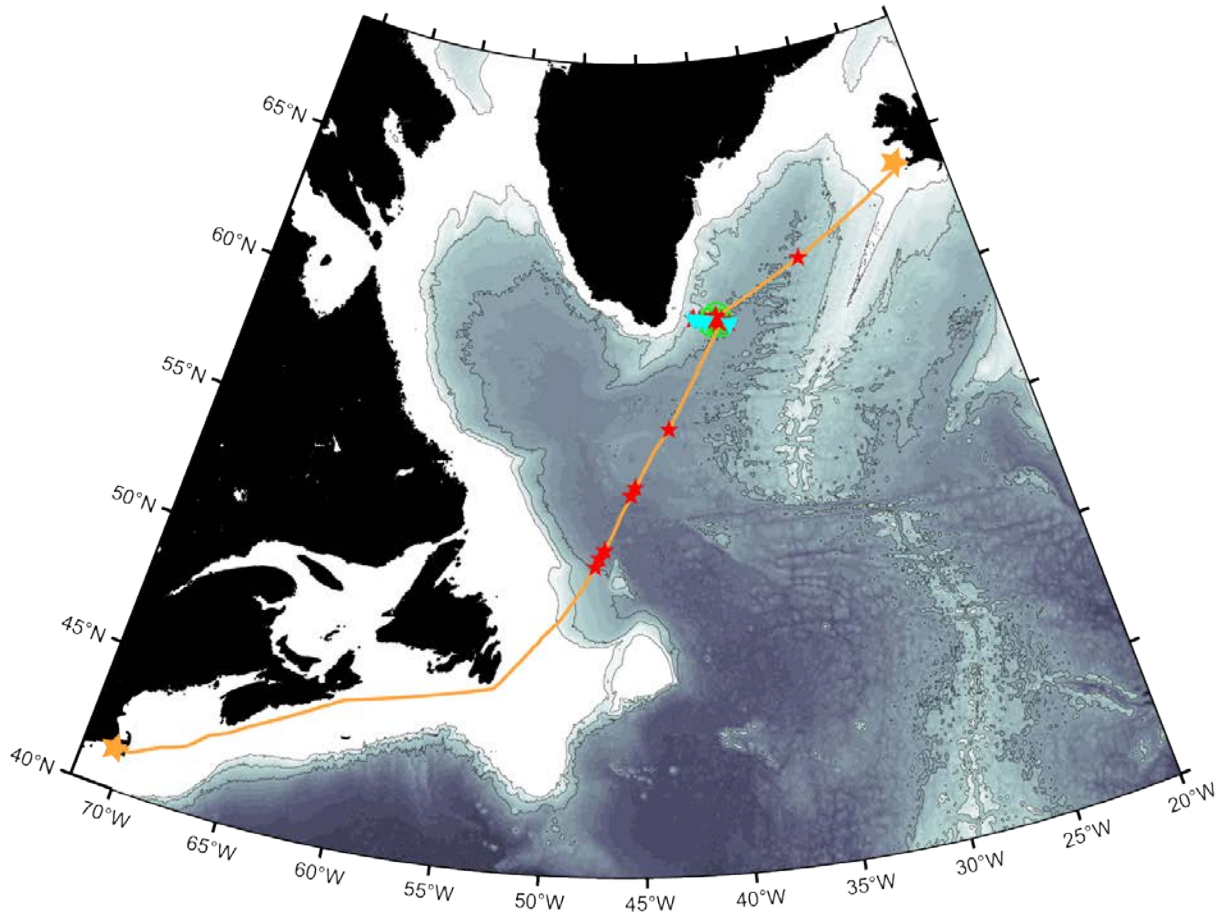


Figure 3. Cruise track with station locations coded by activity. The 1000-m interval isobaths are drawn as black lines, and bathymetry shaded every 250-m. CTD locations are marked as red stars. OSNAP mooring locations are cyan triangles and OOI mooring locations are labelled with green circle-Xs. Ship's cruise track is plotted. Port stops are marked by orange stars.

4.a. Mooring Recoveries

Moorings were recovered as we were able, weather permitting. Table 2 contains information on the mooring recovery operations. Mooring recoveries went smoothly. There were two wuzzles on mooring M4 from ~2200-2500m and 2800-2945m, but everything was recovered safely. This recovery was the last time M4 was designed with pairs of glass floats at ~2000m and ~2450 m. The 2022 deployed M4 has no mid-depth flotation. Recovery diagrams are included in Appendix B. The total instrument recovery counts were: 8 Edgetech acoustic releases, 19 Aanderaa Aquadopp current meters, 30 Seabird microcats, and 11 RBR Virtuoso optodes, all successfully recovered. Description of recovered instruments and data return are in 'Section 5: Mooring Instrumentation'.

M3 Recovery – decided to do in afternoon at last minute. Kemp wanted to make hay while weather was good, so as we had just deployed FMLA, we scooped this mooring up. We were able to do this because M3 verification/calibration CTD had been done a few days earlier on a bad weather day waiting for SUMO deployment weather window. Recovery went smoothly. Release fired at 1410 local time, top flotation sighted 9 minutes later, and entire mooring on deck by 1557. Recovery allowed us to shorten OSNAP work and avoid possible weather coming.

M4 Recovery – Deck set up occurred 0600-0800, release fired at 0920 local time, and completed by 1103. Quick and fast, to prepare for afternoon deployment of same mooring. Flotation arrived 14 minutes after release fired. Recovery went smoothly, though cold and raining on deck.

M1 Recovery – Deck set up occurred 0600-0800, release fired at 0848 local time. Gray and raining, 46F. Rain halted and winds and seas picked up, temperature dropped; foreboding. Tried to push through caldip, to turn around optodes for late afternoon deployment. Caldip done while Kemp and crew turned around top sphere. Seas became too rough, afternoon deployment called off.

M2 Recovery – Deck set up evening prior in anticipation of early recovery. More deck setup occurred between 0600 and 0630. Popped release at 0632 local time to get a jump on weather. Recover went smoothly and we were done by 0839.

Table 2. Mooring recovery table.

Mooring	Recovery Date	2020 Surveyed location	Time Release Fired	Release #	Length of time to recover
M1	05 July 2022	59° 54.178'N 41° 06.652'W	09:48UTC	28037	2hr 32min
M2	08 July 2022	59° 51.436'N 40° 41.522'W	07:32UTC	35616 or 31336	1hr 58min
M3	03 July 2022	59° 49.911'N 40° 16.628'W	15:10UTC	35321	1hr 47min
M4	04 July 2022	59° 38.737'N 38° 34.017'W	10:20UTC	27687	1hr 43min

4.b. Mooring Deployments

Moorings were all deployed in the mornings. Tables 3, 4 and 5 contain information on the mooring deployment operations. Mooring deployments went smoothly. A. Houk performed all anchor surveys. H. Furey helped and re-did all surveys with Art Newhall m-files to double check. Anchor positons matched. Mooring locations are shown in Figure 4. Deployment diagrams are included in Appendix C. Anchor survey images and data are located in Appendix D. Description of deployed instrument setup are in 'Section 5: Mooring Instrumentation'.

In chronological order…

Mooring M4 deployment - Kemp asked for 3.5-mile distance from anchor drop and a 250-meter fall back estimate (a touch up from the 2020 240-m fallback). Bridge adjusted distance to 4.0 nm due south of target based on surface current of 0.3 knots towards aft-starboard quarter. Course not recorded. First flotation was put over side at 13:05 local time, and anchor was dropped 15:50 local time. Time between releases over and anchor drop, or time to finish steaming to anchor drop site, was 50 minutes, up 10' from last year's 40 minutes. Beacon is on top 3-ball radio float. Smooth and dull deployment, exactly what's best.

Mooring M1 deployment - Kemp again (3rd year) asked for 3.5-mile distance from anchor drop and a 110-meter fall back estimate. This is a taller mooring, so less fallback. I did not record bridge's course or adjusted distance. First flotation was put over side at 08:09 local time, and anchor was dropped 11:08 local time. Time between releases over and anchor drop, or time to finish steaming to anchor drop site, was 26 minutes. XEOS beacon is on sphere for first time.

Mooring M2 deployment - Kemp asked for 3.6-mile distance from anchor drop and a 280-meter fall back estimate. Course was 195. First flotation was put over side at 08:07 local time, and anchor was dropped 11:56 local time. Calculated fallback greater than anticipated, again. J. Kemp stated in 2020 that the mooring is 'too light' for local conditions, and could be re-designed with heavier anchor (and therefore stronger wirerope). Time between releases over and anchor drop was 43 minutes. Beacon is on top 3-ball radio float.

Mooring M3 deployment - Kemp asked for 3.5-mile distance from anchor drop and a 350-meter fall back, up from 280m. This was a bad decision, and one I should not have made – Kemp originally thought 400m would be better based on M2 results, and I cut it down to 350m. Adam pointed out that there was a sea surface to 1200 m 0.3 m/s southward current at this site that I should have considered. Anchor location ended up being very near anchor drop location. Moorings M2, M3, and M4 are not heavy enough for the sites – this has been a persistent problem. First flotation was put over side at 13:56 local time, and anchor was dropped 16:26 local time. Time between releases over and anchor drop was 24 minutes. Total time of deployment, 2hrs 58 minutes. Beacon is on top 3-ball radio float.

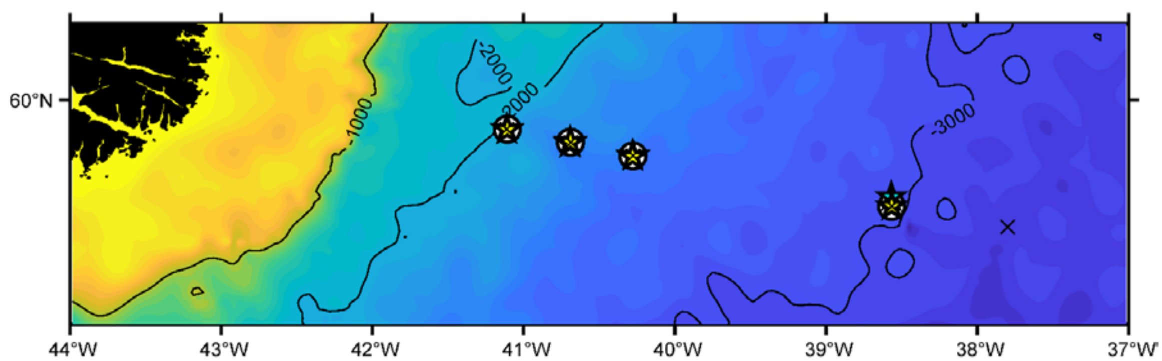


Figure 4. Mooring locations for 2018, 2020, and 2022. In 2018, site M4 had a different location 1nm north of current position. Location of 2014-2018 M5 is designated by the 'X'.

Table 3. Mooring deployment information July 2022.

Mooring	Distance from target at first buoy over, ship's course	Fallback estimate used	Fallback actual*	Mooring deploy duration	Conditions
M1	3.5 nm / Course unrecorded.	110m	157m (but in a very different direction)	3hr 25min	Gray, fog, spitting rain, wind and seas picked up over course of deployment. Work halted when deployment ended. Did not record ADCP currents.
M2	3.6 nm / Course 195	280m	395 m	2hr 49 min	Calm; did not record ADCP currents.
M3	3.5 nm (adjusted by bridge - unknown) / Course unrecorded.	350m	411 m (but in a very different direction)	2hr 58min	Calm; 0.3 m/s currents 0-1200m during deployment.
M4	3.5 nm (bridge adjusted to 4.0 miles due to current at aft-starboard) / Course unrecorded.	250m	338 m	2hr 45min	Calm, gray, fog. Did not record ADCP currents.

*distance between target and surveyed anchor location

Table 4. Mooring anchor survey information July 2022.

Mooring	Anchor Drop		Surveyed Anchor Position		
	Date	Position	Corrected Depth (m)	Trilaterated position	Distance between anchor and target position (m)
M1	07 July 2022	59° 54.127'N 41° 06.594'W	~2086m	59° 54.067'N 41° 06.475'W	209 m
M2	11 July 2022	59° 51.416'N 40° 41.524'W	~2423m	59° 51.622'N 40° 41.415'W	79 m
M3	11 July 2022	59° 48.662'N 40° 16.710'W	~2557m	59 48.718'N 40 16.747'W	312 m
M4	04 July 2022	59° 38.610'N 38° 34.069'W	~2984m	59 38.778'N 38 33.925'W	69 m

Table 5. A compilation of fallback and offset from target for the 2018, 2020, and 2022 deployments.

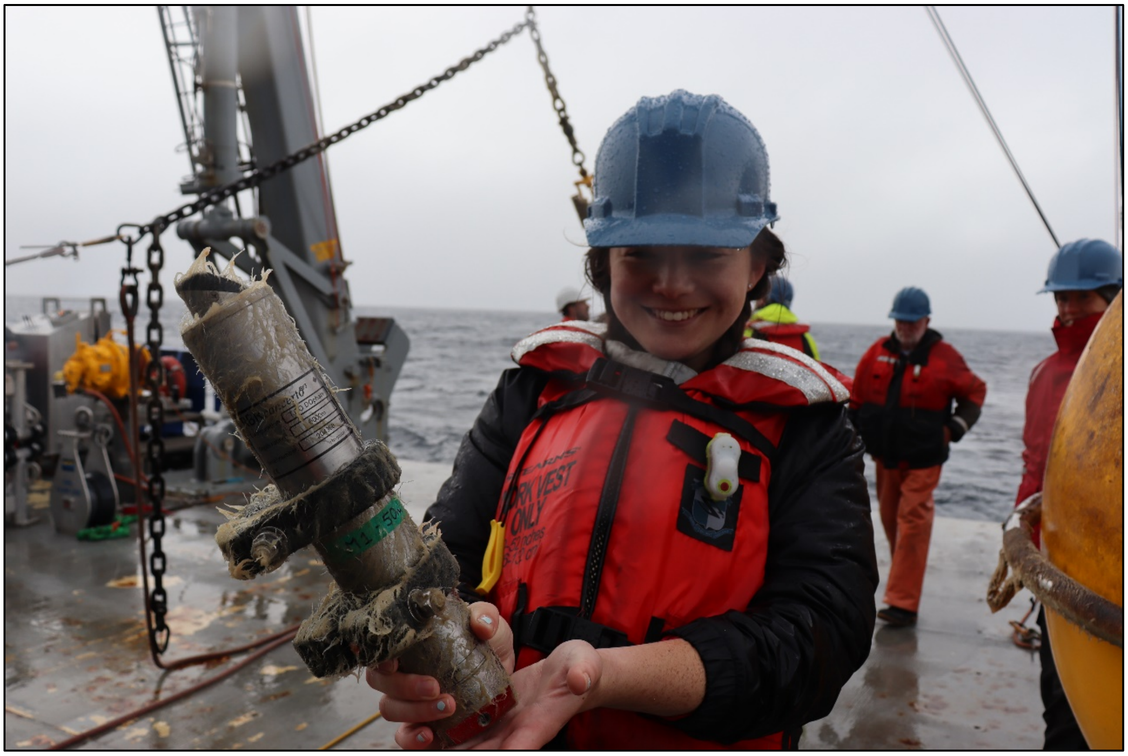
		M1	M2	M3	M4
2018	fallback	n/a	n/a	n/a	n/a
	offset	266	418	289	diff. loc.
2020	fallback	72	547	109	283
	offset	160	280	76	49
2022	fallback	157	395	411	338
	offset	209	79	312	69

Mooring Instrumentation …

All moorings were instrumented with Aquadopp current meters, Seabird SBE37 microcats and Edgetech acoustic releases. Moorings M1-M3 were instrumented with RBR Concerto optodes, for PI Isabela Le Bras. An additional microcat with optode (SBE-37 SMB-ODO) was added to the cable at 150 meters depth on M1. Kemp and crew measured out where to put the mark, 98.1 meters below the cable top termination, on deck prior to deployment. This SBE37 SMB-ODO was originally supposed to replace the 50-m microcat, but the instrument did not have enough battery life to sample at 15-minute intervals for 2 years. Le Bras asked for 150-m depth placement, and for instrument to sample hourly for the mooring deployment period. Five RBR Duets were sent as spare optodes, in case needed. The turnaround of the optodes were a strain and limiting factor on success of the oxygen program. In the end, we did not need to use the RBR Duet optodes. The schematic in Figure 5 shows the general configuration of the mooring array. The total instrument deployment count was: 8 releases, 19 current meters, 30 microcats, 1 microcats with oxygen, and 11 optodes. Current meter and CTD instruments were placed at nominal depths of [50 300 500 750 1000 1250 1500 1750 2000 2250 2500 2750 3000], except near the bottom, where instruments were located 40 meters above bottom depth, and at M2, where the second instrument from bottom was located mid-way between the bottom instrument pair and the one at 2000 m. Optodes were placed to target specific oxygen features throughout the water column. Details on instrumentation may be found in Appendices C - F.

Adam and Ellen, with John's help, putting instruments inline on mooring deployment.

Adam and John check placement of optode and microcat/current meter cage on the line.



Ellen brings recovered optode to washing station on deck.

Care and keeping of the optodes.

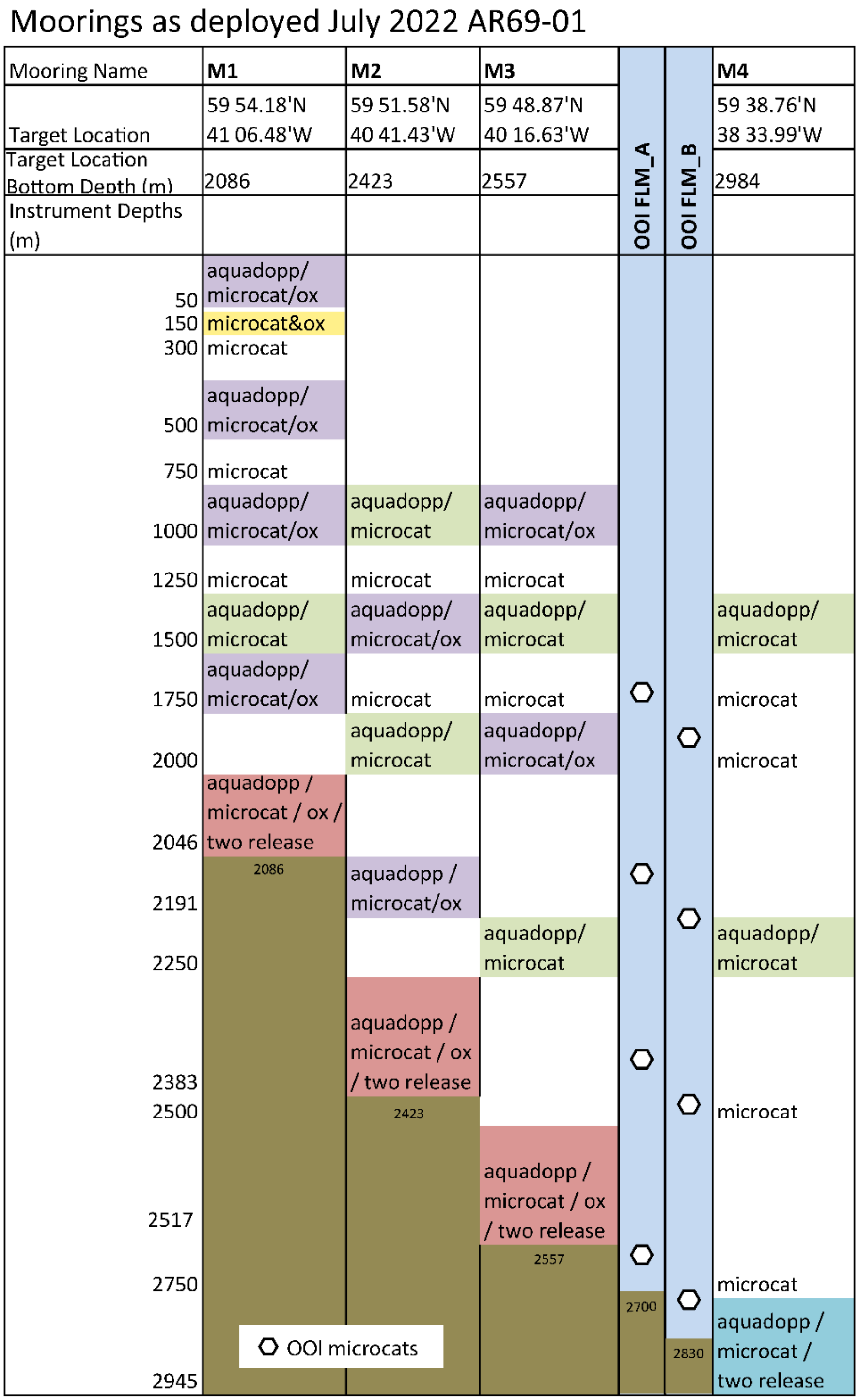


Figure 5. Schematic of the 2022 GDWBC array. Colors indicate different combinations of instruments. Mooring target locations and corrected depths on the schematic are from P Holliday 2016 cruise report 'OSNAPY3L2report_NOC_CR_40.pdf', Table 6.4.

5. Mooring Instrumentation

Instrumentation setup for calibration casts, and for the mooring missions, calibration data download, mission data download, shut down and storage were performed by A. Houk. All microcats and optodes were calibrated prior to deployment. All acoustic releases were tested to at least 1500-m and given 20 minutes to chill to deep water temperatures before testing. All pre-deployment initialization files, pre- and post-calibration data, and mission data may be found in the AR69-01 data directory. Overview matrix of instrument calibration and mission configurations, and CTD protocol may be found in Table 5. Instrument serial number assignments for each mooring may be found on the mooring diagrams in Appendices B and C, and recovered instrument summary table in Appendix E.

Table 5. Instrument protocol matrix.

OSNAP-GDWBC: AR69-01 20 June – 17 July 2022		
Event	Protocol	Comments
CTD cast salinity bottle stops	[50 300 500 750 1000 1250 1500 1750 2000 2250 2500 2750 3000] m salt water sampling, single samples. Wait at depth **1** minute before bottle fire.	The OSNAP 'standard depths'. (Leah does 30-second sit time.) Johns does 60-second sit time. Femke does 60-second soaks, fired bottle, then 60-second soaks.
CTD cast oxygen bottle stops	4 feature depths, 2 samples per depth. See 'O2-DWBC_OOI-AR46-2020_AugustUpdate.docx'.	2 samples per depth is new protocol, yields better quality results. Palevsky/Nicholson/Le Bras prefer double samples and less depths over single samples and more depths.
Microcat caldips	10-second rep rate; 10-minute soaks; 4 depths deeper than 1000m (deep stable water). Freshwater rinse when recovered. ~[1000 1500 2000 2500]m.	OSNAP-GDWBC/OOI 2018: A 2500-m cast with 15 microcats and 5 min bottle stops at the OSNAP stnd depths took 3 hours. 15 on frame max per dip. OSNAP protocol capdips before / after 2-year deployment.
Microcat Caldip Notes	F.Straneo: 15 minute soaks, 10-sec rep rate, @ 3 depths. J.Karstensen: 5 minute soaks, 6-10 depths, 10-sec rep-rate. B.Johns: 5 minute soaks, 12 bottle stops, 10-second rep rate. F.deJong: 5- or 10-sec rep rate, 10-min bottle stops, depths at inst depths (skip uppers) GDWBC2020: 10-sec rep-rate, 10-minute soaks, 5 depths below 1000m. GDWBC2022: 10-sec rep-rate, 10-minute soaks, 4 depths below 1000m.	
Microcat mooring deployment	**15-minute sample-rate**, start at whole hour, UTC! Midnight even better.	OOI mcats are 7.5-minute sample rate
Current meter mooring deployment	**30-minute sample-rate**, start at whole hour, UTC! Midnight even better.	OOI AQDs are 1-hour sample rate

Release testing	1000m min for cast depth; 3 per frame max; 20-minute soaks at depth before test.	3 on frame max per dip. Kemp soaks releases for 20 minutes each to get them to temp before testing. Shallowest 2018 ooi-osnap cast was to 1000m. Test [enable, range, release].
Oxygen sensor testing	Freshwater soak before dip; 10-minute soaks, 10-second rep-rate. 4 feature depths, with oxygen water sampling; OFF PRIOR TO DEPLOYMENT. Rinse w/ freshwater. NO SUNLIGHT. KEEP DAMP.	2 water samples taking per depth, new protocol.
RBR Concerto / Virtuoso or Duet Optode deployment	15-minute sample-rate; start at whole hour interval; UTC; CAP OFF PRIOR TO DEPLOYMENT.	
SBE37 SMP-ODO	Set up on M1@150m for hourly sample rate.	This instrument does not have enough battery to do 30-min samples for 2 years. Can do hourly samples.
Mooring site CTDs	0.5 nm	How close to site? Depends on watch circle. 1.0 nm is totally safe, 0.5 nm is good.

5a. Optodes

Eleven RBR Concerto optodes secured on moorings M1-M3 were turned around at sea and redeployed for the 2022-2024 observational period. A set of 5 RBR Duets were sent as spares in case turn-around of optodes was not possible between recovery and deployment of a mooring. We were close to having to use these instruments, but in the end were able to turn-around the RBR Concertos that were deployed from 2020-2022. One additional instrument was sent by I. Le Bras – a microcat with an optode (SBE37-SMP-ODO). This instrument was planned to be used at the 50-m depth on Mooring M1, but Adam discovered it did not have enough battery life to take 15-min samples for 2 years. Therefore, it was put at 150m on mooring M1, sampling hourly for the duration of its mission. All optodes were calibrated before deployment, all calibration dip soaks had triplicate sampling (appendix G, Hydrography Report). See Appendix F for details on recovered optode results.

5b. Microcats and current meters

Calibrations:

Pre-deployment calibration was performed by attaching the microcats to the rosette frame using ratchet straps, zip-ties and hose clamps when microcats were bracket-less (when they had been removed from a cage where paired with a current meter). Microcats were calibrated by setting to run at 10-second sampling rate for 10-minutes at 4 depths => 2000m, or as close to this as possible. Calibration casts were CTD#004, CTD#007, and CTD#008. Note that CTD#004 was bio-fouled badly, and calibrations had to be repeated. The OOI microcat calibrations done on CTD#004 were not repeated. The person processing the OOI microcats could use the caldip data by comparing it to the repeated, and calibrated, OSNAP microcats that were done twice. Might be of use.

All microcats recovered from OSNAP moorings, and recovered from FLMA and FLMB were strapped to the rosette frame and calibrated by setting to run at 10-second sampling rate for 10-minutes at 4 depths. Prior to calibrating, the 2-year mission data were downloaded from each instrument. Recovered microcats were calibrated on casts #018, #020, #021, with 10-minute soaks at 4 depths => 2000m if possible.

5c. 2020-2022 instrument data return

Overall, we had 99.9% data return for instruments on all four moorings combined.

> **M1:** 6 current meters, 9 microcats, 5 optodes: 100% data return.
> **M2:** 5 current meters, 7 microcats, 3 optodes: 100% data return.
> **M3:** 5 current meters, 7 microcats, 3 optodes: 100% data return.
> **M4:** 5 current meters, 7 microcats: 92% data return. We had one aquadopp leak (bottom instrument), and return possibly corrupted data. Adam was able to pull a complete record, but that record should be treated as suspect after the leak occurred. The remaining 9 instruments (aquadopps and microcats) had 100% data return.

Uncalibrated microcat, current meter, and optode data were plotted to assess data quality, and look 'reasonable'.   Plots of instrument uncalibrated data records created by A. Houk (current meters and microcats) and E. Park (optodes) may be found in Appendix F, and with instrument data on the AR69-01 cruise drive.

6. CTD Casts

CTDs were not completed sequentially along the OSNAP line due to OOI operations interleaved with OSNAP operations. CTD locations are presented in Figure 6, and uncalibrated CTD sections are plotted in Figure 7. Table 7 lists all CTDs, sampling strategies, and instrumentation on rosette for calibration/testing. Each cast at an OSNAP mooring site sampled water at depths in a manner designated by past OSNAP cruises: at nominal [surface 100 200 300 400 600 800 1000 1300 1600 2000 2250 2500 2750 3000] meters depth. Additionally, we made sure to sample at depths of optodes on moorings prior to recovery, taking duplicates at all oxygen depths. A detailed report on CTD and seawater sampling may be found in report by E. Park, and included in Appendix G.

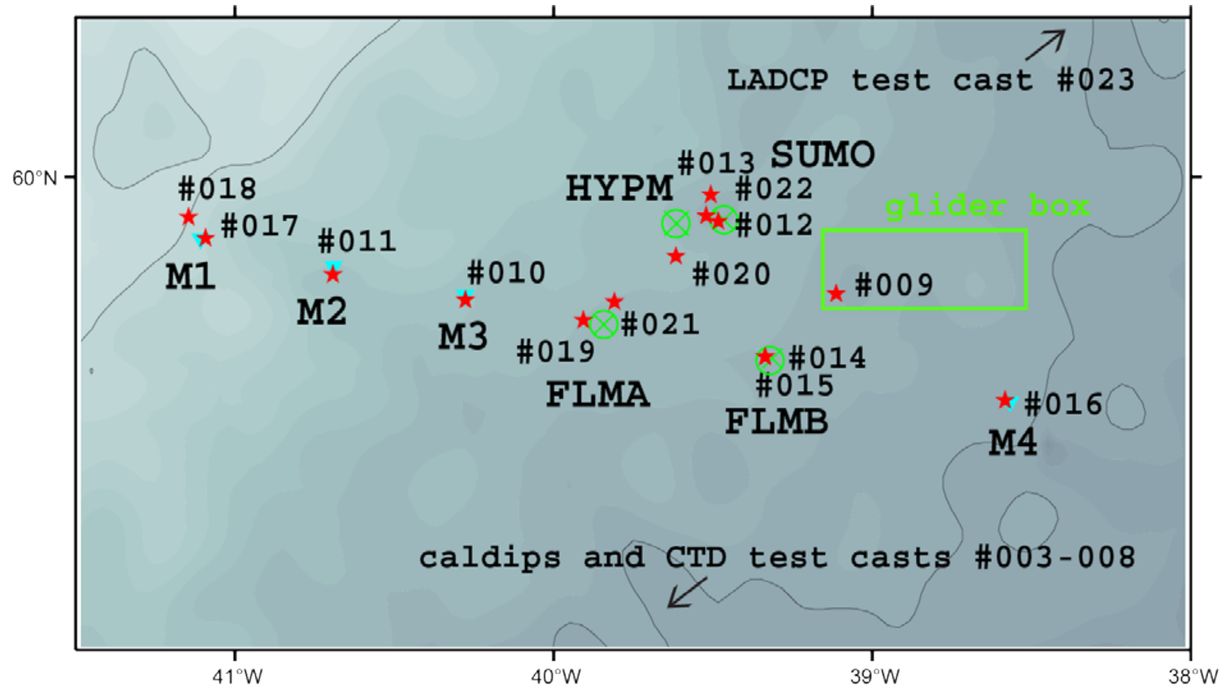


Figure 6. Map showing CTD station numbers relevant to OSNAP line and GDWBC moorings. CTD locations are marked as red stars. OSNAP mooring locations are cyan triangles and OOI mooring locations are labelled with green circle-Xs. The 2000-m and 3000-m isobaths are drawn as black lines, and bathymetry shaded every 100-m.

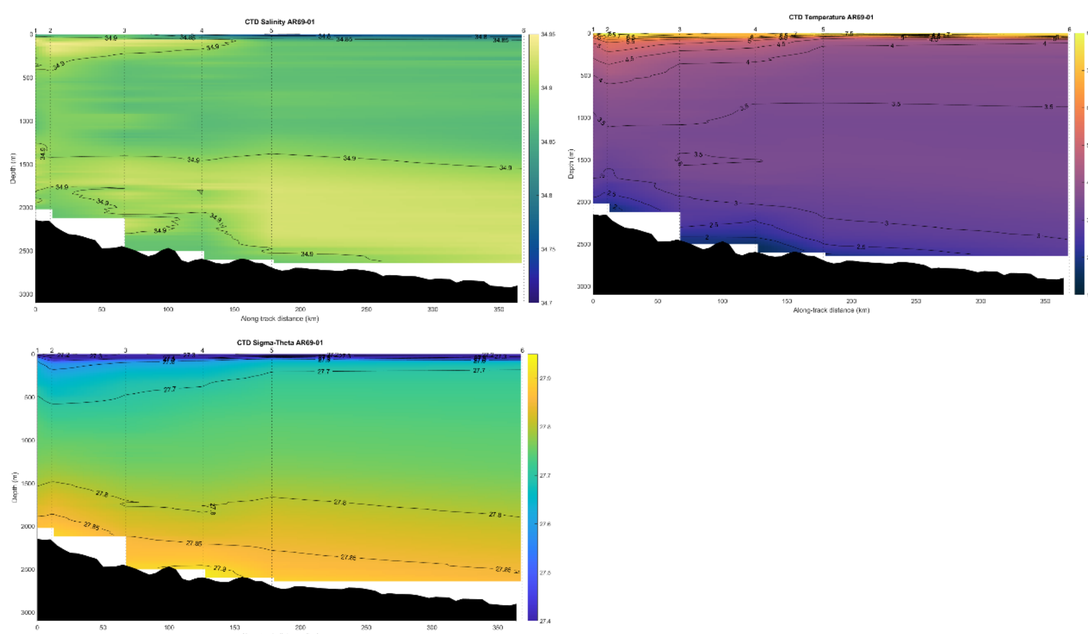


Figure 7. Cross sections of properties along OSNAP mooring line from CTD data. Figures by A. Houk.

Table 7. Table of CTDs taken during AR69.

Cast #	Date	Time (UTC)	Site (at max depth)	Water Depth	Cast Depth	Water Samples
001	2022-06-21	12:20-12:32	42.289 N 67.262 W	>200 m	50 m	Gulf of Maine; Test altimeter. Replace altimeter.
002	2022-06-21	12:40-12:55	42.289 N 67.262 W	>200 m	50 m	Gulf of Maine; Test altimeter.
003	2022-06-25	10:31-12:00	51.029 N 47.734 W	3376 m	1000 m	Test 3 OOI acoustic releases. Test salt samples taken.
004	2022-06-25	14:12-17:26	51.333N 47.486W	3581 m	3000 m	OSNAP cal-dip with 10 optodes. OSNAP water samples: Salt. Microcat SBE37 s/ns 14634; 14612; 14599; 14635; 7586; 7587; 6655; 6664; 7581; 7592. Eight (8) additional OOI FLMA/FLMB mcats. CAST COMMS QUIT 1800m on downcast. Did soaks anyway on Adam's recommendation – have 18 microcats running, can intercompare. Worth the time.
004b					600 m	Second cast started when comms resumed w/ CTD; did one 10' soak at 600m, and took 4xsalt. Salts at 400 and 200m, too.
005	**2022-06-25**	**19:39-21:47**	**51.634N 47.203W**	**3729 m**	**3000 m**	**Test new 'fish' (lowered CTD) to 3K. Test 3 OOI acoustic releases.** **No samples taken. NO D2.**
006	2022-06-26	10:46-13:01	53.620N 45.658W	3764 m	3000 m	Replaced fish to orig (newer calibrated one) to 3K. Test 3 OOI acoustic releases. Two Niskins fired at 2400 to test. No salt samples taken. No D2.

Cast #	Date	Time (UTC)	Site (at max depth)	Water Depth	Cast Depth	Water Samples
007	2022-06-26	15:14-18:30	53.908N 45.396W	3575m	3400 m	OSNAP calibrations. Repeat Microcat SBE37 s/ns 14634; 14612; 14599; 14635; 7586; 7587; 6655; 6664; 7581; 7592. Additional SBE37 mcats: 23986; 13215; 8417; 7580; 11527. Le Bras microcat w/ oxygen: SBE37SMP-ODO-SN 37-23986 Optodes: 21800; 21801; 210802; 210803;210804 Bottle stops at [3400 3000 2600 2100 1400 75]m
008	2022-06-27	10:59-13:41	55.981N 43.186W	3350m	3000 m	16 OSNAP mcats: 7589; 7585; 7597; 6660; 7601; 6668; **6666;** 6669; 6056;7602; 7596; **6657**; 7590; 7593; 7607; 7588.
009	2022-06-28	17:45-19:03	59.817N 39.113W	3578 m	1000 m	Glider site, 2 OOI releases.
010	2022-06-29	14:52-17:07	59.807N 40.277W	2563 m	2550 m	M3 site; salt, O_2
011	2022-06-29	18:36-20:31	59.847N 40.693W	2464 m	2450 m	M2 site; salt, O_2
012	2022-06-30	16:26-17:48	59.939N 39.521W	2680m	1500m	SUMO site; all the things
013	2022-07-01	16:35-18:32	59.972N 39.507W	2668m	2600m	HYPM site; salt, O_2, and other stuff
014	2022-07-02	14:03-16:37	59.717N 39.336W	2823 m	2800 m	FLMB site; salt, O_2 3 OSNAP releases [33041 28038 33042] – two releases turned off; 28038 successful.
015	2022-07-02	17:27-18:43	59.717N 39.336W	2825 m	1000 m	FLMB site; no samples 3 OSNAP releases [33041 33412 28038] redo.
016	2022-07-04	07:15-09:52	59.648N 38.583W	2984 m	2974 m	M4; Salt only. 2 OSNAP releases [31335 32479]. *Both primary and secondary sensors got clogged – all CTD data bad.*

Cast #	Date	Time (UTC)	Site (at max depth)	Water Depth	Cast Depth	Water Samples
017	2022-07-05	07:18-09:13	59.904N 41.092W	2102 m	2090 m	M1 site; 2 OSNAP releases [30846 35317]
018	2022-07-05	13:59-16:36	59.937N 41.146W	2066 m	2000 m	**Insanity Cast.** Near M1 site, 8 M1&M3 optodes, 12 M3&M4 microcats. Optodes [204368 204369 204362 204378 204371; 204381 204382 204380] and microcats [5916 3590 5922 3589 5290 5908 5920 5921 5904 5918 5917 5910].
019	2022-07-05	21:18-23:20	59.775N 39.907W	2686 m	2590 m	FLMA site; OOI sample suite with 4 double oxygens.
020	2022-07-06	17:04-19:32	59.876N 39.616W	2682m	2600m	Calibration cast @ SUMO site. Thirteen OSNAP microcats [(6666, 6667), {5915, 3587}, {5914, 5925, 5930, 5924, 5913, 3588, 5912, 5911, 5907}]
021	2022-07-08	18:50-21:27	59.804N 39.809W	2692m	2600m	Calibration cast near FLMA with M2 recovered instruments. Seven microcats [5909 5927 5929 5926 5933 5931 5932 35616], 3 optodes [204373 204379 204377].
022	2022-07-12	09:29-11:56	59.931N 39.483W	2692m	2600m	OOI microcat caldip: 8 microcats from FLMA and FLMB dipped. One set incorrectly so not calibrated. Use others on line to cal.
023	2022-07-13	09:32-10:19	61.634N 32.894W	2838m	1000m	Cast to test LADCP for next two cruises.

7. Notes for next cruise, lessons learned, and supply list for 2024.

The OSNAP portion cruise went well with instrumentation specialist Adam Houk and an experienced water sampler, Ellen Park. Improvements on performance for this cruise included: excellent oxygen sampling for optodes (E. Park), good adherence to casts 'reaching the bottom' and timed bottle and caldip stops on OSNAP casts (E. Park and H. Furey), much better attention to lowered CTD sensor data quality (E. Park and H. Furey). Leah McRaven acted as on-call hydrographer, and assisted H Furey almost daily at beginning of cruise to make sure sensors good and good data being recorded. Excellent use of pre-deploy caldip data to make careful assignments of instruments on moorings and to weed out 'bad' instruments prior to deployment (A. Houk).

Additional items to bring on next cruise:

- Hand carry tote (carryall) for tools. Would be nice.

Items that would have been useful for R. Graham 2020, and compiled and brought in 2022 by A. Houk:

- ✓ Fish totes (2-4) in which to put instruments coming off of or going onto mooring lines.
- ✓ Scrubbing squares for cleaning instruments and Simple Green.
- ✓ All tools and hardware needed to access instruments and put on/remove from moorings.

Items that would have been useful for H. Furey 2022:

- Trip Mode software – download and install before leaving the dock.
- Matlab/Adobe - check that software can run offline well before leaving dock, 2++ weeks prior.
- Rain overalls. Big baggy fit-over-pants-and-long-johns things. Same with coat.
- Triton X, syringe.
- Printer?
- Anchor survey software! Hydrography software.

Items that would have been useful for H. Furey 2020, and brought in 2022:

- ✓ Rite-in-Rain paper and pen.
- ✓ Camera from Graphics for documentation.
- ✓ More clipboards.
- Charting software and knowledge of how to use it (did not get this – relied on Sheri for charting).

Lessons learned in 2022:

1. **Clarity.** Be clear and upfront on cast depth, instruments on cast, if possible. Plan for deepest depth, and then can back off if needed. Do not undersell what you plan to do – lack of clarity leads to confusion, effects chief sci in decision modifications. For specific example, on first

caldip, I assumed chief sci knew that we go to bottom, I hedged it by saying 3000m, we asked for 3400 m on the fly, this did not go over well. On second cast depth, I had 2500 m on the cast guess, we went to 3000m instead – I thought we would be in shallower water, but should have asked for more at the outset rather than assuming. Don't assume less. The caldip to 3400 m put Sheri in a bad position of having to adjust bottom depth w/ bridge and winch. Let's avoid this situation next time. In the end, by end of cruise, we were doing microcat caldips to 2600 m only as water masses deeper than that are not better mixed. This was a sufficient depth to characterize sensors. Stick to this depth on next cruise. Note caldip cast depth to Chief Sci / ship before cruise begins.

2. **Method for near-bottom CTD casts:** method for going to bottom: give winch target for 90 m off bottom, after winch reaches target, check that altimeter 'sees' bottom, give winch new deeper target 10 meters from bottom [wire out+(altimeter depth – 10 m)]. Watch close as package lowered to bottom. State this method at outset of cruise. Note CTD-to-bottom method to Chief Sci / ship before cruise begins.
3. **Acoustic release testing:** make sure that if the power-off type, power on prior to release testing. We got caught on one cast trying to test releases that were not turned on. Good safety check and lesson.
4. **Validation CTDs (pre-recover CTDs):** can happen days before recovery, do not need to wait until recovery day.
5. List method of **calibration CTDs** on waypoints to Chief Sci – 0.5 nm from mooring site.
6. **Anchor survey:** OOI method: 750 m (0.75nm) at three equidistant points in circle around mooring target. Adam does this differently, asking each waypoint on the fly, e.g., 1 nm north, 1 nm west, etc. Which is how M4 and M1 went. Final call (M2, M3) was to do three points 120° apart on a 1 nm circle, with last point headed towards next waypoint / mooring. I should make this clear deployment starts; and this method should be revisited with each ship and crew. The Armstrong can handle picking their own points and fidelity. List anchor survey method on waypoints to Chief Sci before cruise begins.
7. Remember to ask and record **ship's course and adjusted distance** before deployment begins.

An aside 2022: *The pandemic eased by the start of this cruise, but we still had to get tested 72 hours prior to boarding. If a person had had covid within 90 days of travel (this included me, and others), then a positive c19 test and dr note pronouncing recovery from covid was necessary for travel and exempted the person from taking the 72-hour window test. We were asked to isolate as much as possible and use caution for 7 days prior to departure. We were (unexpectedly) allowed to de-mask the day we arrived on the boat, once we had set to sea – we had been expecting to wear masks for 5 days after departure.*

On Day 5, 24 June 2022, Roe v. Wade was overturned. It hit a lot of folks on the boat hard, profoundly, me included.

We had thoughts of breaking down the SUMO mooring in Prince Christian Sound, but too much ice, Captain Mike was not inclined - not at all safe. Maybe someday?

We saw a pod of orcas off of Iceland. Amazing.

Appendix A: Work performed for both OOI and OSNAP.

Days-at-Sea at start of operation	Hour of day at start of operation **LOCAL TIME**	Operation	Date
1	1300	Ship docked at WHOI, board boat.	20 JUN, Monday
1	13:30-~15:30	Fire and safety drills, move in.	
1	16:10	Lines cast.	
2	0800	Transit to test cast site	21 JUN, Tuesday
2	1219	**CTD#001:** on shelf in US waters CTD to test altimeter, altimeter replaced (shallow depth).	
	1239	**CTD#002:** on shelf in US waters CTD to test replacement altimeter, worked.	
2	1400	enter international waters ~20:00	
3		transit	22 JUN, Wednesday
4		Time change from GMT-4hrs to GM -3hrs.	23 JUN, Thursday
4		transit	
5		transit	24 JUN, Friday
6	0000	Time change from GMT-3hrs to GM -2hrs.	25 JUN, Saturday
6	1030	**CTD#003**, 1000m, 3 OOI releases	
6	1412	**CTD#004**, aborted at ~1800 m, 8 OOI and 10 OSNAP microcats	
6	~1630	**CTD#004b**, restarted acquisition at ~600m to surface	
6	1939	**CTD#005**, spare fish installed, 3 OOI releases	
7	1045	**CTD#006**, repaired fish, reinstalled, 3 OOI releases	26 JUN, Sunday
7	1514	**CTD#007**, 14 OSNAP microcats, 1 OSNAP microcat w optode, 5 RBR duets	
8	0000	Time change from GMT-2hrs to GMT-1hrs.	27 JUN, Monday
8	0959	**CTD#008**, 16 OSNAP microcats.	
9	1600	Arrive Glider Box.	28 JUN, Tuesday
9	1644	Deploy gliders	
9	1745	**CTD#009**, 2 OOI acoustic releases.	
9		Transit SUMO.	
10	1100	Made call to not deploy SUMO, too windy in morning, then seas a little too squirrely.	29 JUN, Wednesday

10	1326	**CTD#010**@M3; pinged on mooring releases, all good.	
10	1736	**CTD#011**@M2; pinged on mooring releases, all good.	
11	0800	**Deploy SUMO**	30 JUN, Thursday
11	1526	**CTD #012**@SUMO site	
11	1708	Anchor survey SUMO	
12	0803	**Deploy HYPM**	01 JUL, Friday
12	1338	Recover glider	
12	1535	**CTD#013**@HYPM	
12	1759	Anchor Survey HYPM	
13	0801	**Deploy FLMB**	02 JUL, Saturday
	1343	**CTD#014**@FLMB w/ 3 acoustic releases (enable, range, release) [33041 33042 28038] – 2 releases not enabled prior to launch; try again. Release [33042] successful.	
13		**CTD#015**@FLMB w/ same exact 3 acoustic releases [33041 33412 28038]	
13		Anchor survey FLMB	
14	0757	**Deploy FLMA**	03 JUL, Sunday
14	1410	**Recover M3**	
14	1718	Anchor survey FLMA	
15	0615	**CTD#016**@M4 calibration w/ 2 acoustic releases	04 JUL, Monday
15	0921	**Recover M4**	
15	1305	**Deploy M4**	
15	1430	M4 anchor survey	
16	0617	**CTD#017**@M1 calibration, w/ 2 acoustic releases [30846 35317]	05 JUL, Tuesday
	0848	**Recover M1**	
16	12:30	**Rebuild M1 Sphere**	
16	12:59	**CTD#018**@M1 caldip; **Triplicates for O2; Insanity cast.**	
16	~14:00	Mooring work halted due to weather.	
16		Transit FLMA.	
16	20:17	**CTD#019**@FLMA.	
17	0800	**Recover SUMO8**	06 JUL, Wednesday
17	1634	**CTD#020**@SUMO8, capdip for 13 osnap microcats	
18	0803	**Deploy M1**	07 JUL, Thursday
18	1200	Anchor survey	
18	1500	Transit FLMA	
19	0632	**Recover M2**	08 JUL, Friday
19	1154	**Recover FLMA top half**	
19	1325	**Recover FLMA bottom half**	

19	1750	**CTD#021** Post M2 caldips w/O2	
20	0629	**Recover FLMB top half**	09 JUL, Saturday
20		Work stopped due to weather – riding out storm.	
21	0810	**Recover HYPM**	10 JUL, Sunday
21	1448	**Recover FLMB bottom half**	
22	0807	**Deploy M2**	11 JUL, Monday
22	11:15	Anchor survey M2	
22	1356	**Deploy M3**	
22	1644	Anchor survey M3	
23	0828	**CTD#022** OOI "OSNAP" microcat caldips	12 JUL, Tuesday
23		Begin transit to Reykjavik	
24	0832	**CTD#023** test LADCP for upcoming OSNAP cruises	13 JUL, Wednesday
25		transit	14 JUL, Thursday
26		transit	15 JUL, Friday
27		Arrive Reykjavik	16 JUL, Saturday

Appendix B: Mooring recovery diagrams for moorings M1-M4.

AR69-01-2022-RECOVER LOG

gray, raining 40 / 400 m away

Release Fired 0948

Sphere seen 0948

Hooked at 10:05

Date (YYYY-MM-DD) 2022-07-05

Surveyed Position:
59° 54.178'N
41° 06.652'W
Depth (corrected): 2081m
AR46-01 23-August-2020

*Please record serial number of wirerope segments.

Note A
Clamp RBR Virtuoso Below
50 meter Aquadopp
500 meter Aquadopp
1000 meter Aquadopp
1750 meter Aquadopp
2025 meter Aquadopp

Table A
Instrument Depth and Marking

Instrument	Serial No.	Mount at
SBE 37 SMP		300 m

Table B
Instrument Depth and Marking

Instrument	Serial No.	Mount at
SBE 37 SMP		750 m

Table C
Instrument Depth and Marking

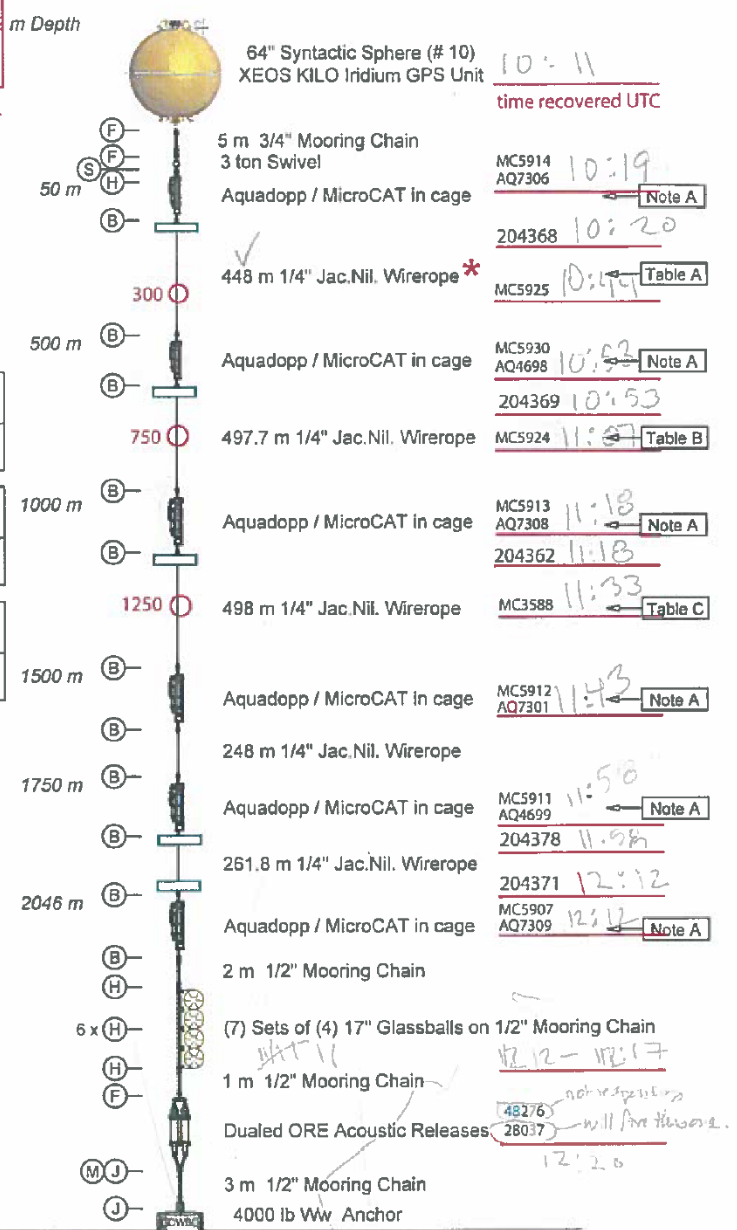
Instrument	Serial No.	Mount at
SBE 37 SMP		1250 m

Hardware Required (per mooring without spares)

(33)	5/8" Anchor Shackle
(3)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(25)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation

(B)	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
(F)	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
(H)	(2) 5/8" SH, (1) 5/8" SL
(J)	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
(M)	Master Link
(S)	Swivel



Mooring Operations & Engineering
www.mooringops@whoi.edu
Rev 1.0

Greenland Deep Western Boundary Current M1
To Be Deployed 2020

Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder
file OSNAP Bower date 03/19/2020

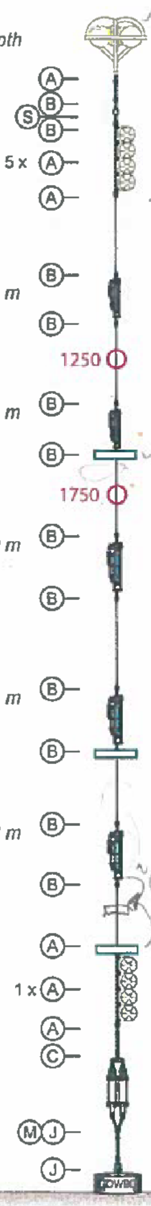
AR69-01-2022-RECOVER LOG

Surveyed Position:
59° 51.436'N
40° 41.522'W
Depth (corrected): 2433 m
AR46-01 22 August 2020

Date (YYYY-MM-DD) 2022-07-08
07:32 fired release

* Please record serial number of wirerope segments.

Fire wind speed ~ 10 knots
45.5°F / 7.5°C



3 Ball Radio Float	07:46 (time recovered UTC)
2 m 3/8" Mooring Chain; 3 ton Swivel	07:56 – 08:07
(6) Sets of (4) 17" Glassballs on 3/8" Mooring Chain	HHT I
20 m 3/16" Jac.Nil. Wirerope*	
Aquadopp / MicroCAT in cage	MC5909, AQ7299 — 08:11
497.4 m 3/16" Jac.Nil. Wirerope	MC5927 — 08:28 — Table A
Aquadopp / MicroCAT in cage	MC5929, AQ7328 — 08:39 — Note A
497.4 m 3/16" Jac.Nil. Wirerope	204373; MC5926 — 08:53 — Table B
Aquadopp / MicroCAT in cage	MC5933, AQ7307 — 09:03
189.1 m 3/16" Jac.Nil. Wirerope	
Aquadopp / MicroCAT in cage	MC5931, AQ7327 — 09:16 — Note A; 204379 — 09:16
190 m 3/16" Jac.Nil. Wirerope	
Aquadopp / MicroCAT in cage	MC5932, AQ9312 — 09:30 — Note A
16.7 m 3/16" Jac.Nil. Wirerope	204377 — 09:32
(2) Sets of (4) 17" Glassballs on 3/8" Mooring Chain	//
5 m 3/8" Mooring Chain	09:35
Dualed ORE Acoustic Releases	35616, 31336 — 09:39
5 m 3/8" Mooring Chain	
2333 lb Ww Anchor	

Note A
Clamp RBR Virtuoso Below
1500 meter Aquadopp
2200 meter Aquadopp
2423 meter Aquadopp

Table A — Instrument Depth and Marking

Instrument	Serial No.	Mount at
SBE 37 SMP		1250 m

Table B — Instrument Depth and Marking

Instrument	Serial No.	Mount at
SBE 37 SMP		1750 m

Hardware Required (per mooring without spares)

(35)	1/2" Anchor Shackle (SH)
(12)	5/8" Anchor Shackle
(1)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(25)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation

(A)	(2) 1/2" SH, (1) 5/8" SL
(B)	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
(C)	(1) 1/2" SH, (1) 5/8" SL, (1) 3/4" SH
(J)	(1) 1/2" SH, (1) 5/8" SL, (1) 7/8" SH
(M)	Master Link
(S)	Swivel

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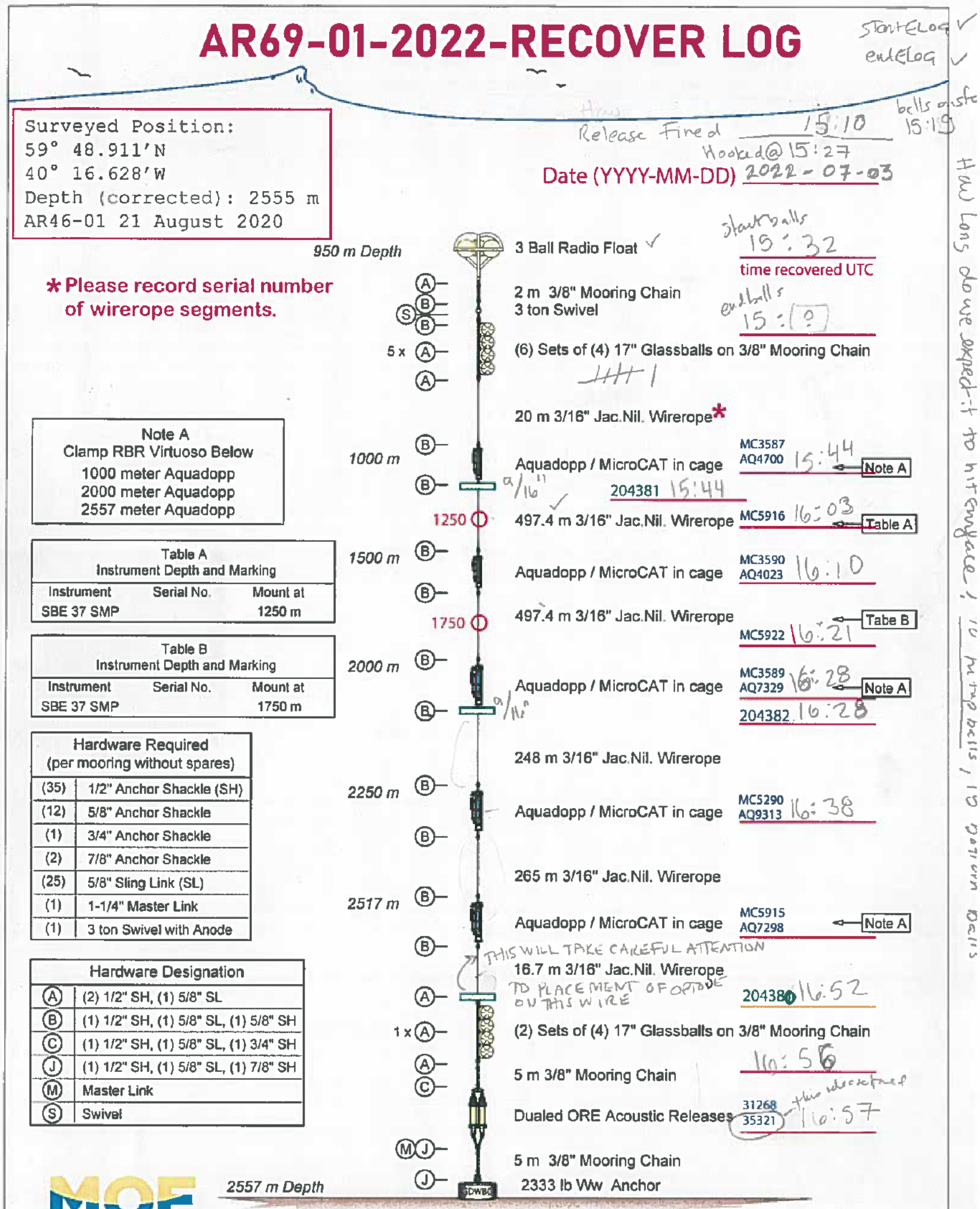
Greenland Deep Western Boundary Current M2
To Be Deployed 2020

Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder
file: OSNAP Bower — date 03/19/2020

AR69-01-2022-RECOVER LOG

Surveyed Position:
59° 48.911'N
40° 16.628'W
Depth (corrected): 2555 m
AR46-01 21 August 2020

*** Please record serial number of wirerope segments.**



Note A
Clamp RBR Virtuoso Below
1000 meter Aquadopp
2000 meter Aquadopp
2557 meter Aquadopp

Table A
Instrument Depth and Marking

Instrument	Serial No.	Mount at
SBE 37 SMP		1250 m

Table B
Instrument Depth and Marking

Instrument	Serial No.	Mount at
SBE 37 SMP		1750 m

Hardware Required
(per mooring without spares)

(35)	1/2" Anchor Shackle (SH)
(12)	5/8" Anchor Shackle
(1)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(25)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation

(A)	(2) 1/2" SH, (1) 5/8" SL
(B)	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
(C)	(1) 1/2" SH, (1) 5/8" SL, (1) 3/4" SH
(J)	(1) 1/2" SH, (1) 5/8" SL, (1) 7/8" SH
(M)	Master Link
(S)	Swivel

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Greenland Deep Western Boundary Current M3
To Be Deployed 2020

Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder
file: OSNAP Bower | date: 03/18/2020

400m due north

AR69-01-2022-RECOVER LOG

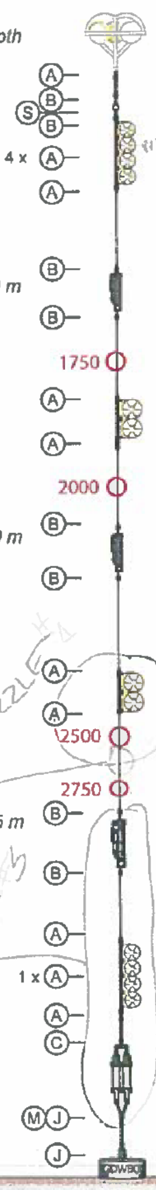
Elos Start ☑
Elos end ☐

Surveyed Position:
59° 38.737′N
38° 34.017′W
Depth (corrected): 2984 m
AR46-01 24 August 2020

FIRE RELEASES 10:20
FLOTATION SIGHTED 10:35 ~15min (10 min)
Date (YYYY-MM-DD) 2022-07-04

*** Please record serial number of wirerope segments.**

Captain Mike's rule of thumb ...



1455 m Depth

3 Ball Radio Float — 10:49 time recovered UTC

2 m 3/8" Mooring Chain
3 ton Swivel — start 10:49 – 10:56

(5) Sets of (4) 17" Glassballs on 3/8" Mooring Chain — 4 x (A) — tangled, cleared — wuzzle

20 m 3/16" Jac.Nil. Wirerope *

1500 m — Aquadopp / MicroCAT in cage — MC5908 AQ7310 — 10:58

1750 m — 344.5 m 3/16" Jac.Nil. Wirerope — MC5920 — 11:11 ← Table A

(1) Set of (2) 17" Glassballs on 3/8" Mooring Chain — 11:13

2000 m — 400 m 3/16" Jac.Nil. Wirerope — MC5921 — 11:20 ← Table B

2250 m — Aquadopp / MicroCAT in cage — MC5904 AQ7300 — 11:25

189.7 m 3/16" Jac.Nil. Wirerope

(1) Set of (2) 17" Glassballs on 3/8" Mooring Chain — 11:36 — wuzzle

2500 m — 500 m 3/16" Jac.Nil. Wirerope — MC5918 11:36 ← Table C

2750 m — MC5917 11:57 — wuzzle #2

2945 m — Aquadopp / MicroCAT in cage — MC5910 AQ4702 — 12:03 — wuzzle #3

16.8 m 3/16" Jac.Nil. Wirerope

(2) Sets of (4) 17" Glassballs on 3/8" Mooring Chain — 1 x (A) — 12:03

5 m 3/8" Mooring Chain

Dualed ORE Acoustic Releases — 27687 54690 — 12:03 — enclosed release from 2020 fired this one ~2:22

5 m 3/8" Mooring Chain

2984 m Depth — 2333 lb Ww Anchor

+ wicked tight hhg bolts

Table A Instrument Depth and Marking		
Instrument	Serial No.	Mount at
SBE 37 SMP		1750 m

Table B Instrument Depth and Marking		
Instrument	Serial No.	Mount at
SBE 37 SMP		2000 m

Table C Instrument Depth and Marking		
Instrument	Serial No.	Mount at
SBE 37 SMP		2500 m
SBE 37 SMP		~~2800~~ m 2750 m

Hardware Required (per mooring without spares)	
(37)	1/2" Anchor Shackle (SH)
(8)	5/8" Anchor Shackle
(1)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(24)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation	
(A)	(2) 1/2" SH, (1) 5/8" SL
(B)	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
(C)	(1) 1/2" SH, (1) 5/8" SL, (1) 3/4" SH
(J)	(1) 1/2" SH, (1) 5/8" SL, (1) 7/8" SH
(M)	Master Link
(S)	Swivel

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Greenland Deep Western Boundary Current M4
To Be Deployed 2020

Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder
file OSNAP Bower date 03/20/2020

Appendix C: Mooring deployment diagrams for moorings M1-M4.

AR69-01-2022 DEPLOY LOG

@rukeovs water depth ~ 3.5 mi / 110 m fallback

M1 Target Position:
59° 54.18'N
41° 06.48'W
Depth (corrected): 2086 m

Date (YYYY-MM-DD) 2022-07-07

* Please record serial number of wirerope segments.

Note A
Clamp RBR Virtuoso Below
50 meter Aquadopp
500 meter Aquadopp
1000 meter Aquadopp
1750 meter Aquadopp
2046 meter Aquadopp

Table A
Instrument Depth and Marking

Instrument	Serial No.	Mount at
SBE 37 SMP		300 m

Table B
Instrument Depth and Marking

Instrument	Serial No.	Mount at
SBE 37 SMP		750 m

Table C
Instrument Depth and Marking

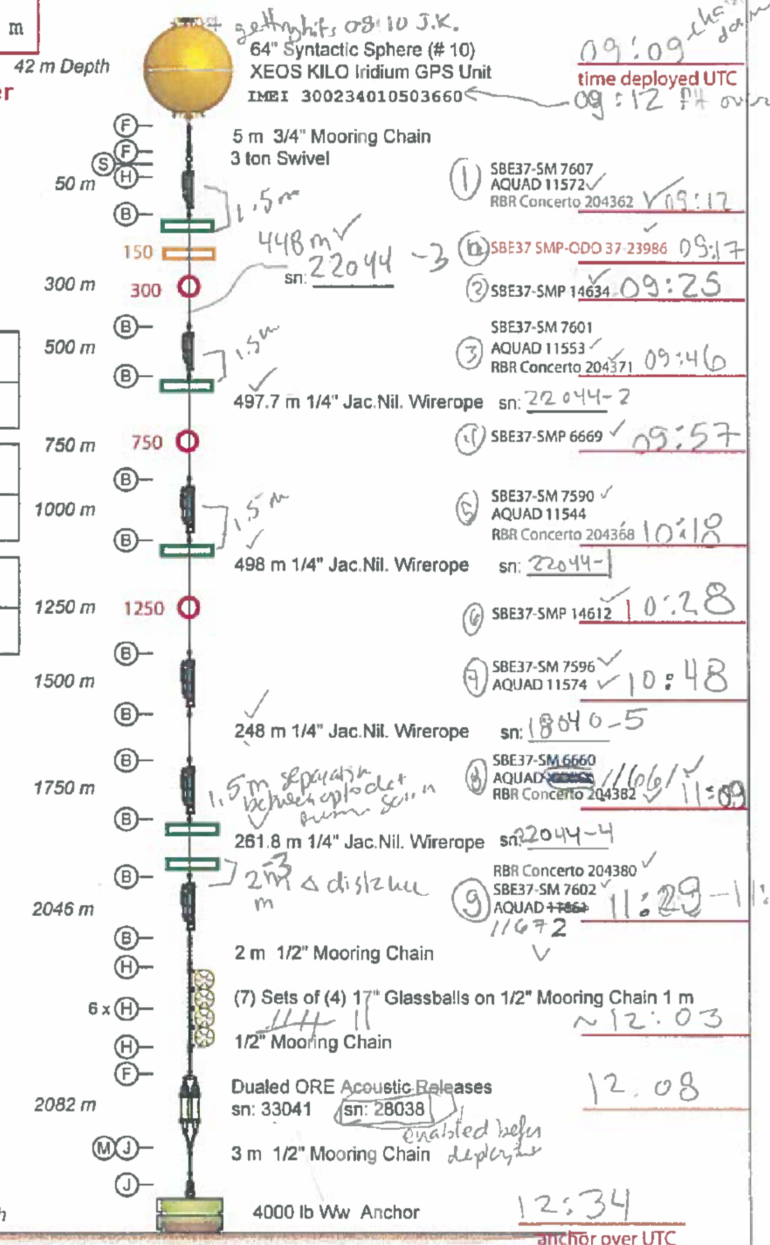
Instrument	Serial No.	Mount at
SBE 37 SMP		1250 m

Hardware Required (per mooring without spares)

(10)	1/2" Anchor Shackle
(35)	5/8" Anchor Shackle
(3)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(25)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation

(B)	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
(F)	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
(H)	(2) 5/8" SH, (1) 5/8" SL
(J)	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
(M)	Master Link
(S)	Swivel



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Greenland Deep Western Boundary Current M1
To Be Deployed 2022

Woods Hole Oceanographic Institution	
designed by John Kemp, drawn by Jim Ryder	
file OSNAP Bower	date 05/26/2022

AR69-01 2022 DEPLOY LOG

2440 / 24 / 2436

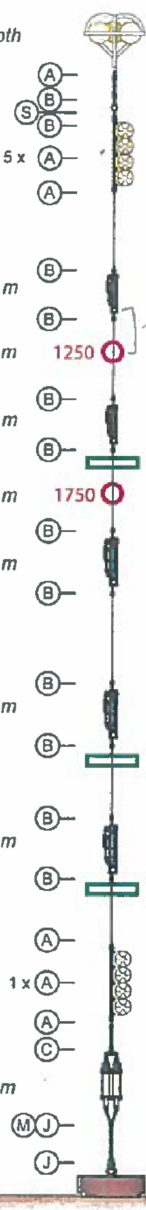
Anchor Drop ________ UTC
Depth Knudsen 2460 uncorrected.
Depth Multibeam off
Date (YYYY-MM-DD) 2022-07-11

course 195
fallback 280 m
distance 3.6 nm

M2 Target Position:
59° 51.58′N
40° 41.43′W
Depth (corrected): 2423 m

+17 2441

*** Please record serial number of wirerope segments.**



950 m Depth

300434066888110 ✓
IMEI 300534[redacted]
3 Ball Radio Float with Xeos Apollo — 09:07 time deployed UTC

(A) (B) (S) (B)
2 m 3/8" Mooring Chain
3 ton Swivel

5 x (A) (A)
(6) Sets of (4) 17" Glassballs on 3/8" Mooring Chain — B 3 . XX
~~||||~~ |

20 m 3/16" Jac.Nil. Wirerope ✓
sn: 18040-32

1000 m (B) (B)
two layer AD?
SBE37-SM 5921 ✓
AQUAD 11555 — 09:22

1250 m — 1250
SBE37-SMP 14635 ✓ — 09:33

497.4 m 3/16" Jac.Nil. Wirerope
sn: 22044-8 ✓

1500 m (B) (B)
SBE37-SM 6056 ✓
AQUAD 11647 ✓ — 09:55
RBR Concerto 204381 ✓

1750 m — 1750
SBE37-SMP 14599 ✓ — 10:06

497.4 m 3/16" Jac.Nil. Wirerope
sn: 220 44-10 ✓

2000 m (B) (B)
needed vulcanized tape, clamp not grabbing
SBE37-SM 7585 ✓
AQUAD 11575 — 10:25

189.1 m 3/16" Jac.Nil. Wirerope ✓
sn: 22044-17 ✓

2191 m (B) (B)
SBE37-SM 7588
AQUAD 11660 ✓ — 10:43
RBR Concerto 204369 ✓

190 m 3/16" Jac.Nil. Wirerope ✓
sn: 22044-16 ✓

2383 m (B) (B)
SBE37-SM 7597
AQUAD 11642 ✓✓ — 11:01
RBR Concerto 204378

16.7 m 3/16" Jac.Nil. Wirerope ✓
sn: 20004-23 ✓

(A) 1 x (A) (A) (C)
(2) Sets of (4) 17" Glassballs on 3/8" Mooring Chain ✓✓ — 11:06
5 m 3/8" Mooring Chain

2417 m
Dualed ORE Acoustic Releases (Dualed) ✓
sn: ~~[illegible]~~ sn: 33042/33412 ✓ — 11:13
(M) (J)
5 m 3/8" Mooring Chain

(J)
2423m Depth
2333 lb Ww Anchor — 11:56 anchor over UTC

Note A
Clamp RBR Virtuoso Below
1500 meter Aquadopp
2200 meter Aquadopp
2383 meter Aquadopp

Table A
Instrument Depth and Marking

Instrument	Serial No.	Mount at
SBE 37 SMP		1250 m

Table B
Instrument Depth and Marking

Instrument	Serial No.	Mount at
SBE 37 SMP		1750 m

Hardware Required
(per mooring without spares)

(35)	1/2" Anchor Shackle (SH)
(12)	5/8" Anchor Shackle
(1)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(25)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation

(A)	(2) 1/2" SH, (1) 5/8" SL
(B)	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
(C)	(1) 1/2" SH, (1) 5/8" SL, (1) 3/4" SH
(J)	(1) 1/2" SH, (1) 5/8" SL, (1) 7/8" SH
(M)	Master Link
(S)	Swivel

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Greenland Deep Western Boundary Current M2
To Be Deployed 2022

Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder
file OSNAP Bower | date 05/26/2022

AR69-01 2022 DEPLOY LOG

Anchor Over 17:26 UTC
Knudsen Depth 2588 Uncorrected

M3 Target Position:
59° 48.87'N
40° 16.63'W
Depth (corrected): 2557 m

Date (YYYY-MM-DD) 2022 07 11

*** Please record serial number of wirerope segments.**

Fallback 350
Distance ______
Course ______

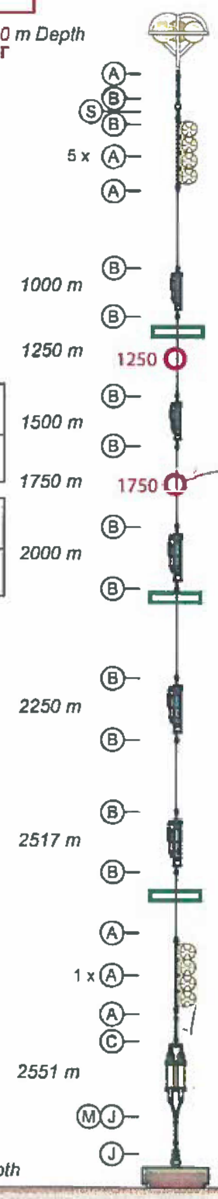
Note A
Clamp RBR Virtuoso Below
1000 meter Aquadopp
2000 meter Aquadopp
2517 meter Aquadopp

Table A Instrument Depth and Marking		
Instrument	Serial No.	Mount at
SBE 37 SMP		1250 m

Table B Instrument Depth and Marking		
Instrument	Serial No.	Mount at
SBE 37 SMP		1750 m

Hardware Required (per mooring without spares)	
(35)	1/2" Anchor Shackle (SH)
(12)	5/8" Anchor Shackle
(1)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(25)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation	
(A)	(2) 1/2" SH, (1) 5/8" SL
(B)	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
(C)	(1) 1/2" SH, (1) 5/8" SL, (1) 3/4" SH
(J)	(1) 1/2" SH, (1) 5/8" SL, (1) 7/8" SH
(M)	Master Link
(S)	Swivel



30043406663920
IMEI 3002340~~[illegible]~~
3 Ball Radio Float with Xeos Apollo — 14:56 time deployed UTC

2 m 3/8" Mooring Chain
3 ton Swivel
(6) Sets of (4) 17" Glassballs on 3/8" Mooring Chain — ~~1111~~ / — 15:02

20 m 3/16" Jac.Nil. Wirerope ✓
sn: 20064-22

SBE37-SM 7593 ✓
AQUAD 11587 ✓
RBR Concerto 2043~~7~~ 204377 — 15:10

497.4 m 3/16" Jac.Nil. Wirerope ✓
sn: 22044-7

SBE37-SMP 6668 ✓ — 15:20

SBE37-SM 7598 ✓
AQUAD 11650 ✓ — 15:40

591.7

SBE37 -SMP ~~6664~~ — 15:49

497.4 m 3/16" Jac.Nil. Wirerope
sn: 22044-9

SBE37-SM 6655 ✓
AQUAD 11677 ✓
RBR Concerto 204~~373~~ 204373 ✓ 204373 — 16:09

248 m 3/16" Jac.Nil. Wirerope ✓
sn: 20004-14

SBE37-SM 7581 ✓
AQUAD 12450 ✓ — 16:28

265 m 3/16" Jac.Nil. Wirerope ✓
sn: 22044-13

SBE37-SM 7586 ✓
AQUAD 11654 ✓
RBR Concerto 204379 ✓ — 16:51

16.7 m 3/16" Jac.Nil. Wirerope ✓
sn: 22644-19

(2) Sets of (4) 17" Glassballs on 3/8" Mooring Chain — //

5 m 3/8" Mooring Chain — 16:55

Dualed ORE Acoustic Releases
sn: ~~[illegible]~~ 30846 sn: ~~[illegible]~~ 35317 — 17:02

5 m 3/8" Mooring Chain
2333 lb Ww Anchor
enabled — 17:26 anchor over UTC

17:44 anchored

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Greenland Deep Western Boundary Current M3
To Be Deployed 2022

Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder
file: OSNAP Bower | date: 05/26/2022

AR69-01-2022 DEPLOY LOG

4.0 mi 250 m fallback

4.0 mi / 2nd fished 250 m fallback

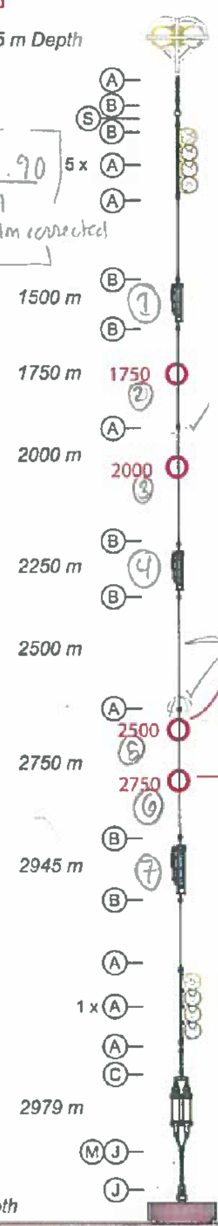
M4 Target Position:
59° 38.76′N
38° 33.99′W
Depth (corrected): 2984 m

Knudsen = (24m) Carter tables

* Please record serial number of wirerope segments.

ANCHOR DROP
Knudsen (uncorrected) 3007.90 −24 = 2984m corrected
Date/time 2022-07-04 16:50
Location 59°38.610N 38°34.069W

Date (YYYY-MM-DD) 2022-07-04



got hits on apollo
IMEI 300434066584620 ✓
3 Ball Radio Float with Xeos Apollon sn 0599 — 14:05 time deployed UTC

2 m 3/8" Mooring Chain
3 ton Swivel — end @ 14:12

(6) Sets of (4) 17" Glassballs on 3/8" Mooring Chain ~~////~~ /

20 m 3/16" Jac.Nil. Wirerope ✓ sn: 18040-58

SBE37-SM 7587 ✓ AQUAD 11560 ✓ 14:16

SBE37-SMP 11527 14:25

346.7 m 3/16" Jac.Nil. Wirerope ✓ sn: 22044-12

SBE37-SMP 7580 14:45

400 m 3/16" Jac.Nil. Wirerope ✓ sn: 22044-11

SBE37-SM 6664 ✓ AQUAD 11645 ✓ 15:04

SBE37-SMP 8417 ✓ 15:XX

191.9 m 3/16" Jac.Nil. Wirerope ✓ sn: 22044-15

SBE37-SMP 13215 ✓ 15:31

500 m 3/16" Jac.Nil. Wirerope ✓ sn: 22044-6

SBE37-SM 7592 ✓ AQUAD 11551 ✓ 15:49

16.8 m 3/16" Jac.Nil. Wirerope ✓ sn: 22044-18

(2) Sets of (4) 17" Glassballs on 3/8" Mooring Chain 5 m //
3/8" Mooring Chain — 15:53

Dualed ORE Acoustic Releases
sn: ~~33042~~ sn: ~~38472~~
32479 / 31335 — 16:00
5 m 3/8" Mooring Chain — (16:48 echo)
31335 Enabled / in deployment
2333 lb Ww Anchor — 16:50 anchor over UTC

2700 lb actual

Table A		
Instrument Depth and Marking		
Instrument	Serial No.	Mount at
SBE 37 SMP		1750 m

Table B		
Instrument Depth and Marking		
Instrument	Serial No.	Mount at
SBE 37 SMP		2000 m

Table C		
Instrument Depth and Marking		
Instrument	Serial No.	Mount at
SBE 37 SMP		2500 m
SBE 37 SMP		2750 m

Hardware Required (per mooring without spares)	
(35)	1/2" Anchor Shackle (SH)
(8)	5/8" Anchor Shackle
(1)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(23)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation	
(A)	(2) 1/2" SH, (1) 5/8" SL
(B)	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
(C)	(1) 1/2" SH, (1) 5/8" SL, (1) 3/4" SH
(J)	(1) 1/2" SH, (1) 5/8" SL, (1) 7/8" SH
(M)	Master Link
(S)	Swivel

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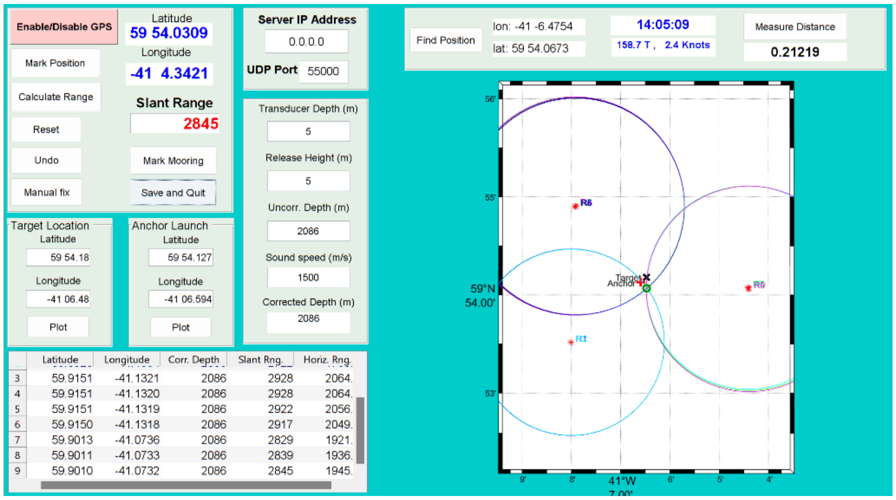
Greenland Deep Western Boundary Current M4
To Be Deployed 2022

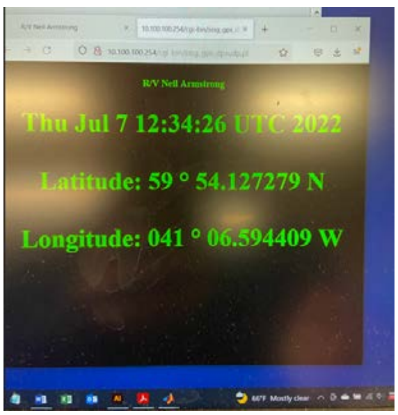
Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder
file: OSNAP Bower date: 05/26/2022

Appendix D. Mooring Anchor Survey Information. Adam Houk used his own software to run surveys, and I re-did all using Art Newhall's Survey 4.1 software. In some cases, it may appear from GUI screen shot that Adam did not use *in situ* sound speed. However, he enters this onto deckbox, so incorporated there. Adam's survey results were sent to bridge, and are the ones used in the tables in cruise report body. Input data for Houk and Newhall methods are saved with cruise data, both save multiple inputs for each survey site. Adam prefers 1 mn distance from target location for survey sites.

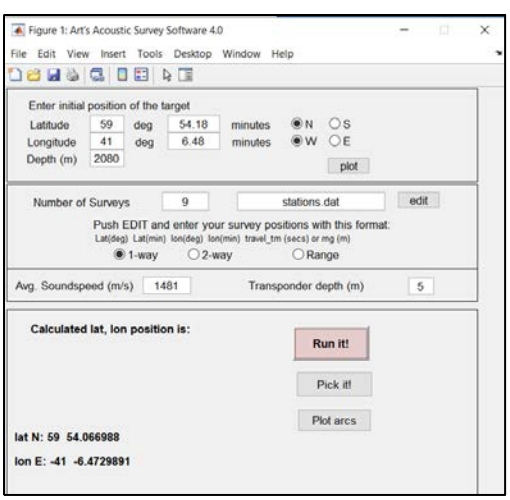
M1:

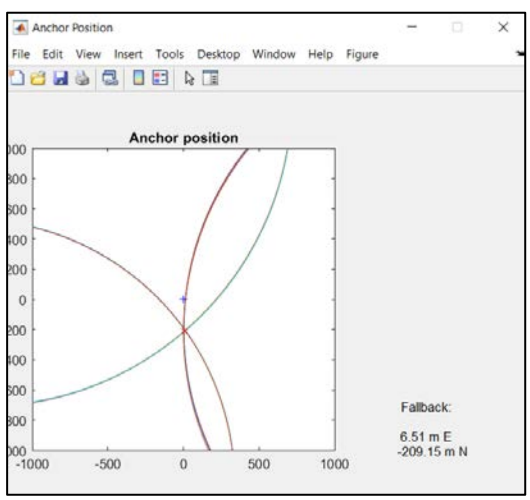
Houk code output:





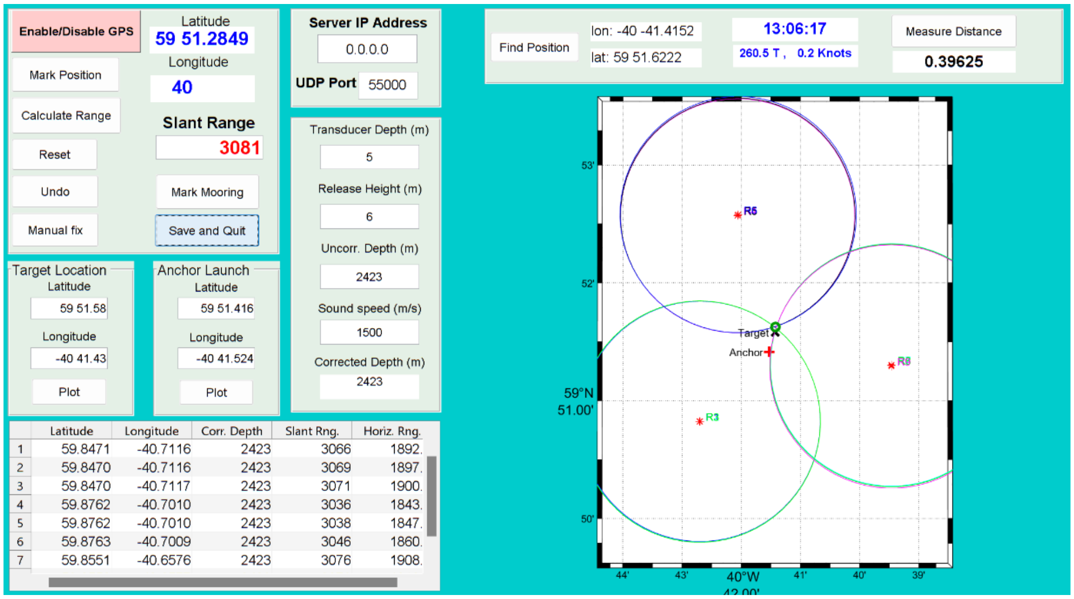
Newhall code output:

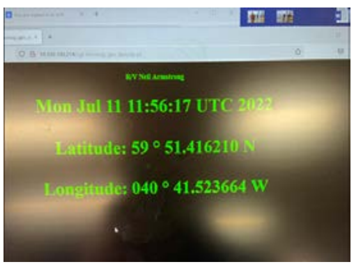




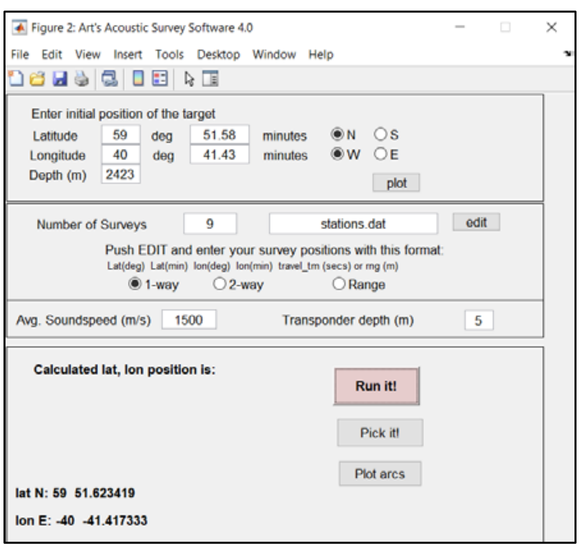
M2:

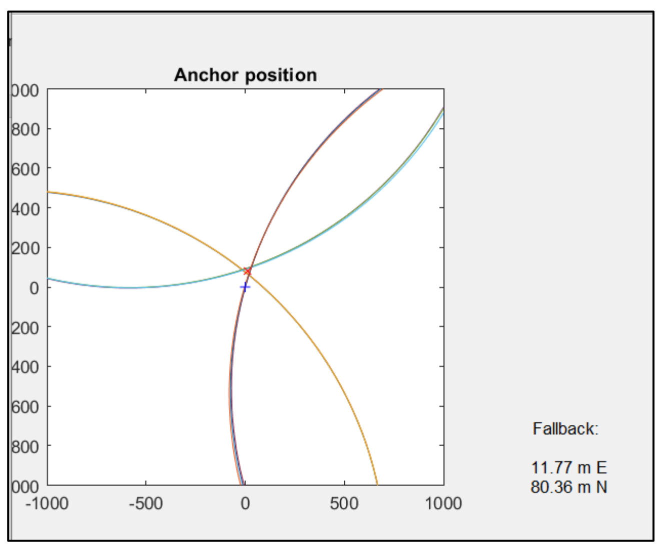
Houk code output:





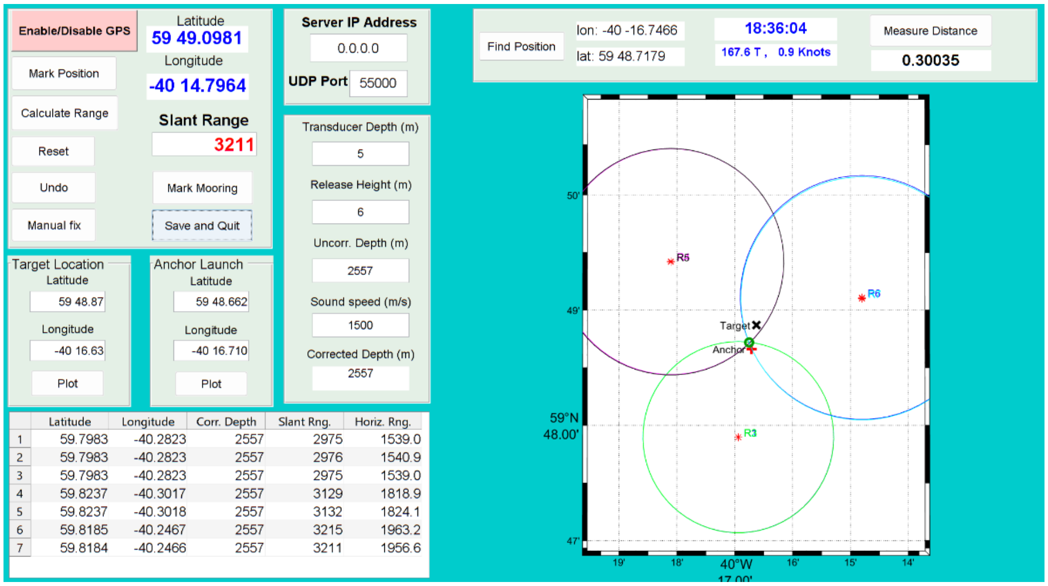
Newhall code output:

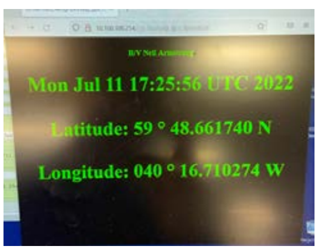




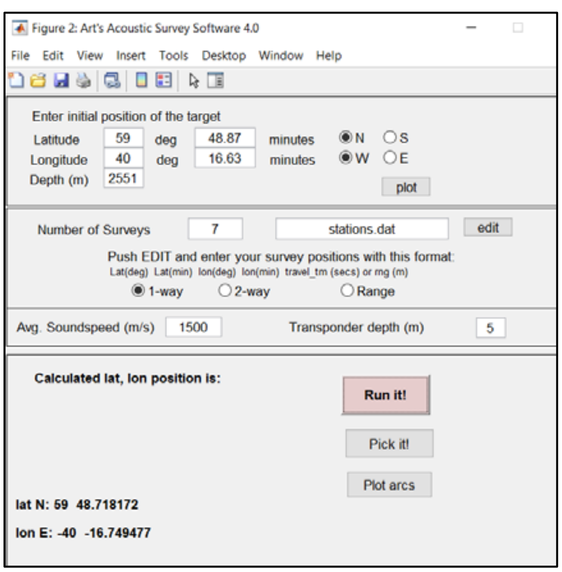
M3:

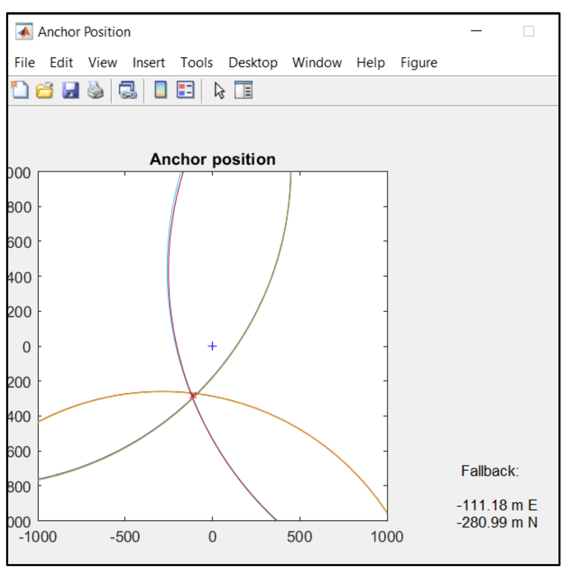
Houk code output:





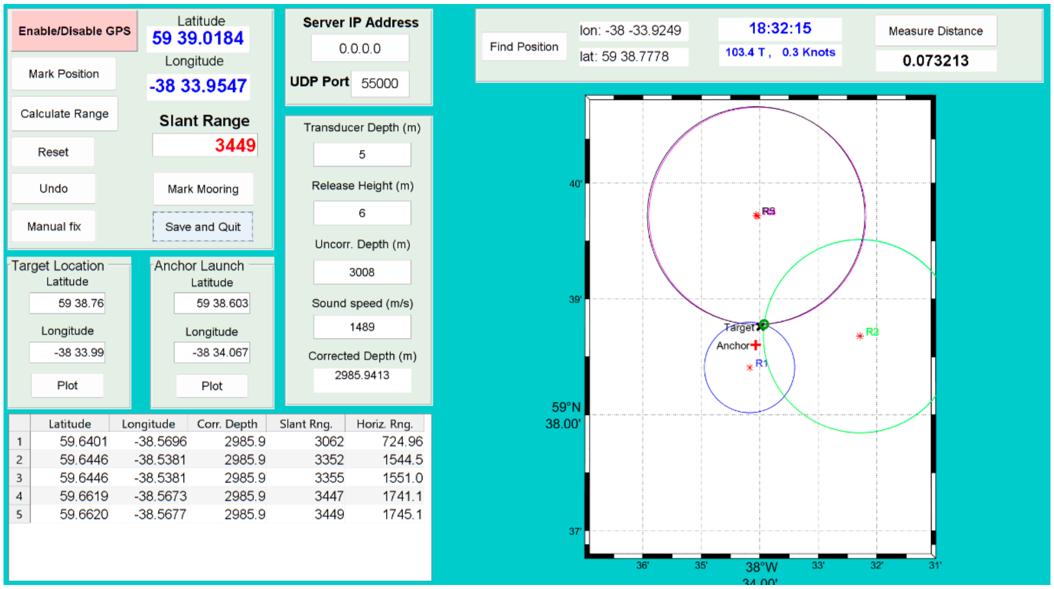
Newhall code output:



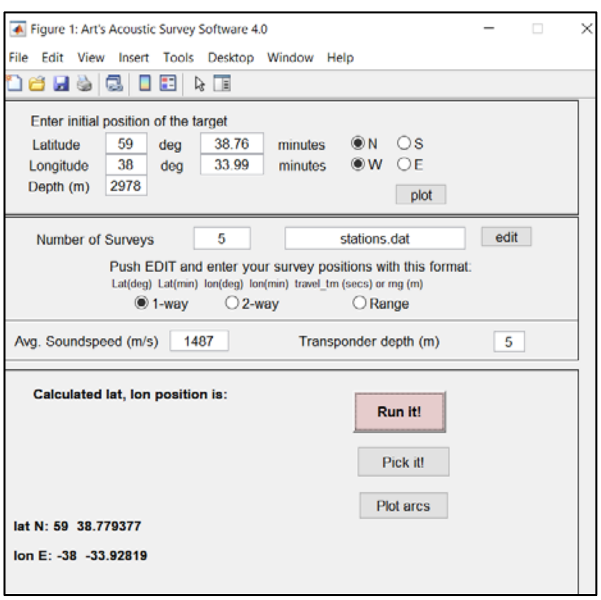


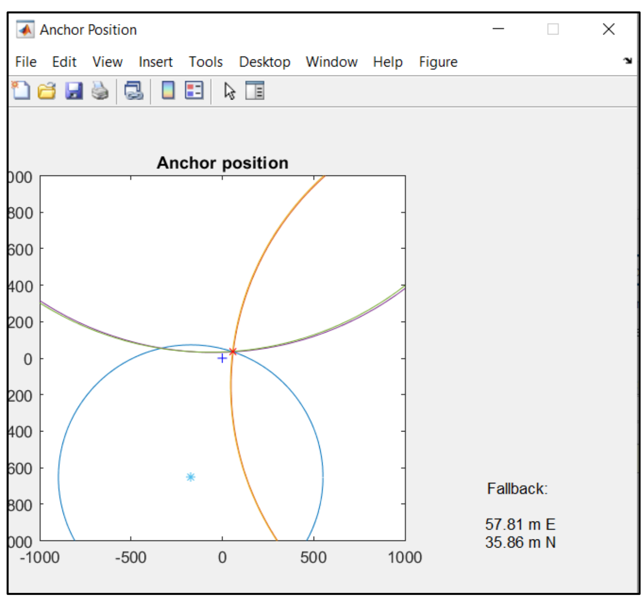
M4:

Houk code output:



Newhall code output:





Appendix E: Recovered instrument summary.

All instrument worked as designed, and reported full data sets, except for: a small segment on M1 300-m microcat 5925 attributed to a bad memory address and M4 2945-m current meter 4702, which leaked and returned 18% good and 82% suspect data. In addition, the caldip data for OOI FLMA bottom instrument failed, so no calibration performed for that instrument. Plots of each instrument out put exist and may be found in the data drive for this cruise.

Mooring	Instrument Type	Nominal Depth (m)	Apparent Depth (m)	Serial Number	Percent Data recovered	Percent Good Data	Post caldipped?	Notes
M1	Aquadopp Current Meter	50		AQD12475	100%	100%	Not applicable (n/a)	
		500		AQD9364	100%	100%	n/a	
		1000		AQD12470	100	100	n/a	
		1500		AQD12466	100	100	n/a	
		1750	1810	AQD9363	100	100	n/a	
		2055		AQD12471	100	100	n/a	
	Seabird SBE37-SM or SBE37-SMP	50	80	5914	~100	~100	yes	
		300	330	5925	~95	~95	yes	BAD MEMORY ADDRESS ON MICROCAT
		500	530	5930	~100	~100	yes	
		750	780	5924	~100	~100	yes	
		1000	1030	5913	~100	~100	yes	
		1250	1290	3588	~100	~100	yes	
		1500	1550	5912	~100	~100	Yes	
		1750	1805	5911	~100	~100	yes	
		2046	2080	5907	~100	~100	yes	
	RBR Concerto	50	n/a	204368	~100	~100	yes	redeployed
		500	n/a	204369	~100	~100	yes	redeployed
		1000	n/a	204362	~100	~100	yes	redeployed
		1750	n/a	204378	~100	~100	yes	redeployed
		2046	n/a	204371	~100	~100	yes	redeployed
	Edgetech ARs	Releases 48276 and 28037 recovered.						
M2	Aquadopp Current Meter	1000		AQD7299	100	100	n/a	
		1500		AQD7328	100	100	n/a	
		2000		AQD7307	100	100	n/a	
		2191		AQD7327	100	100	n/a	
		2383		AQD9312	100	100	n/a	
	Seabird SBE37-SM or SBE37-SMP	1000		5909	~100	~100	yes	
		1250		5927	~100	~100	yes	
		1500		5929	~100	~100	yes	
		1750		5926	~100	~100	yes	

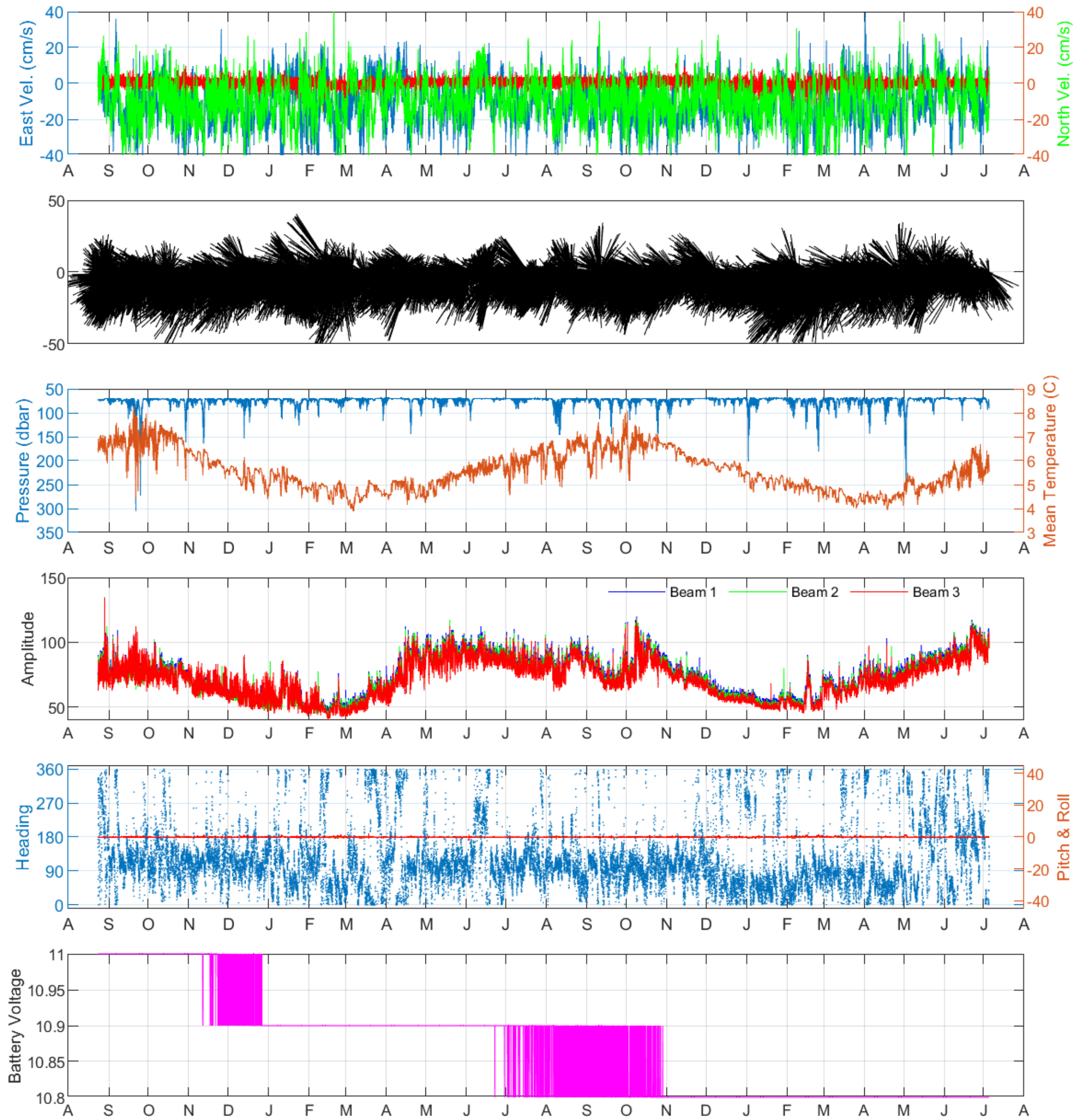
		2000		5933	~100	~100	yes	
		2191		5931	~100	~100	yes	
		2383		5932	~100	~100	yes	
	RBR Concerto	1500		204373	~100	~100	yes	redeployed
		2191		204379	~100	~100	yes	redeployed
		2389		204377	~100	~100	yes	redeployed
	Edgetech ARs	Releases 35616 and 31336 recovered.						
M3	Aquadopp Current Meter	1000	1010	AQD4700 / 9352	100%	100%	n/a	
		1500	1510	AQD4023 / 6744	100%	100%	n/a	
		2000	2010	AQD7329 / 12481	100%	100%	n/a	
		2250	2230	AQD9313 / 14476	100%	100%	n/a	
		2517	2550	AQD7298 / 12456	100%	100%	n/a	
	Seabird SBE37-SM or SBE37-SMP	1000	1100	3587	~100	~100	yes	
		1250	1270	5916	~100	~100	yes	
		1500	1520	3590	~100	~100	yes	
		1750	1780	5922	~100	~100	yes	
		2000	2025	3589	~100	~100	yes	
		2250	2290	5290	~100	~100	yes	
		2517	2565	5915	~100	~100	yes	
	RBR Concerto	1000	n/a	204381	~100	~100	yes	redeployed
		2000	n/a	204382	~100	~100	yes	redeployed
		2523	n/a	204380	~100	~100	yes	redeployed
	Edgetech ARs	Releases 31268 and 35321 recovered.						
M4	Aquadopp Current Meter	1500	1490	AQD7310 / 12474	100%	100%	n/a	
		2250	2275	AQD7300 / 12464	100%	100%	n/a	
		2945	~3000	AQD4702 / 9357	100% (suspect data)	18%	n/a	INSTRUMENT LEAKED THROUGH COMM PORT
	Seabird SBE37-SM or SBE37-SMP	1500	1520	5908	100	100	Yes	
		1750	1780	5920	100	100	Yes	
		2000	2035	5921	100	100	Yes	Redeployed on M2
		2250	2290	5904	100	100	Yes	
		2500	2545	5918	100	100	yes	
		2750	2803	5917	100	100	yes	Redeployed on M3
		2945	3004	5910	100	100	Yes	

	RBR Concerto	No optodes on M4.						
	Edgetech ARs	Releases 27687 and 54690 recovered.						
FLMA-8 (2021-2022)	Seabird SBE37-SMP (IMs)	1000m from bottom	n/a	10227	~100	~100	Yes	
		700m “”	n/a	10265	~100	~100	Yes	
		400m “”	n/a	11597	~100	~100	Yes	
		100m “”	n/a	12619	~100	~100	No	Caldip failed, no data.
FLMB-8 (2021-2022)	Seabird SBE37-SMP (IMs)	1000m “”	n/a	12218	~100	~100	Yes	
		700m “”	n/a	12220	~100	~100	Yes	
		400m “”	n/a	12387	~100	~100	Yes	
		100m “”	n/a	12395	~100	~100	Yes	

Appendix F: Recovered Instrument Data Records.

All figures are of uncalibrated data. Instrument data record plots organized by mooing, with plots showing current meter, then microcat, then optode records, with each instrument type organized by depth.

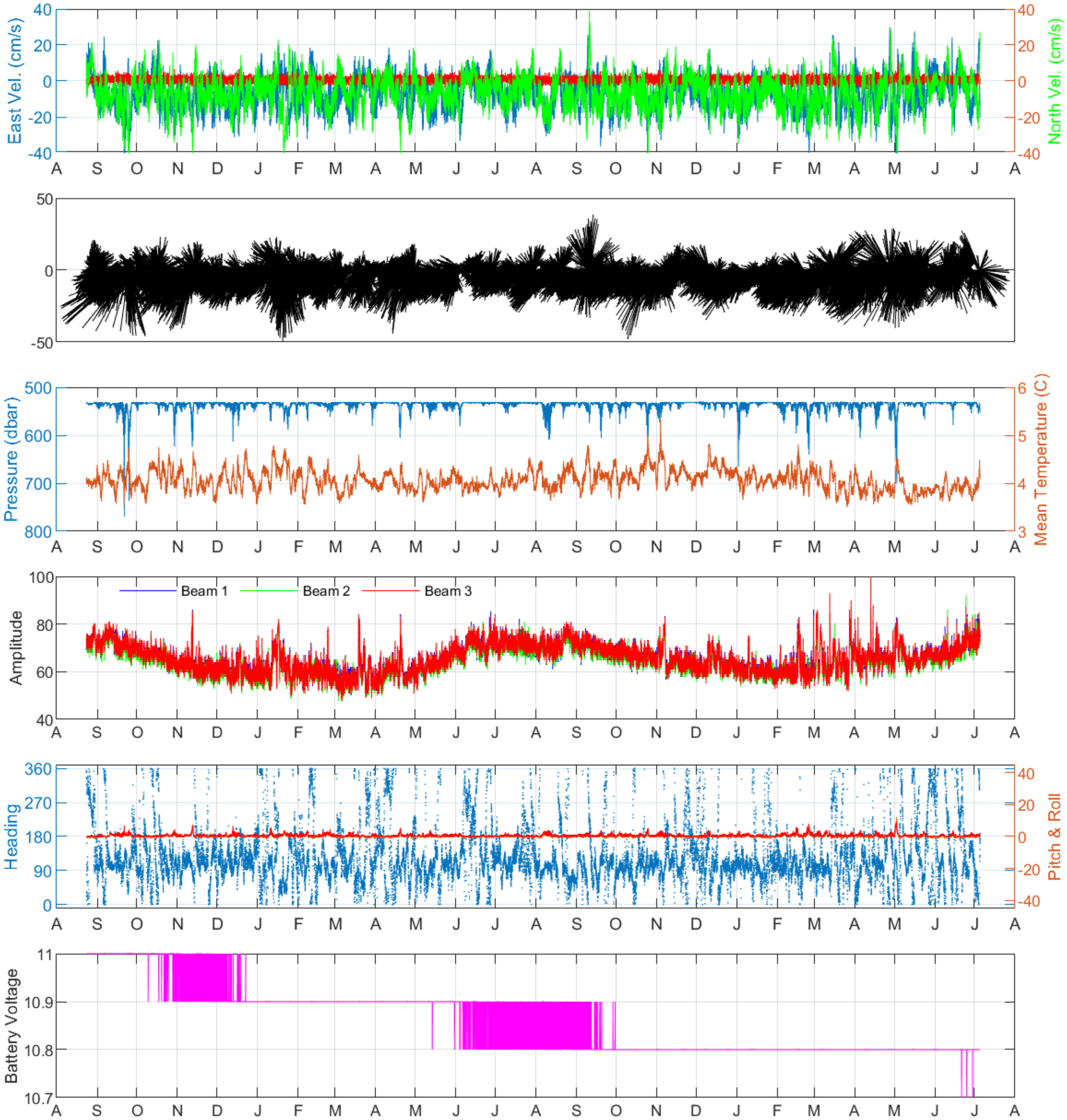
M1



M1-01

Percentage good data: 100%

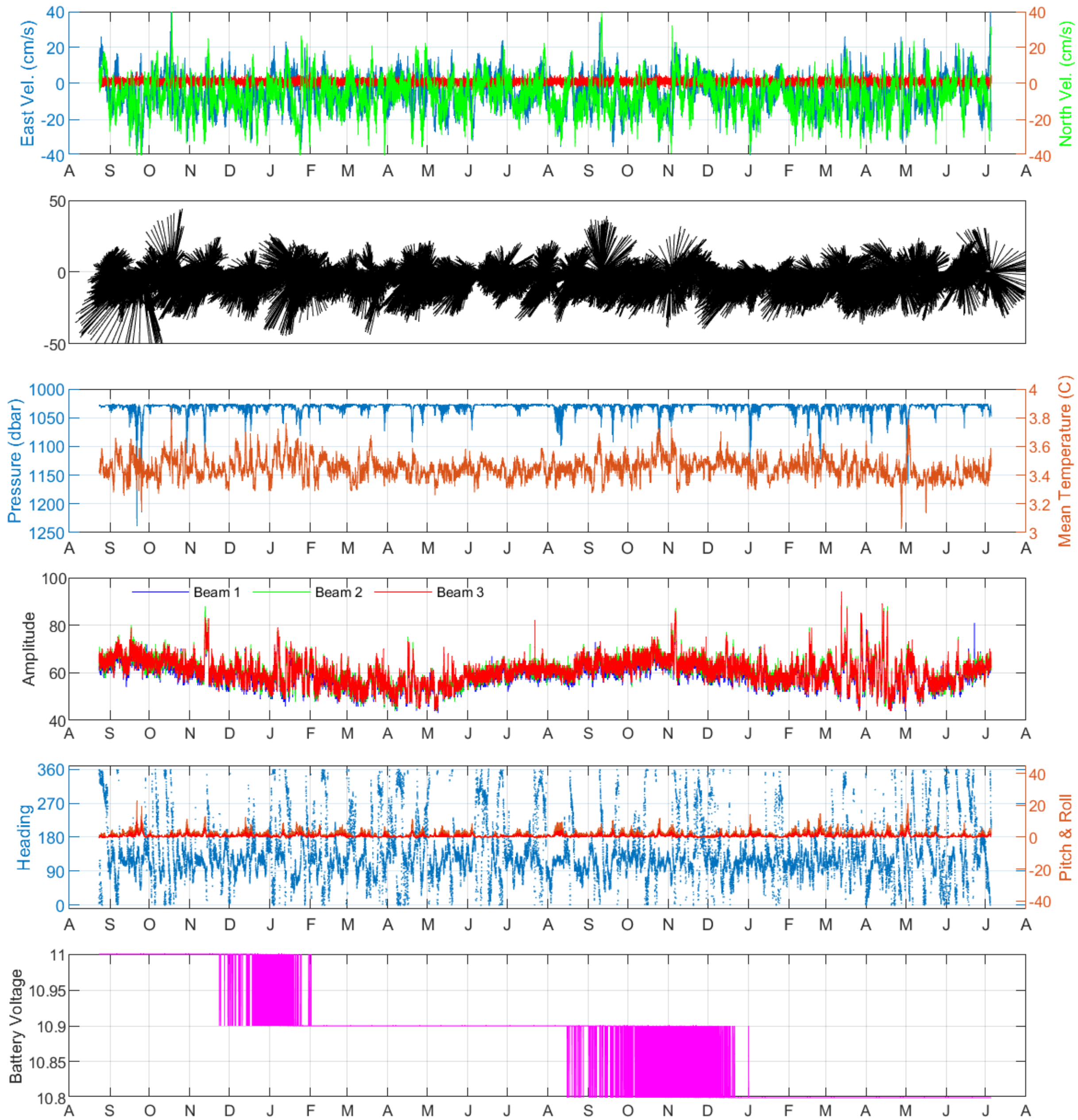
Number of measurements	32729	Serial number	AQD12475
Time of first measurement	8/23/2020	Transmit pulse length	0.75 m
Time of last measurement	7/5/2022 20:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M1-03

Percentage good data: 100%

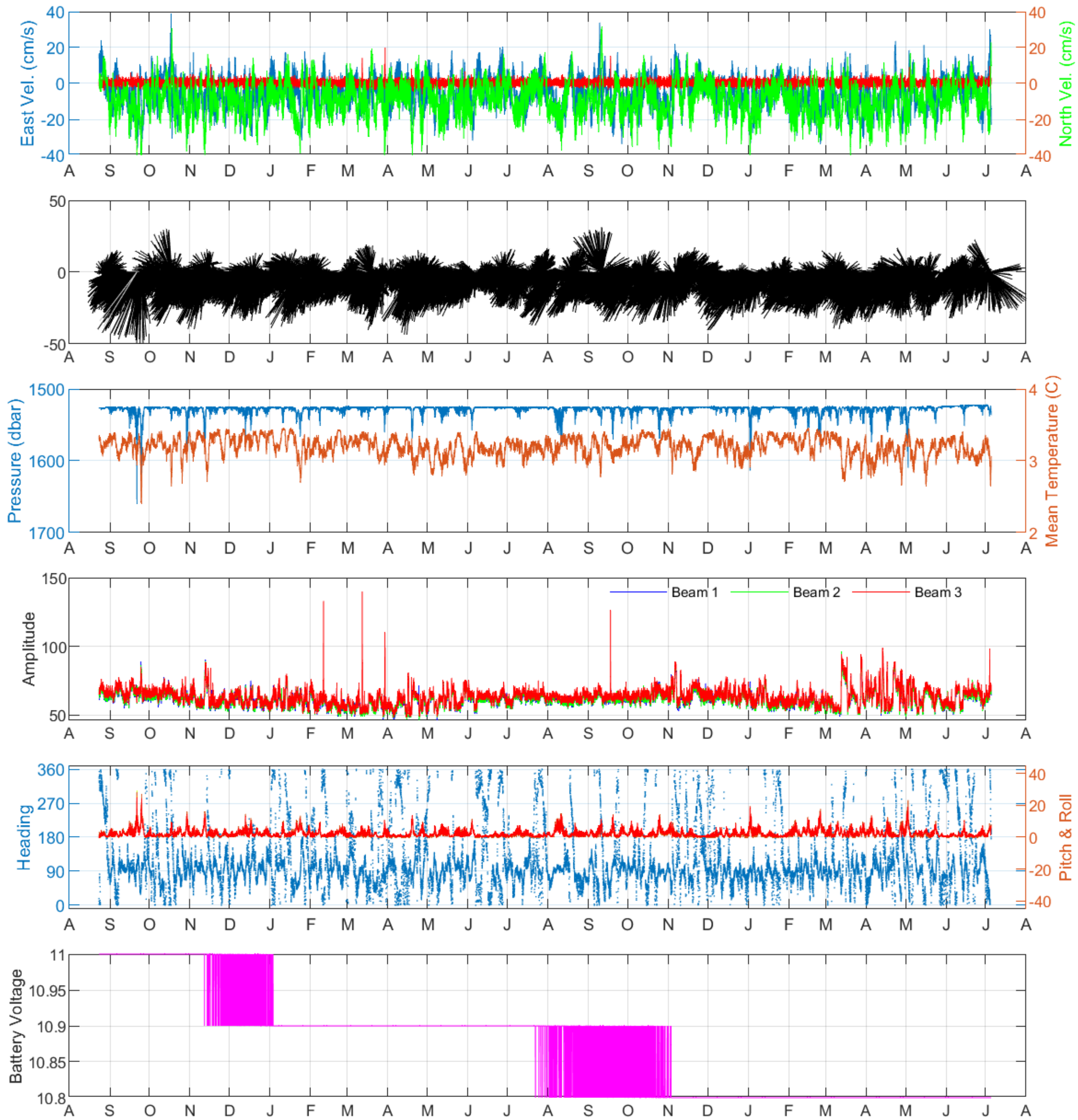
Number of measurements	32729	Serial number	AQD 9364
Time of first measurement	8/23/2020	Transmit pulse length	0.75 m
Time of last measurement	7/5/2022 20:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M1-05

Percentage good data: 100%

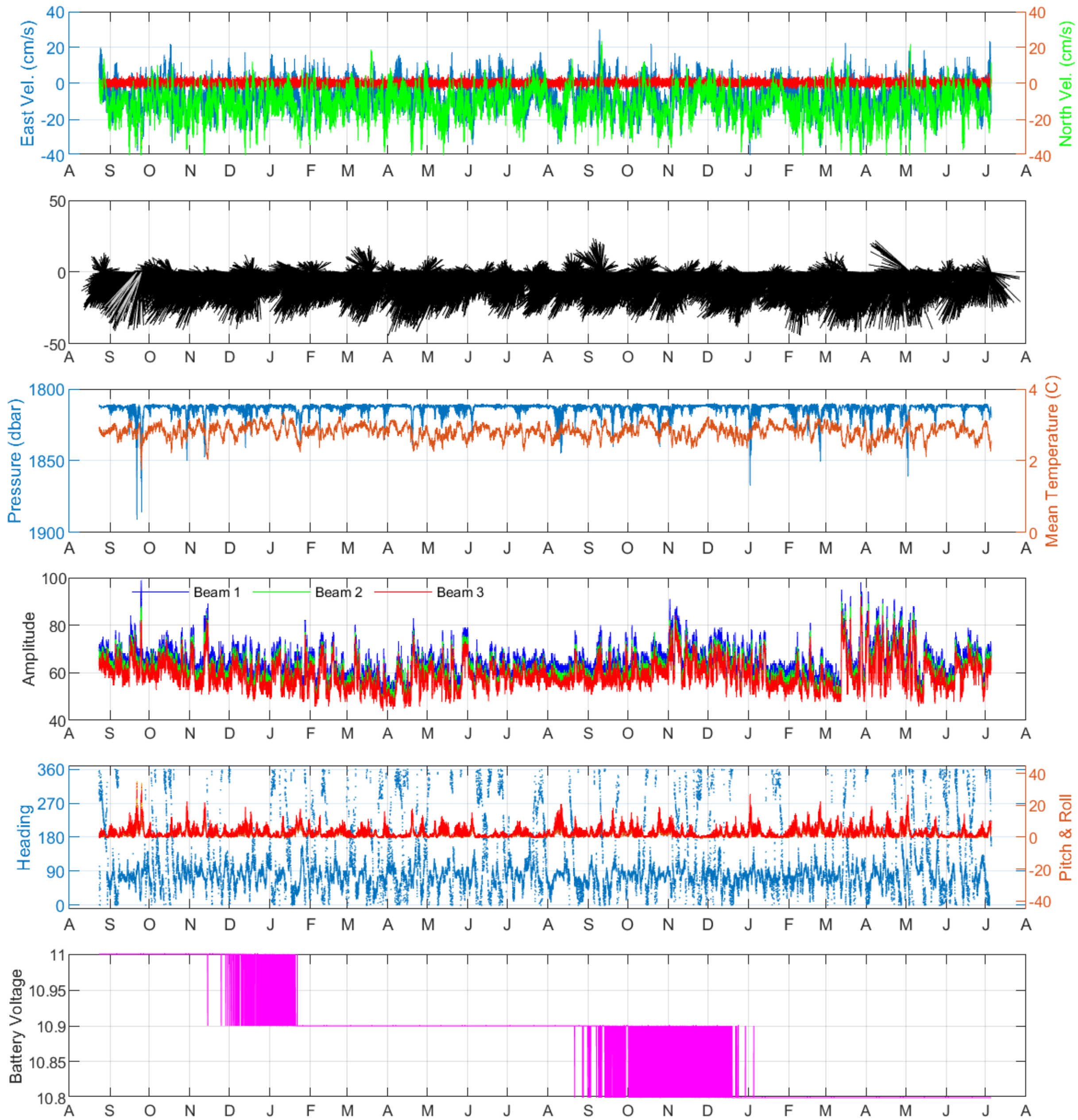
Number of measurements	32727	Serial number	AQD12470
Time of first measurement	8/23/2020	Transmit pulse length	0.75 m
Time of last measurement	7/5/2022 19:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M1-07

Percentage good data: 100%

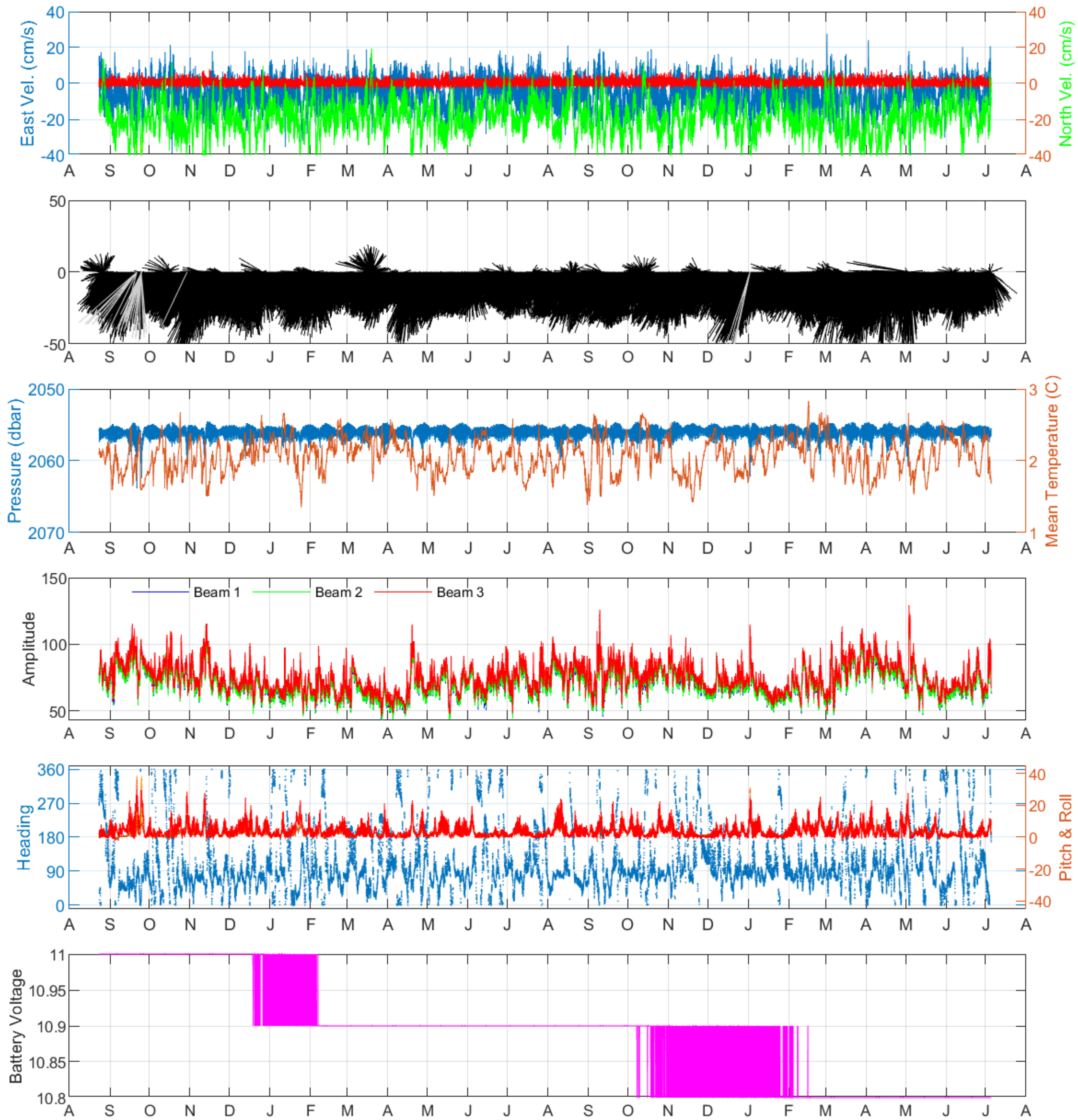
Number of measurements	32728	Serial number	AQD12466
Time of first measurement	8/23/2020	Transmit pulse length	0.75 m
Time of last measurement	7/5/2022 19:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M1-08

Percentage good data: 100%

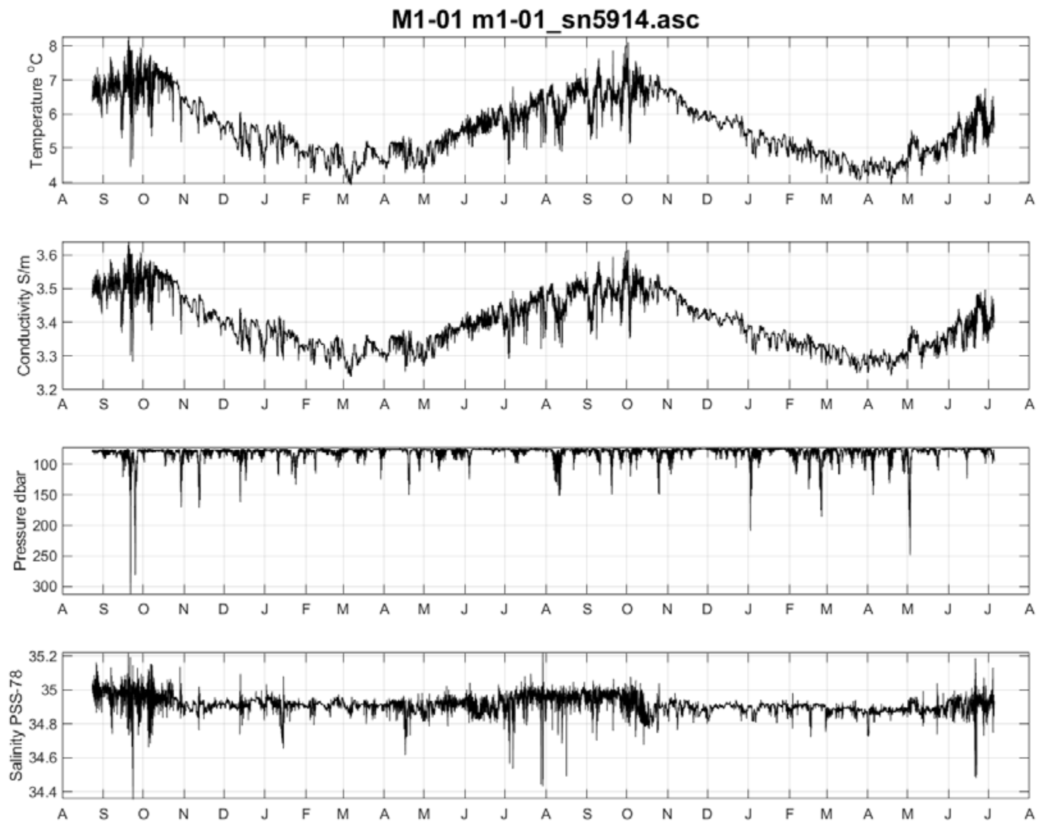
Number of measurements	32727	Serial number	AQD 9363
Time of first measurement	8/23/2020	Transmit pulse length	0.75 m
Time of last measurement	7/5/2022 19:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



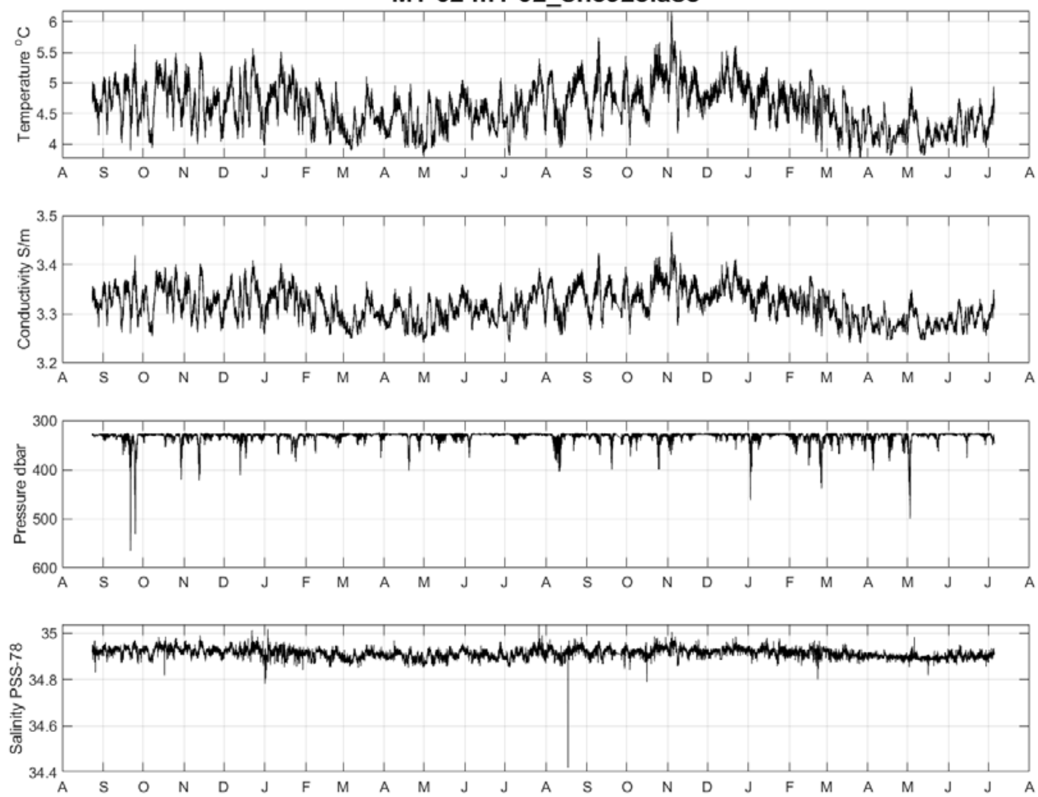
M1-09

Percentage good data: 100%

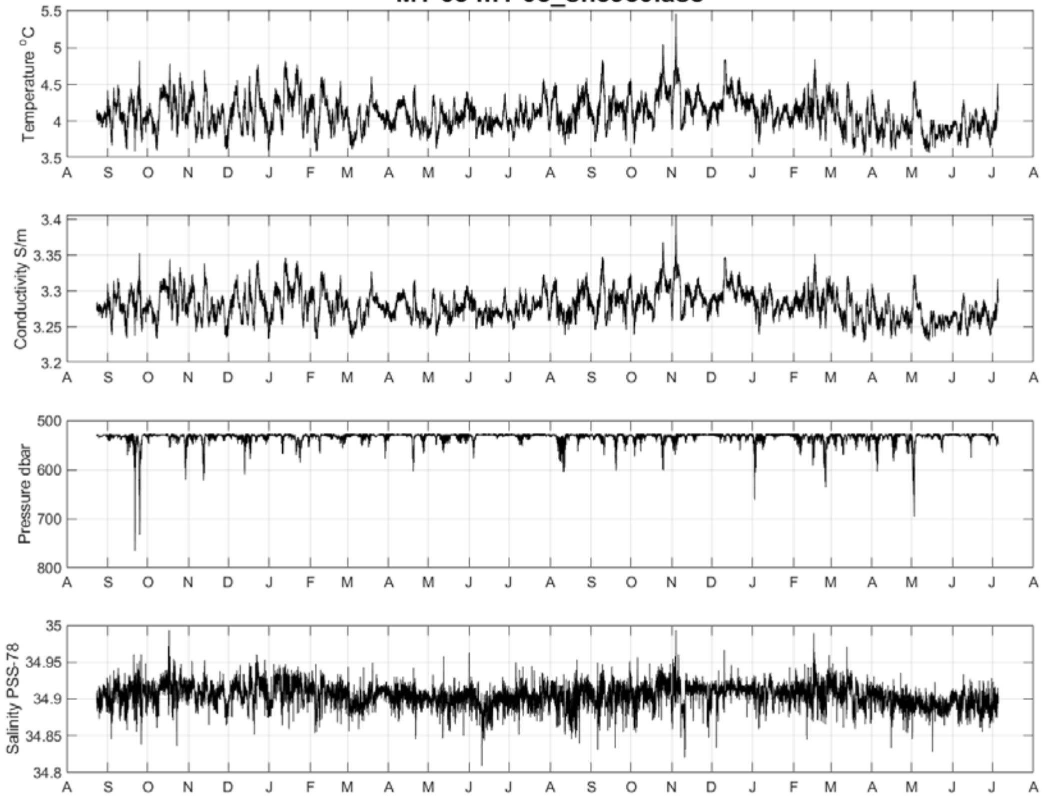
Number of measurements	32728	Serial number	AQD12471
Time of first measurement	8/23/2020	Transmit pulse length	0.75 m
Time of last measurement	7/5/2022 19:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

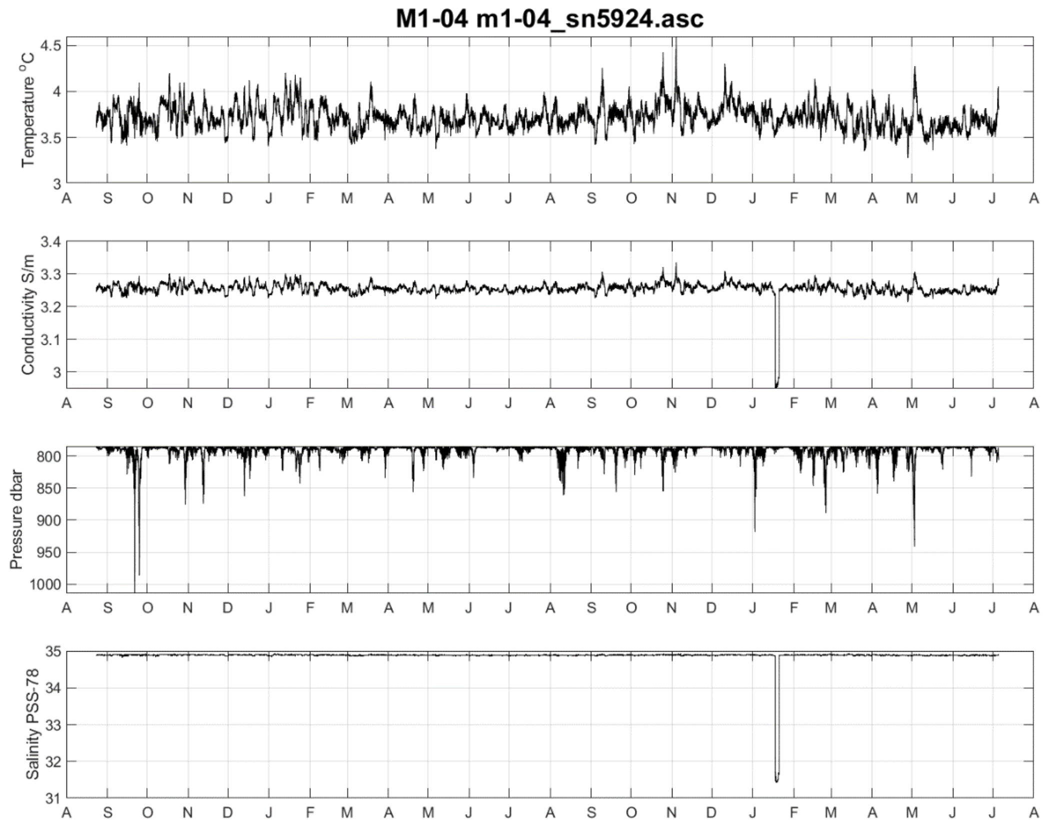

M1-01 m1-01_sn5914.asc
Temperature °C
8
7
6
5
4
A S O N D J F M A M J J A S O N D J F M A M J J A
Conductivity S/m
3.6
3.5
3.4
3.3
3.2
A S O N D J F M A M J J A S O N D J F M A M J J A
Pressure dbar
100
150
200
250
300
A S O N D J F M A M J J A S O N D J F M A M J J A
Salinity PSS-78
35.2
35
34.8
34.6
34.4
A S O N D J F M A M J J A S O N D J F M A M J J A

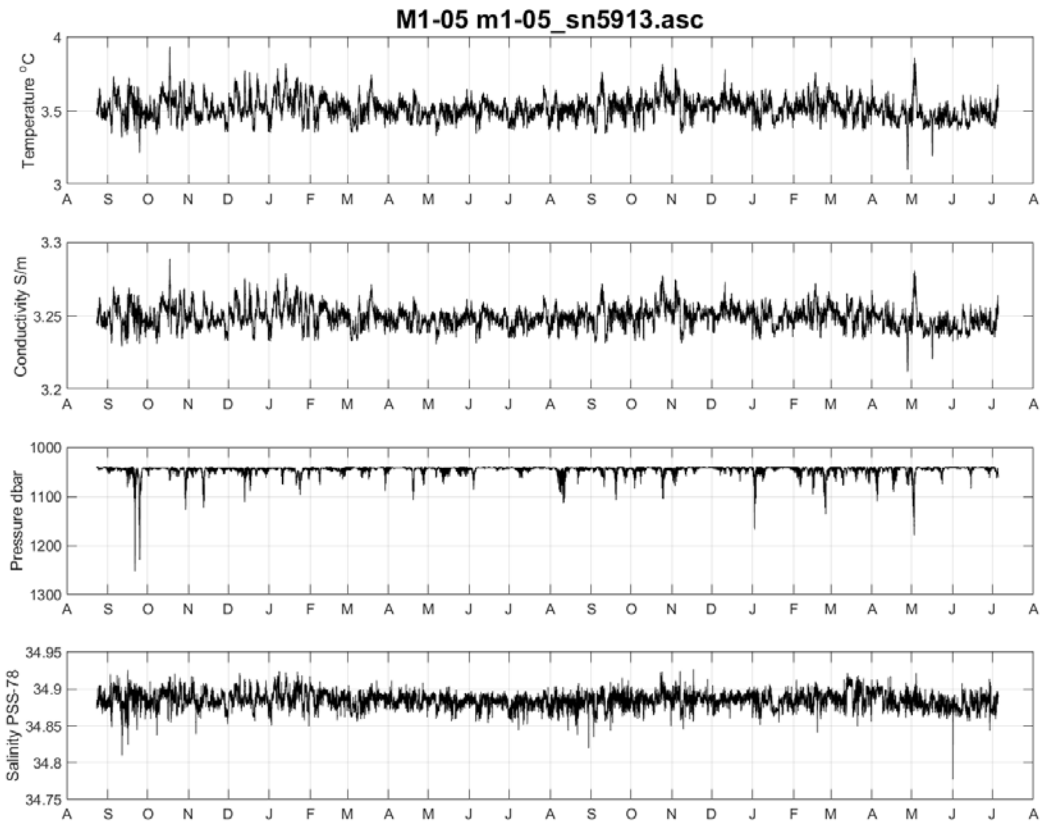
M1-02 m1-02_sn5925.asc



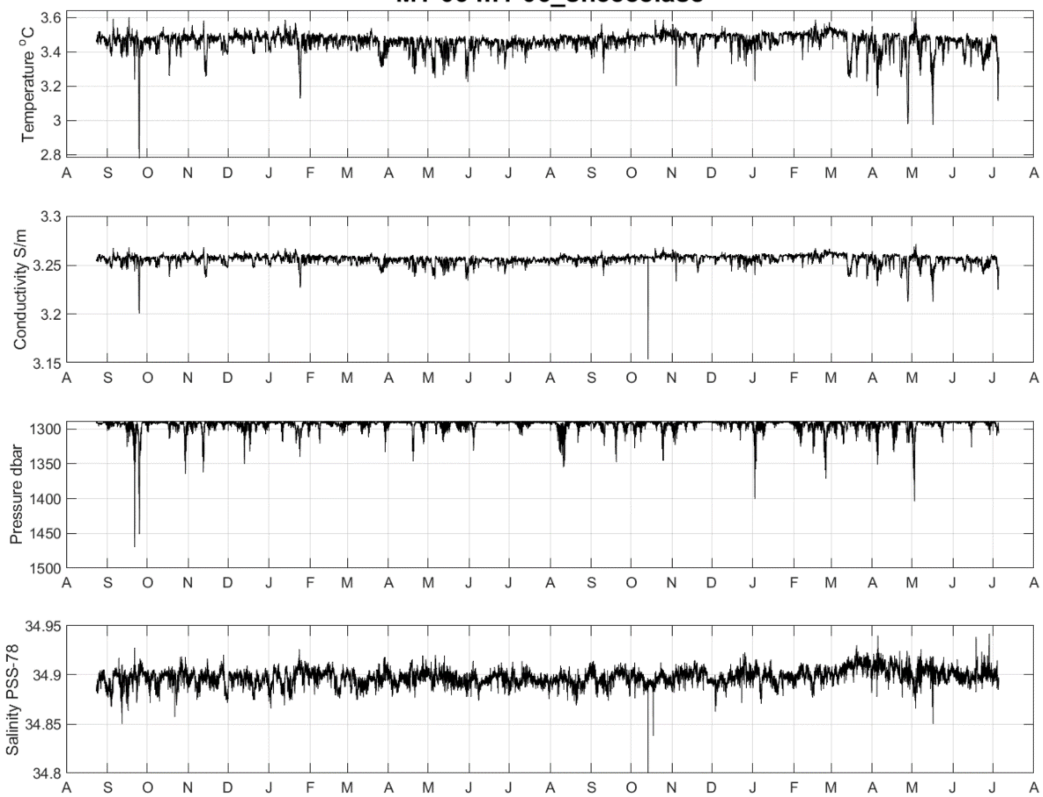
M1-03 m1-03_sn5930.asc



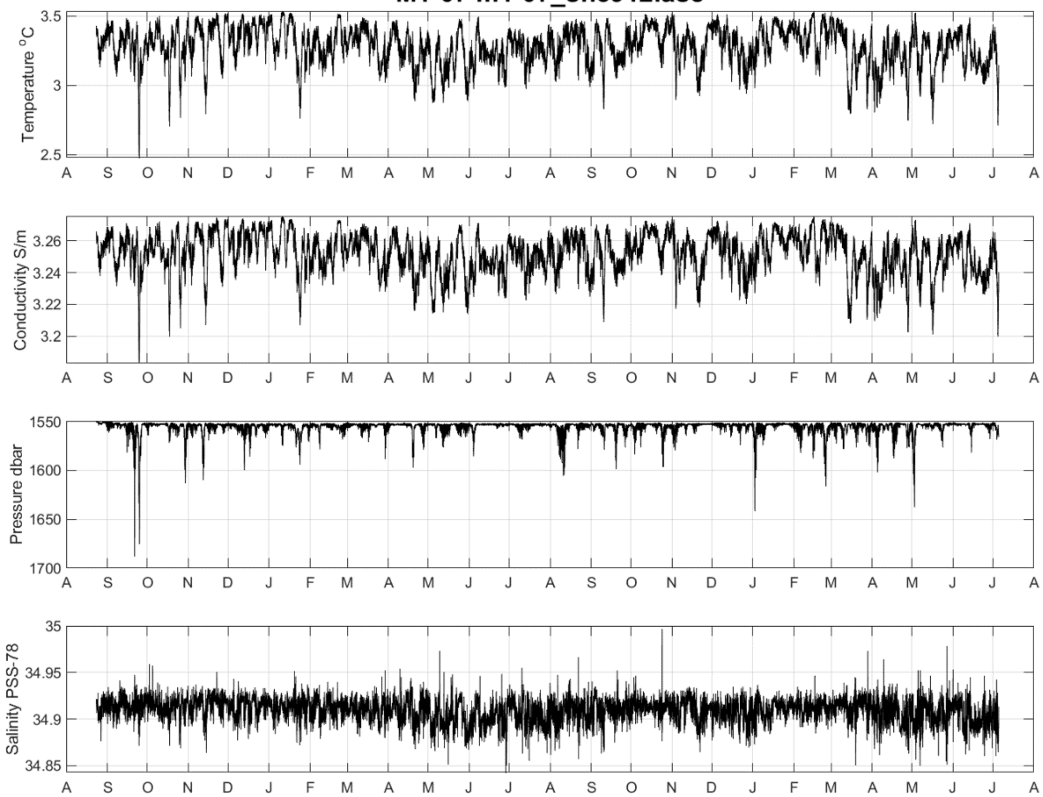

M1-04 m1-04_sn5924.asc
Temperature °C
4.5
4
3.5
3
A S O N D J F M A M J J A S O N D J F M A M J J A
Conductivity S/m
3.4
3.3
3.2
3.1
3
A S O N D J F M A M J J A S O N D J F M A M J J A
Pressure dbar
800
850
900
950
1000
A S O N D J F M A M J J A S O N D J F M A M J J A
Salinity PSS-78
35
34
33
32
31
A S O N D J F M A M J J A S O N D J F M A M J J A

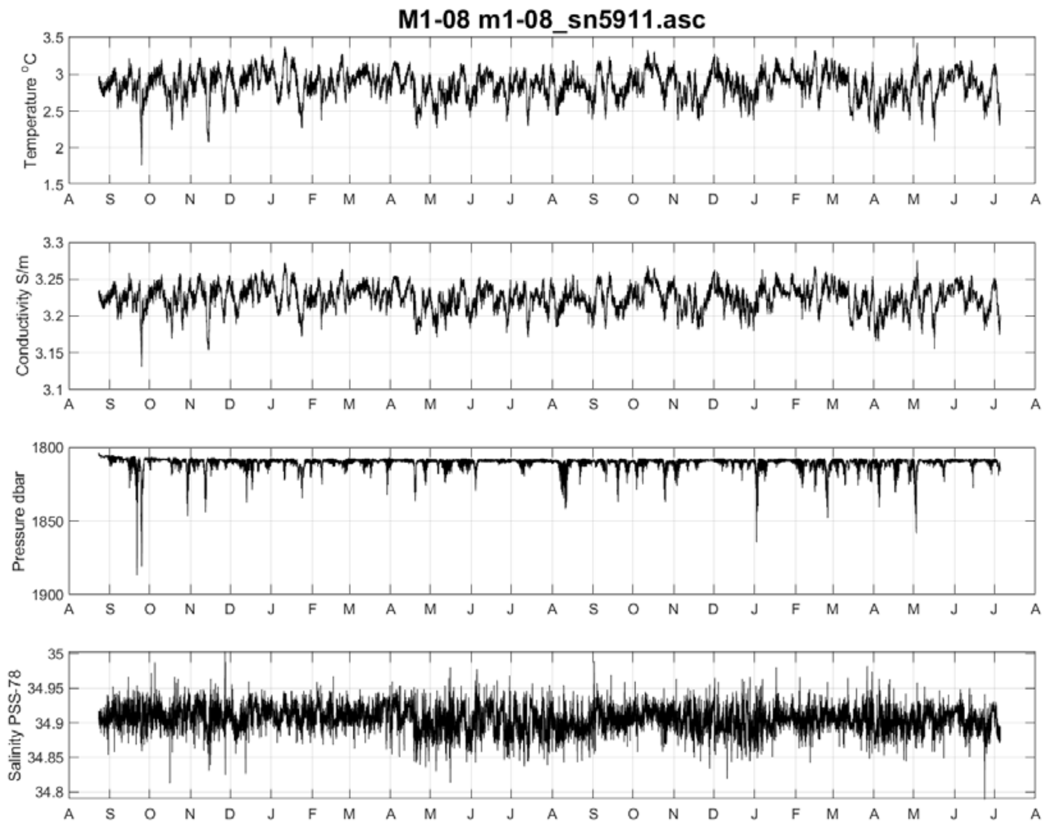

M1-05 m1-05_sn5913.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A

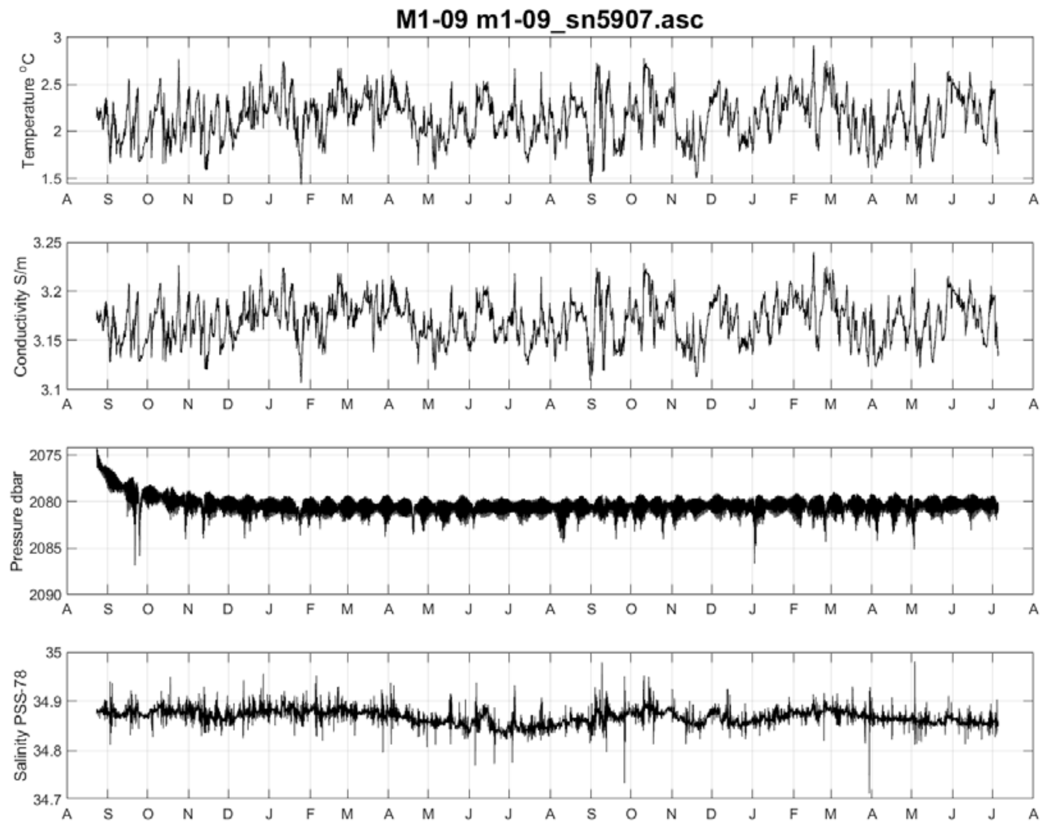
M1-06 m1-06_sn3588.asc

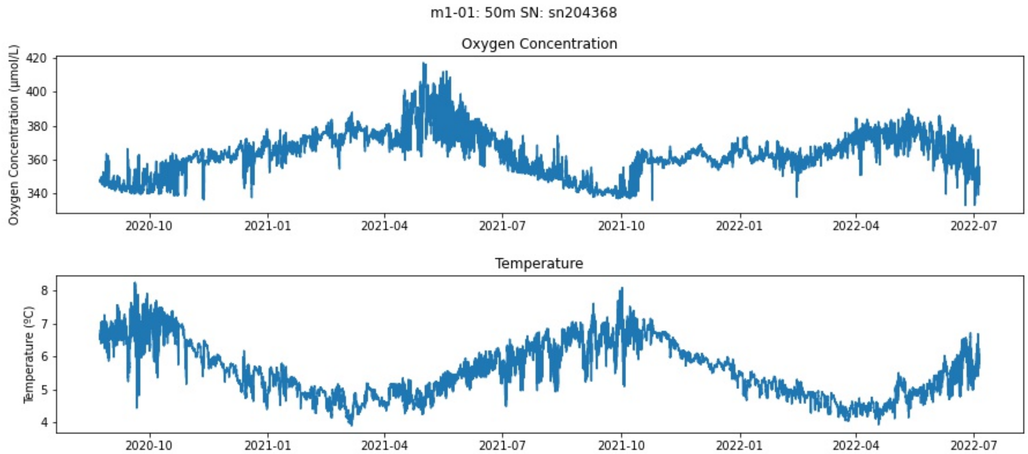


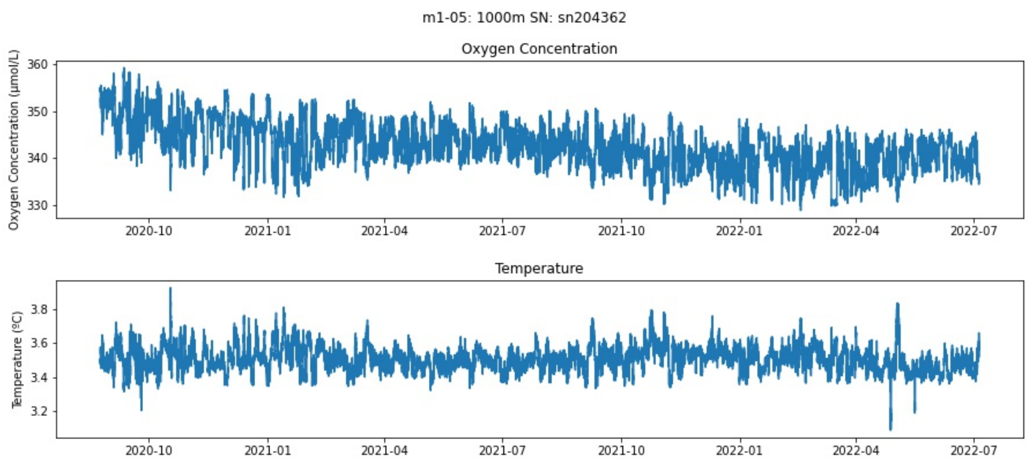
M1-07 m1-07_sn5912.asc

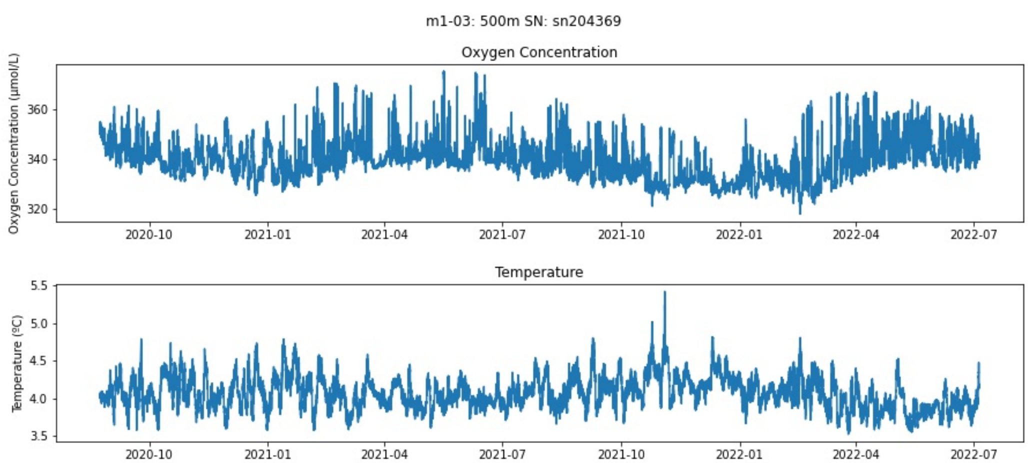



M1-08 m1-08_sn5911.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A

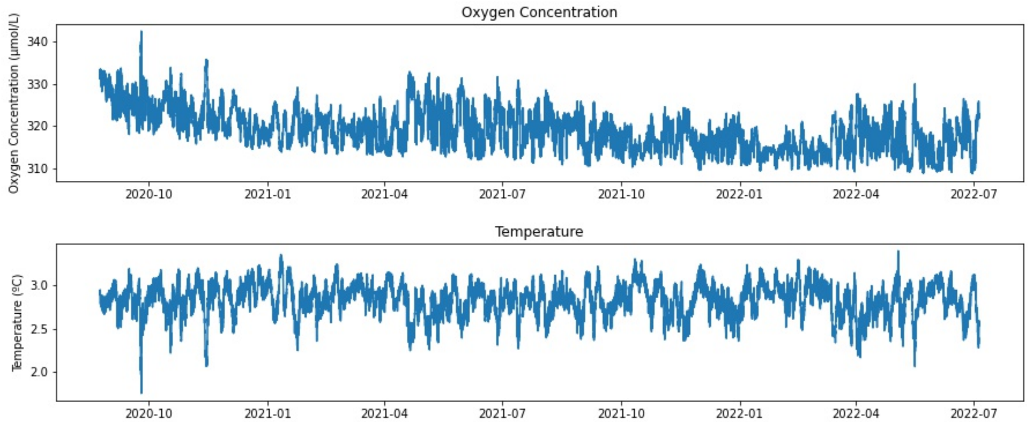

M1-09 m1-09_sn5907.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A


m1-01: 50m SN: sn204368
Oxygen Concentration
Oxygen Concentration (µmol/L)
420
400
380
360
340
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07
Temperature
Temperature (ºC)
8
7
6
5
4

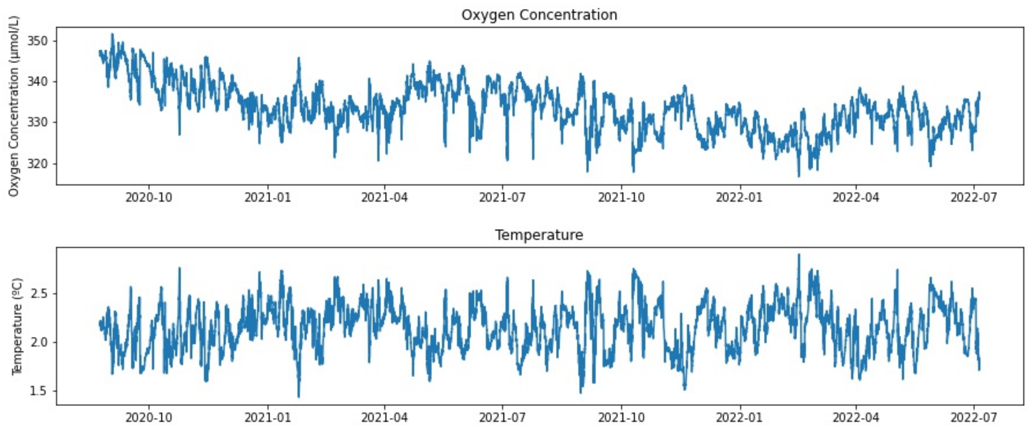

m1-05: 1000m SN: sn204362
Oxygen Concentration
Oxygen Concentration (µmol/L)
360
350
340
330
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07
Temperature
Temperature (ºC)
3.8
3.6
3.4
3.2


m1-03: 500m SN: sn204369
Oxygen Concentration
Oxygen Concentration (µmol/L)
360
340
320
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07
Temperature
Temperature (ºC)
5.5
5.0
4.5
4.0
3.5

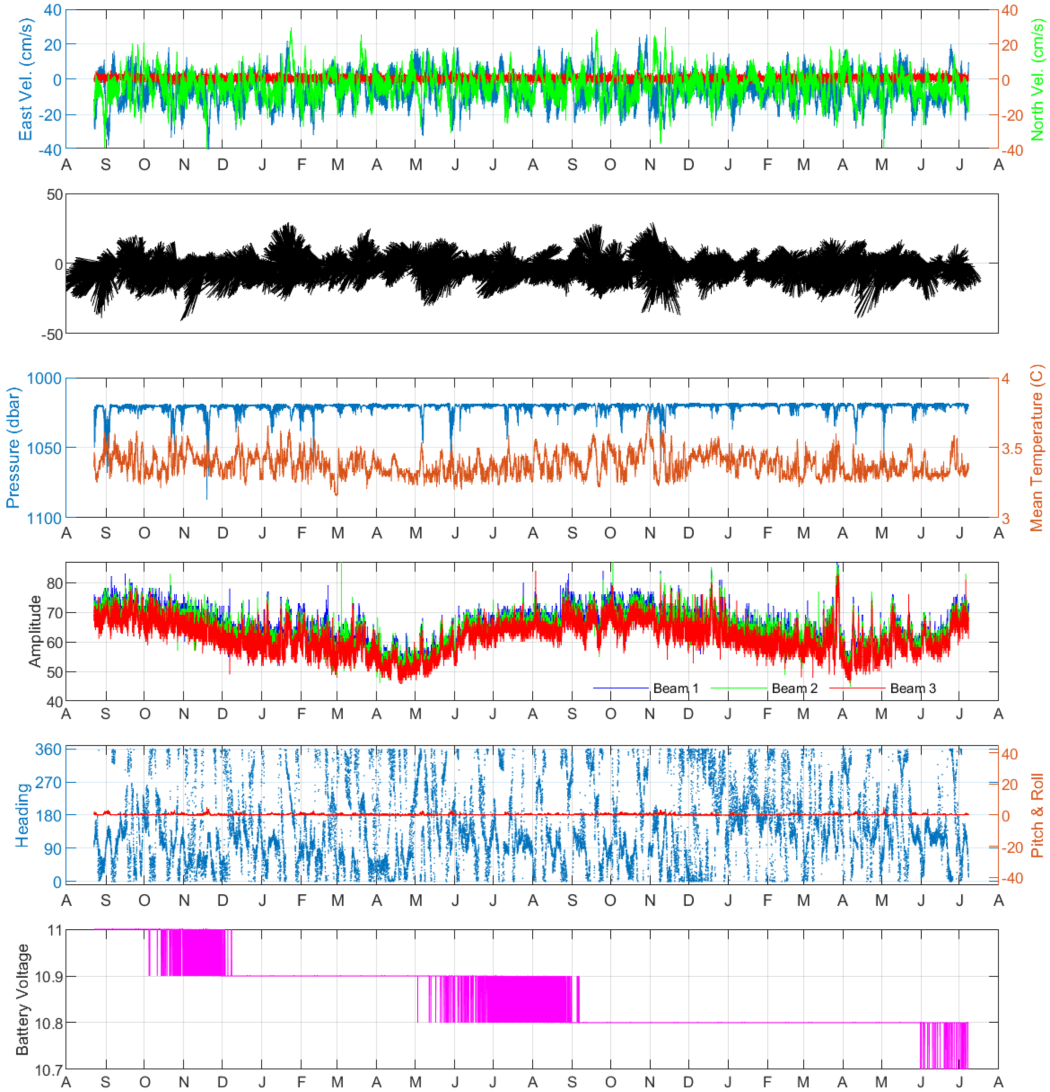
m1-08: 1750m SN: sn204378



m1-09: 2025m SN: sn204371



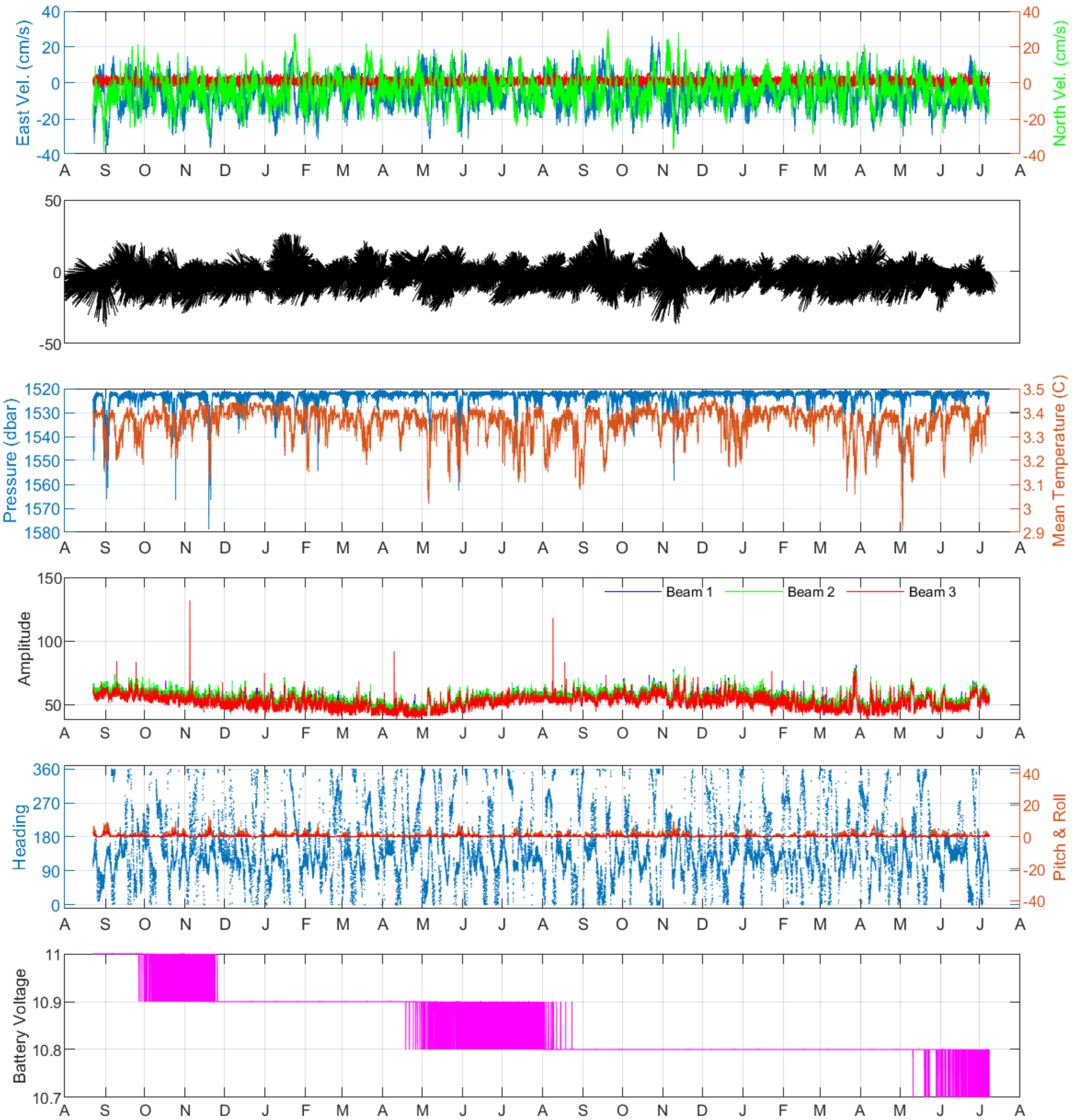
M2



M2-01

Percentage good data: 100%

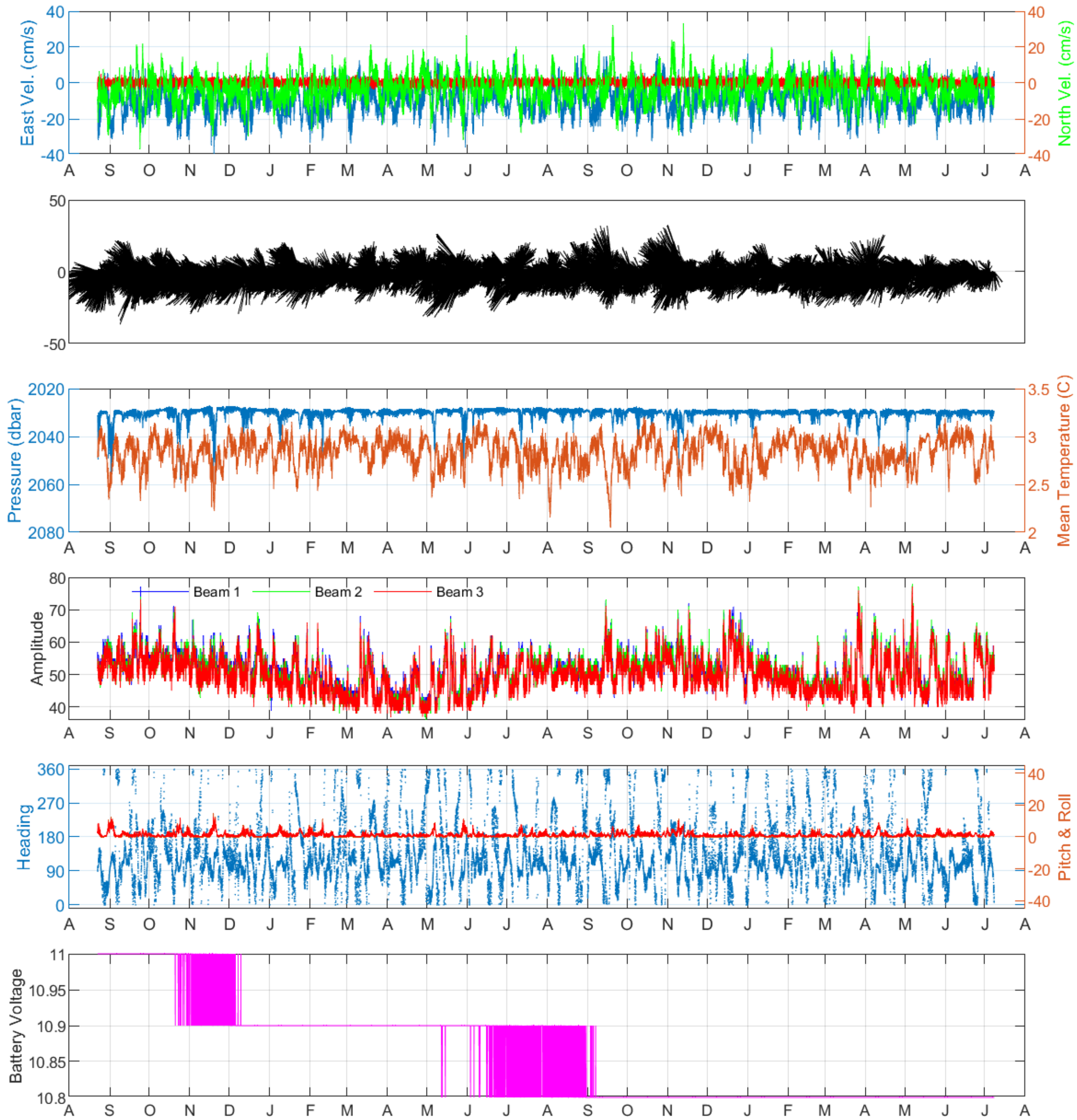
Number of measurements	32903	Serial number	AQD12458
Time of first measurement	8/22/2020	Transmit pulse length	0.75 m
Time of last measurement	7/8/2022 11:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M2-03

Percentage good data: 100%

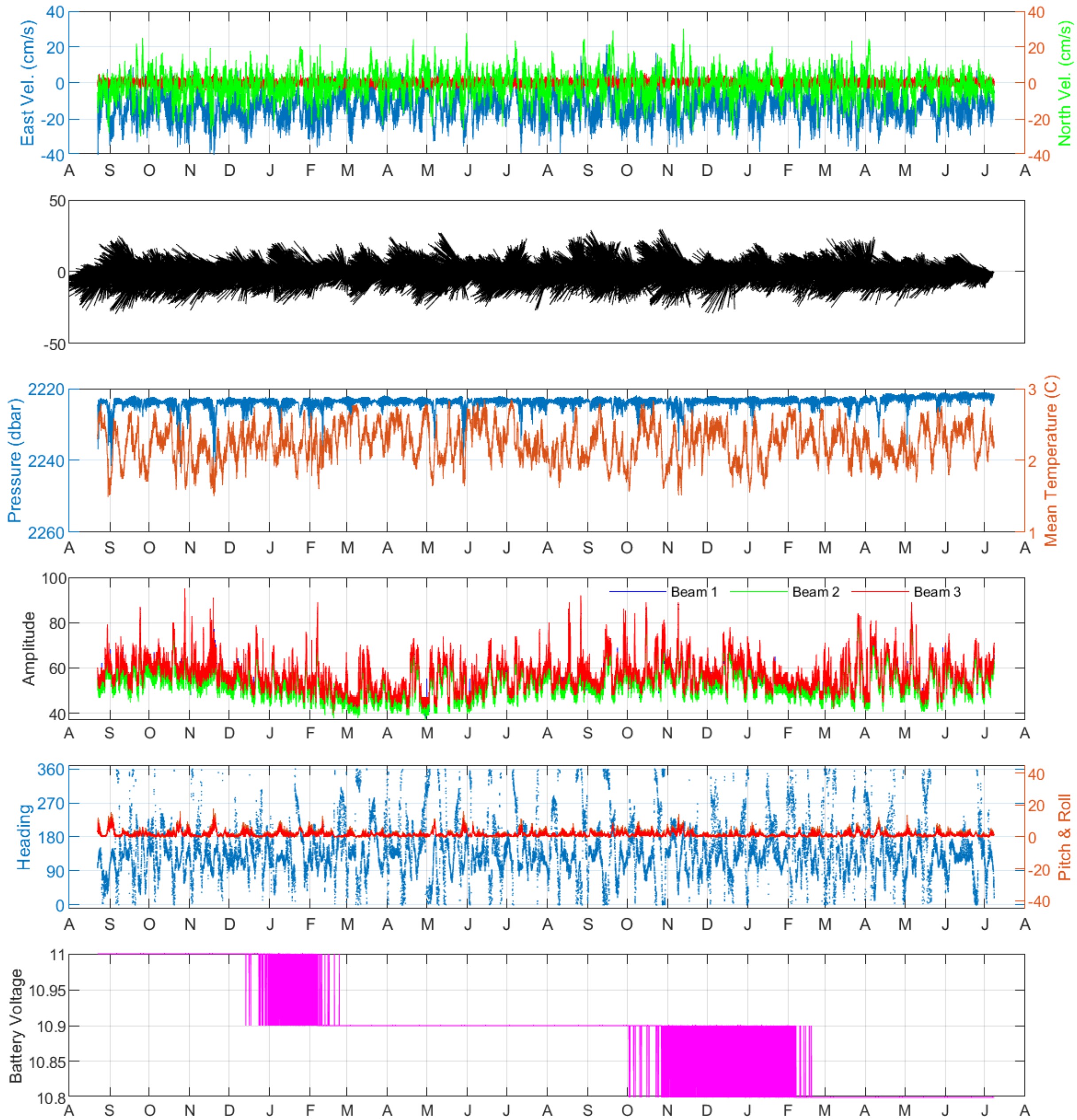
Number of measurements	32901	Serial number	AQD12480
Time of first measurement	8/22/2020	Transmit pulse length	0.75 m
Time of last measurement	7/8/2022 10:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M2-05

Percentage good data: 100%

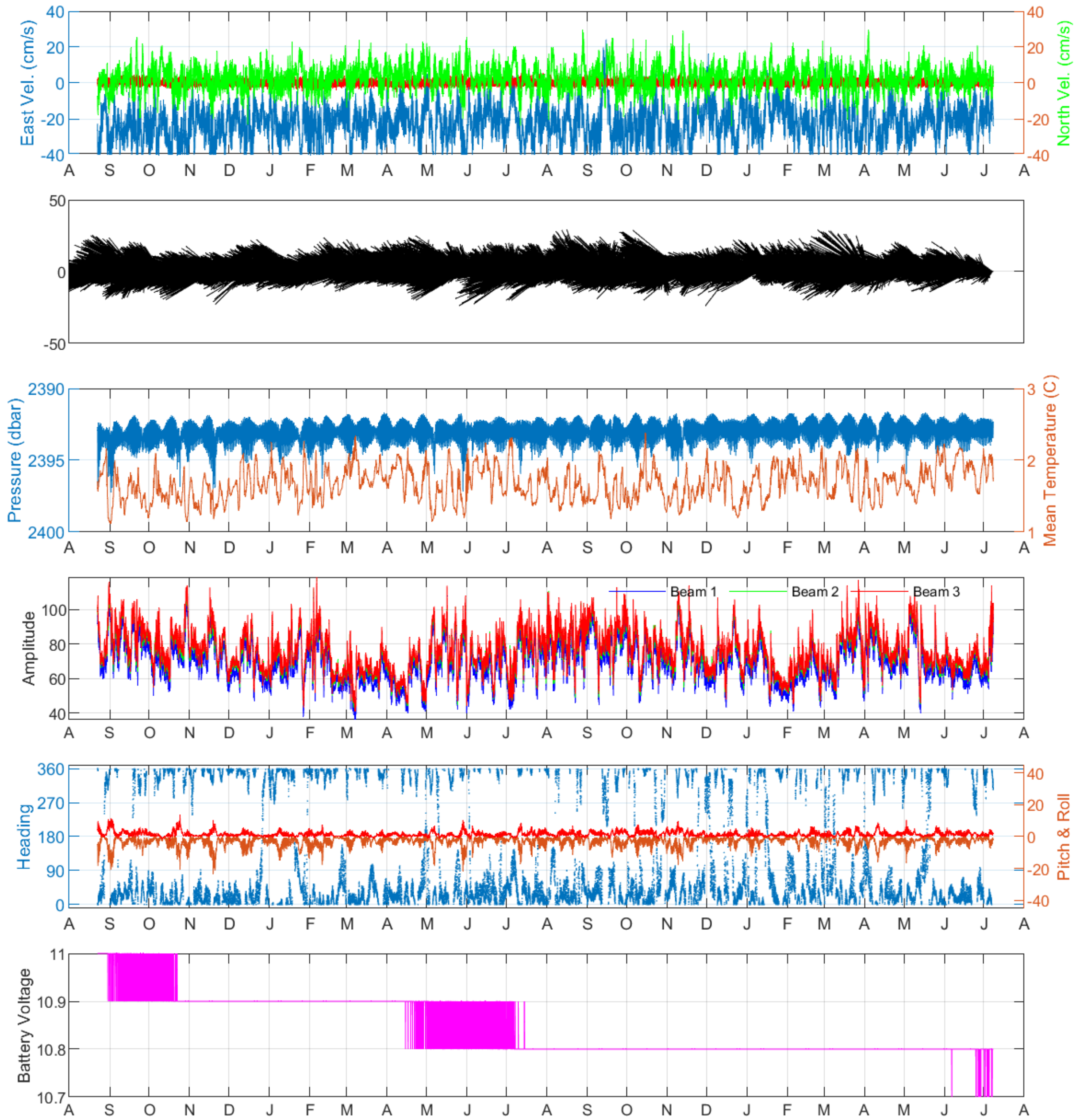
Number of measurements	32903	Serial number	AQD12468
Time of first measurement	8/22/2020	Transmit pulse length	0.75 m
Time of last measurement	7/8/2022 11:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M2-06

Percentage good data: 100%

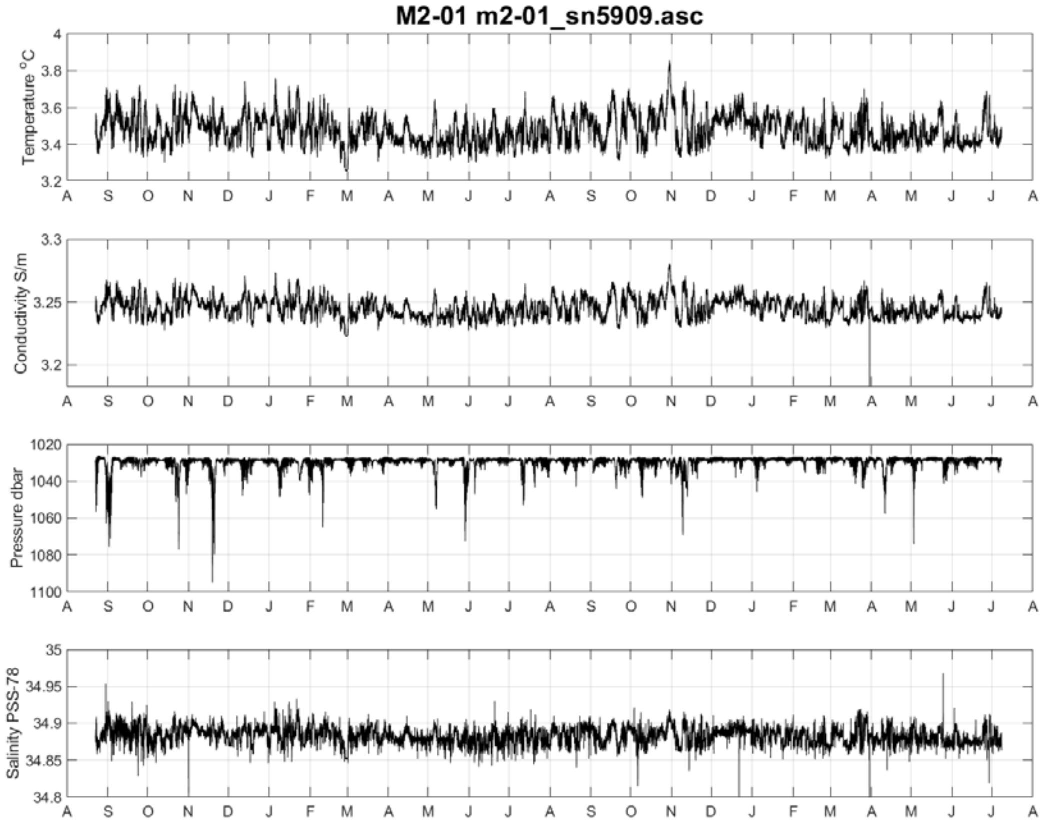
Number of measurements	32903	Serial number	AQD12478
Time of first measurement	8/22/2020	Transmit pulse length	0.75 m
Time of last measurement	7/8/2022 11:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

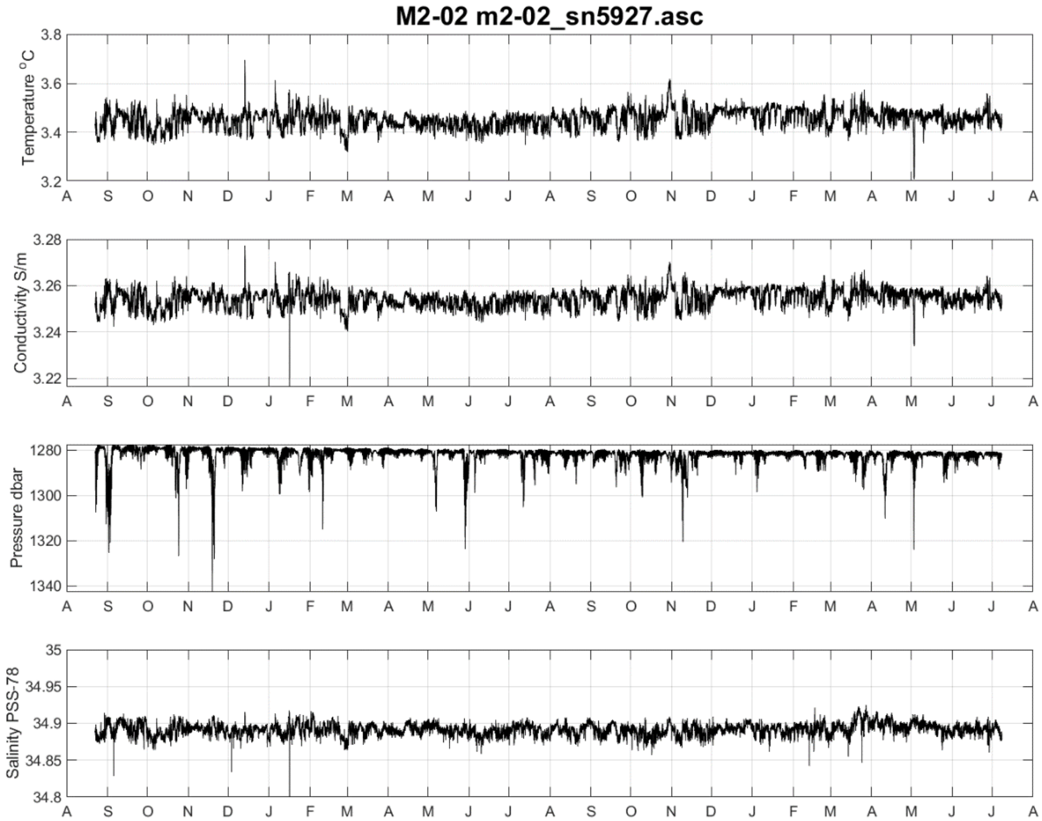


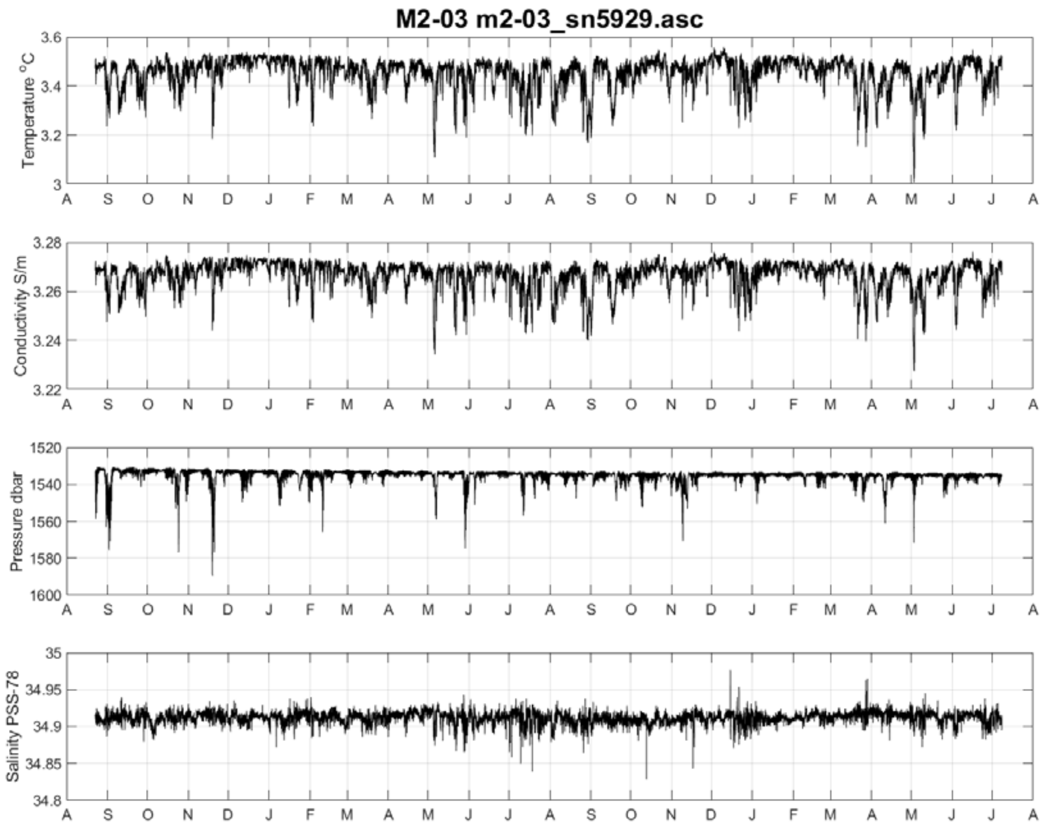
M2-07

Percentage good data: 100%

Number of measurements	32902	Serial number	AQD14472
Time of first measurement	8/22/2020	Transmit pulse length	0.75 m
Time of last measurement	7/8/2022 10:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

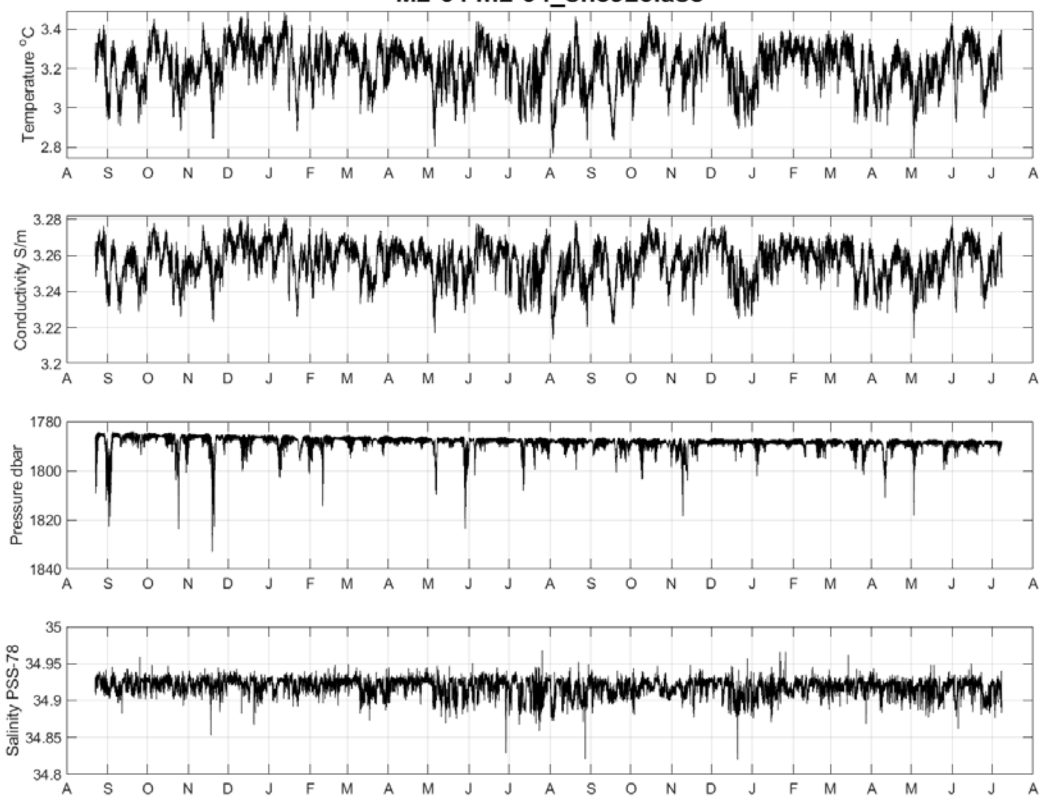

M2-01 m2-01_sn5909.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A


M2-02 m2-02_sn5927.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A

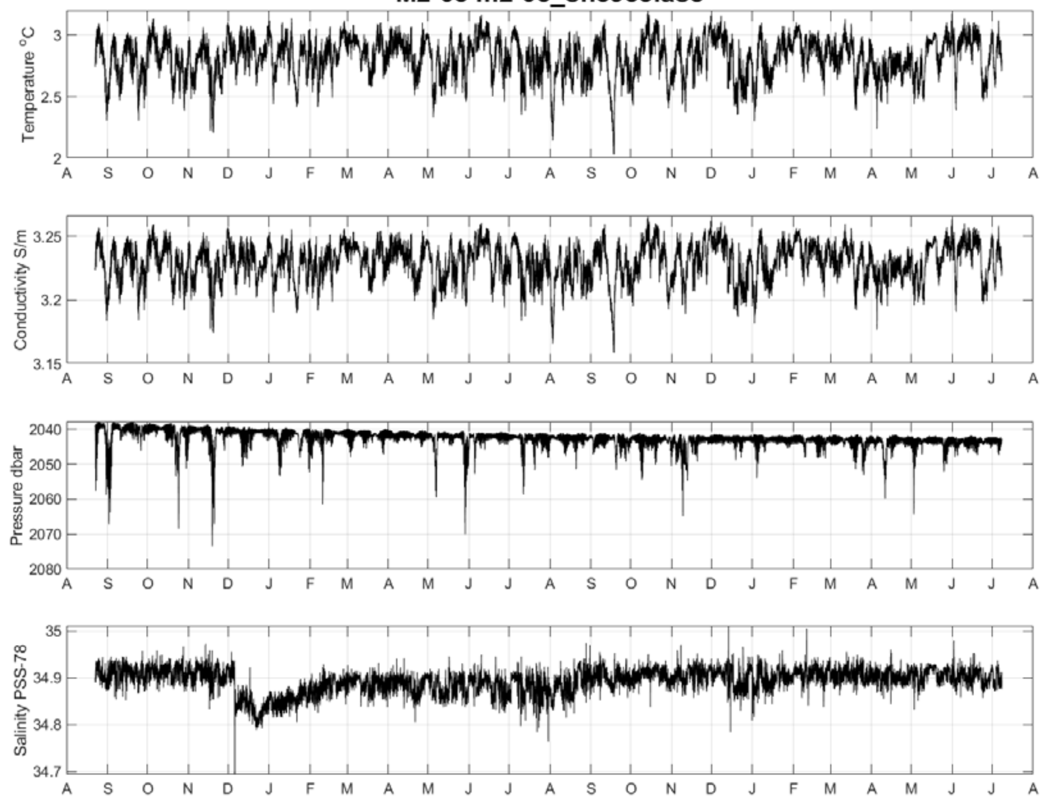


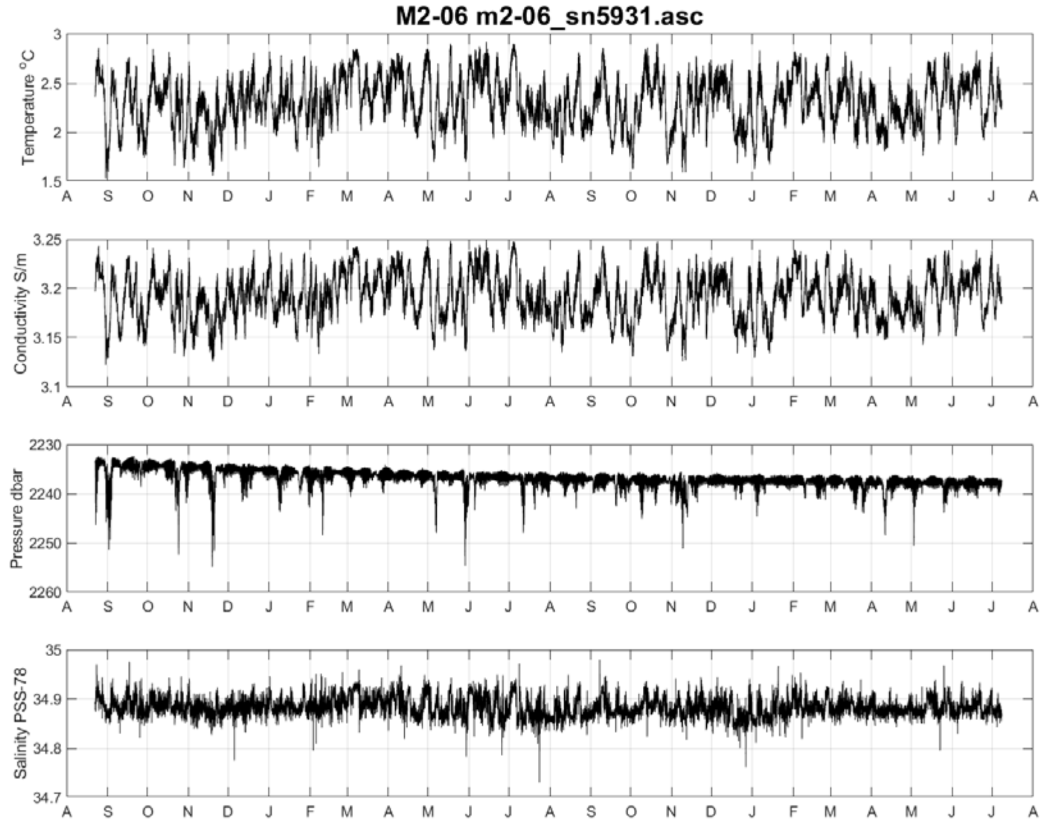
M2-03 m2-03_sn5929.asc
Temperature °C
3.6
3.4
3.2
3
Conductivity S/m
3.28
3.26
3.24
3.22
Pressure dbar
1520
1540
1560
1580
1600
Salinity PSS-78
35
34.95
34.9
34.85
34.8
A S O N D J F M A M J J A S O N D J F M A M J J A

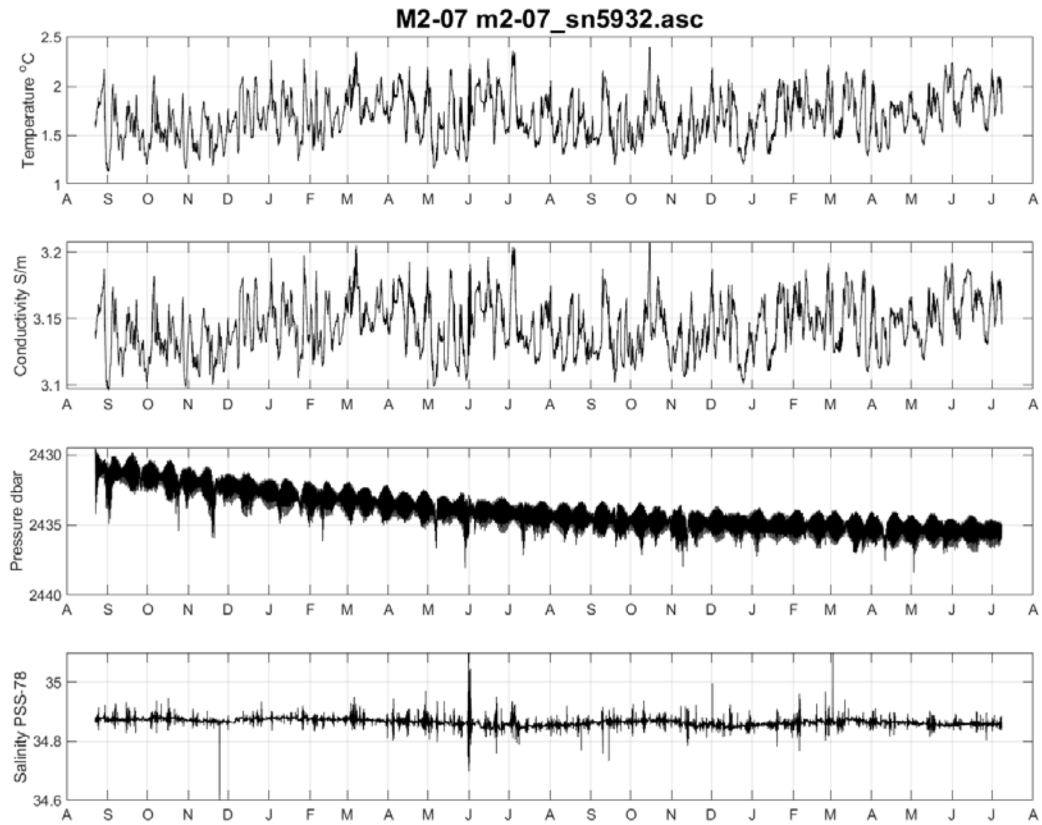
M2-04 m2-04_sn5926.asc

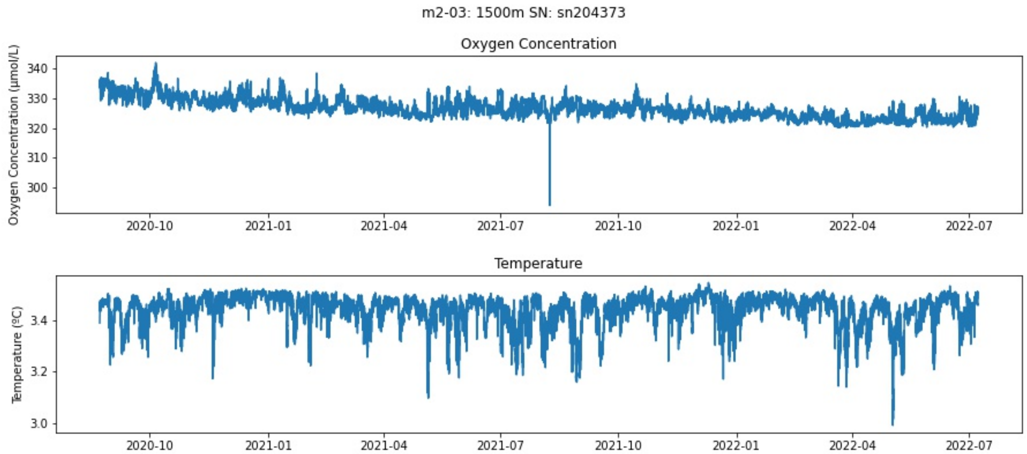


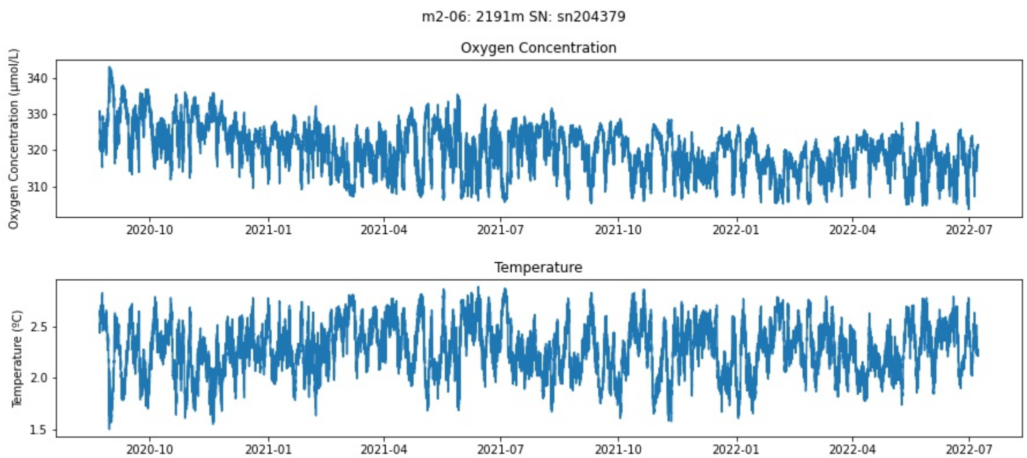
M2-05 m2-05_sn5933.asc

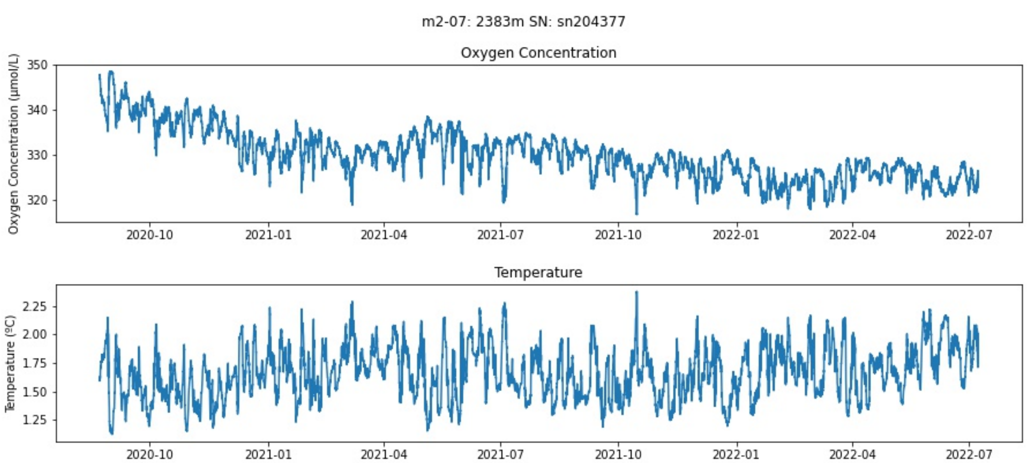



M2-06 m2-06_sn5931.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A

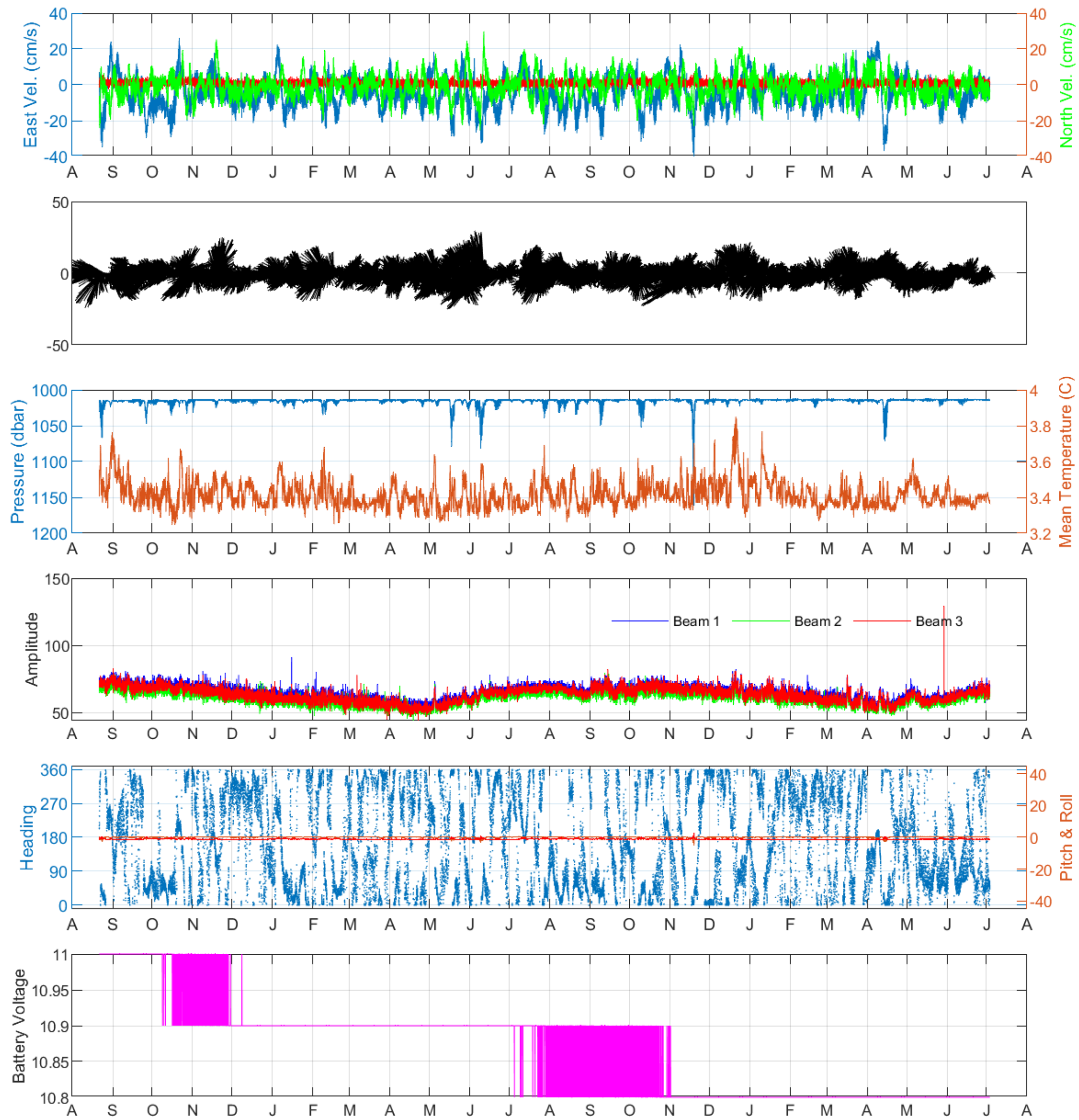

M2-07 m2-07_sn5932.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A


m2-03: 1500m SN: sn204373
Oxygen Concentration
Oxygen Concentration (µmol/L)
Temperature
Temperature (ºC)
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07


m2-06: 2191m SN: sn204379
Oxygen Concentration
Oxygen Concentration (µmol/L)
Temperature
Temperature (ºC)
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07


m2-07: 2383m SN: sn204377
Oxygen Concentration
Oxygen Concentration (µmol/L)
Temperature
Temperature (ºC)
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07

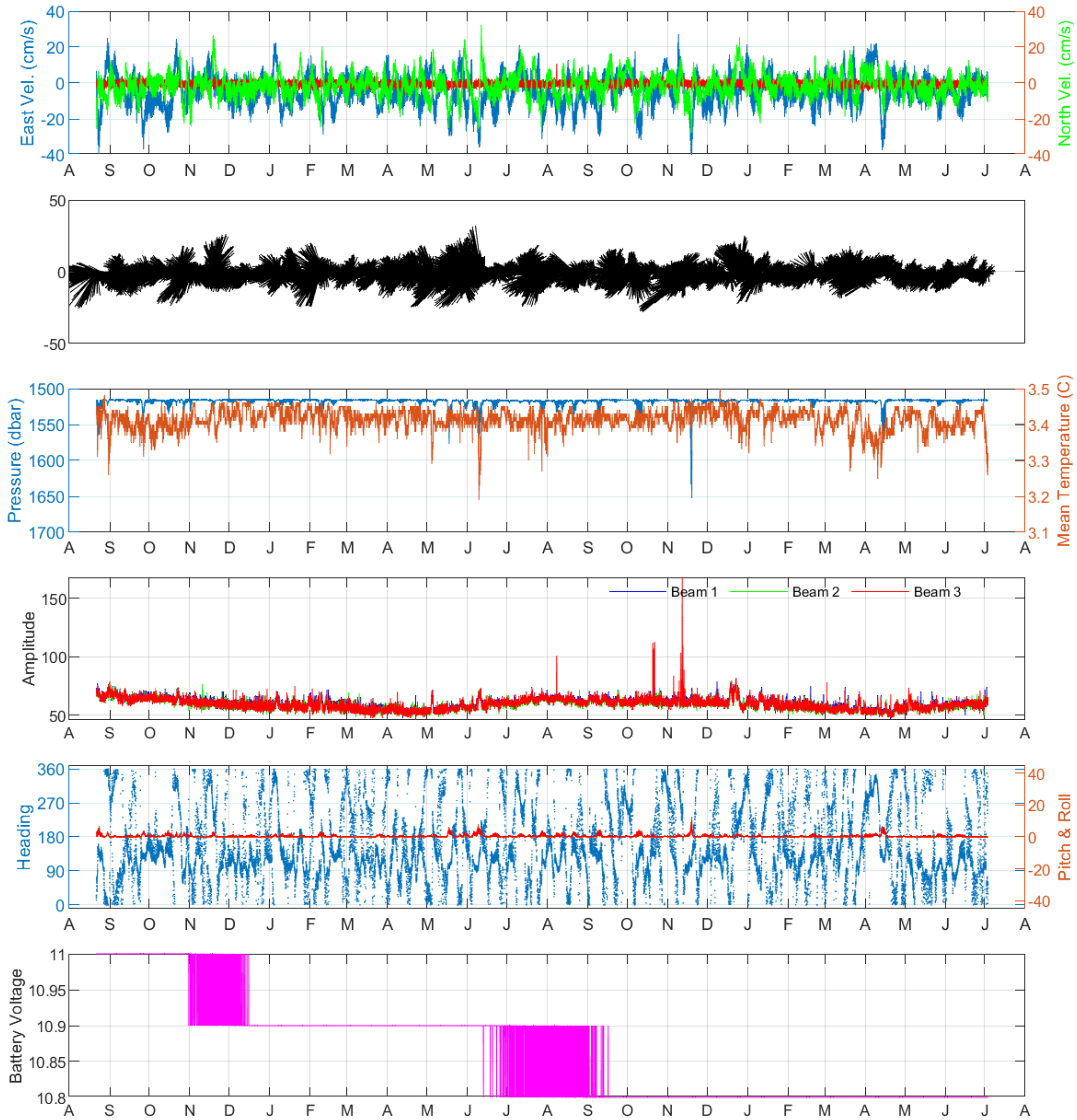
M3



M3-01

Percentage good data: 100%

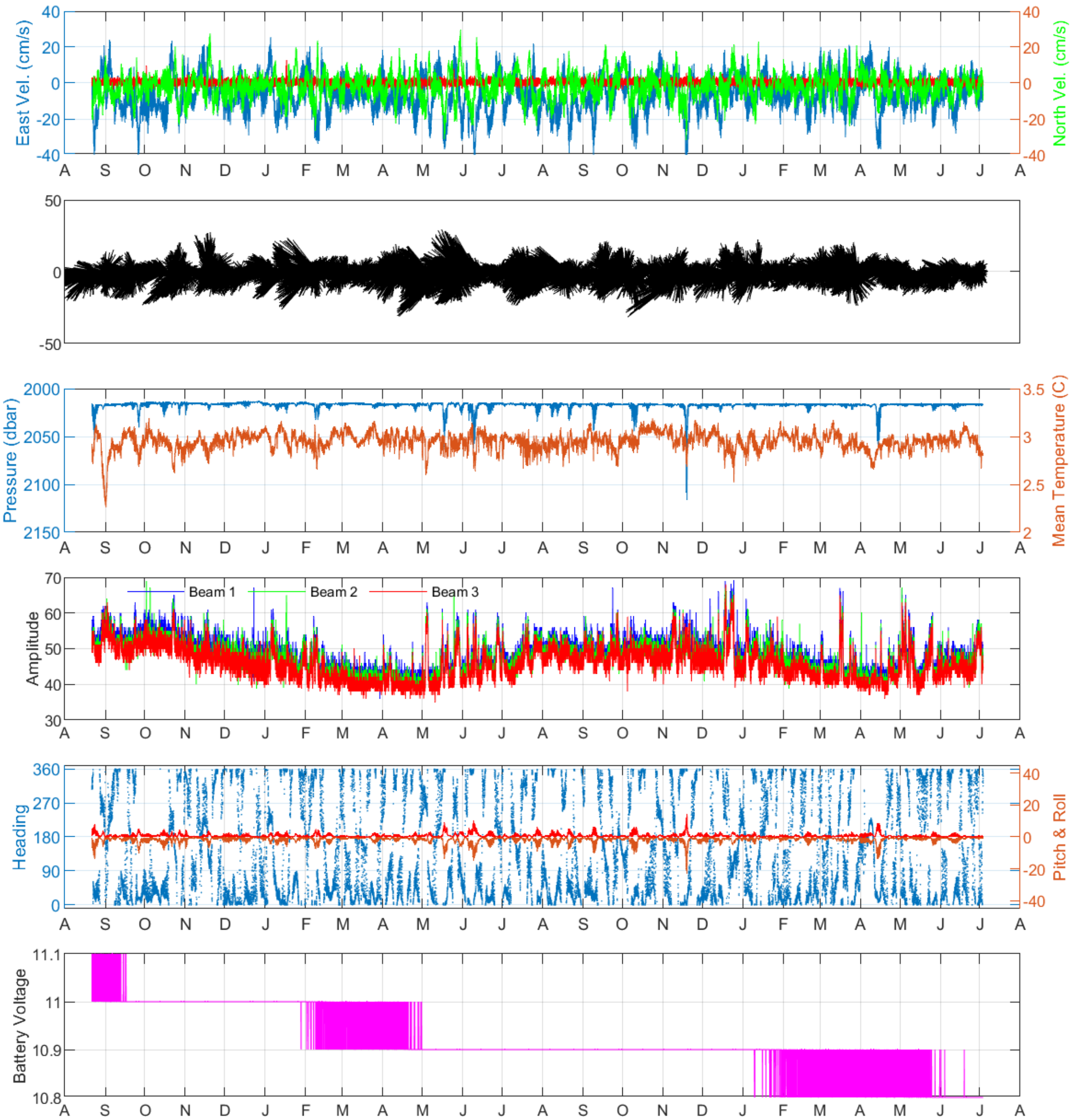
Number of measurements	32728	Serial number	AQD 9352
Time of first measurement	8/21/2020	Transmit pulse length	0.75 m
Time of last measurement	7/3/2022 19:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M3-03

Percentage good data: 100%

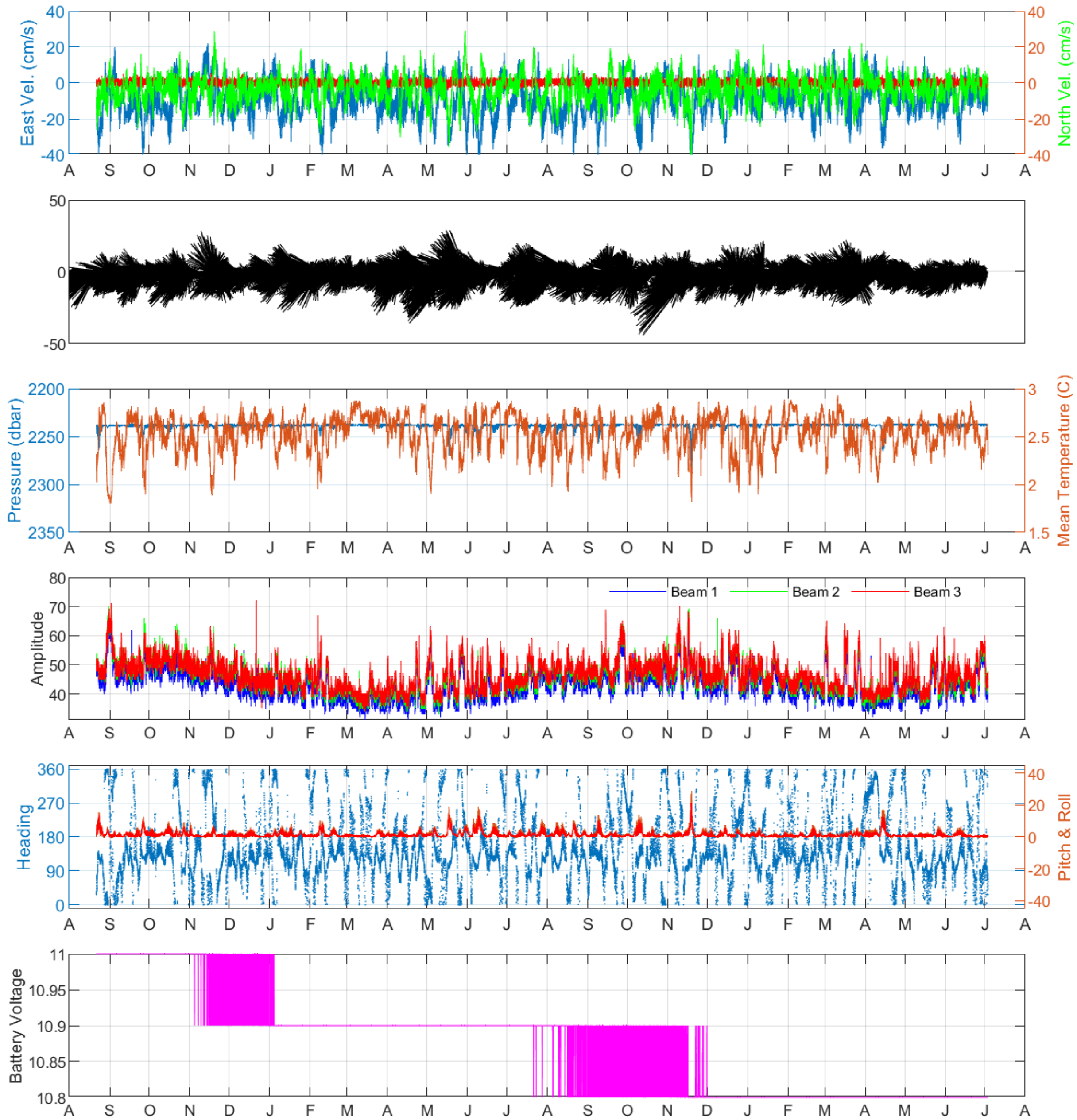
Number of measurements	32742	Serial number	AQD 6744
Time of first measurement	8/20/2020 17:20:06	Transmit pulse length	0.75 m
Time of last measurement	7/3/2022 19:50:06	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M3-05

Percentage good data: 100%

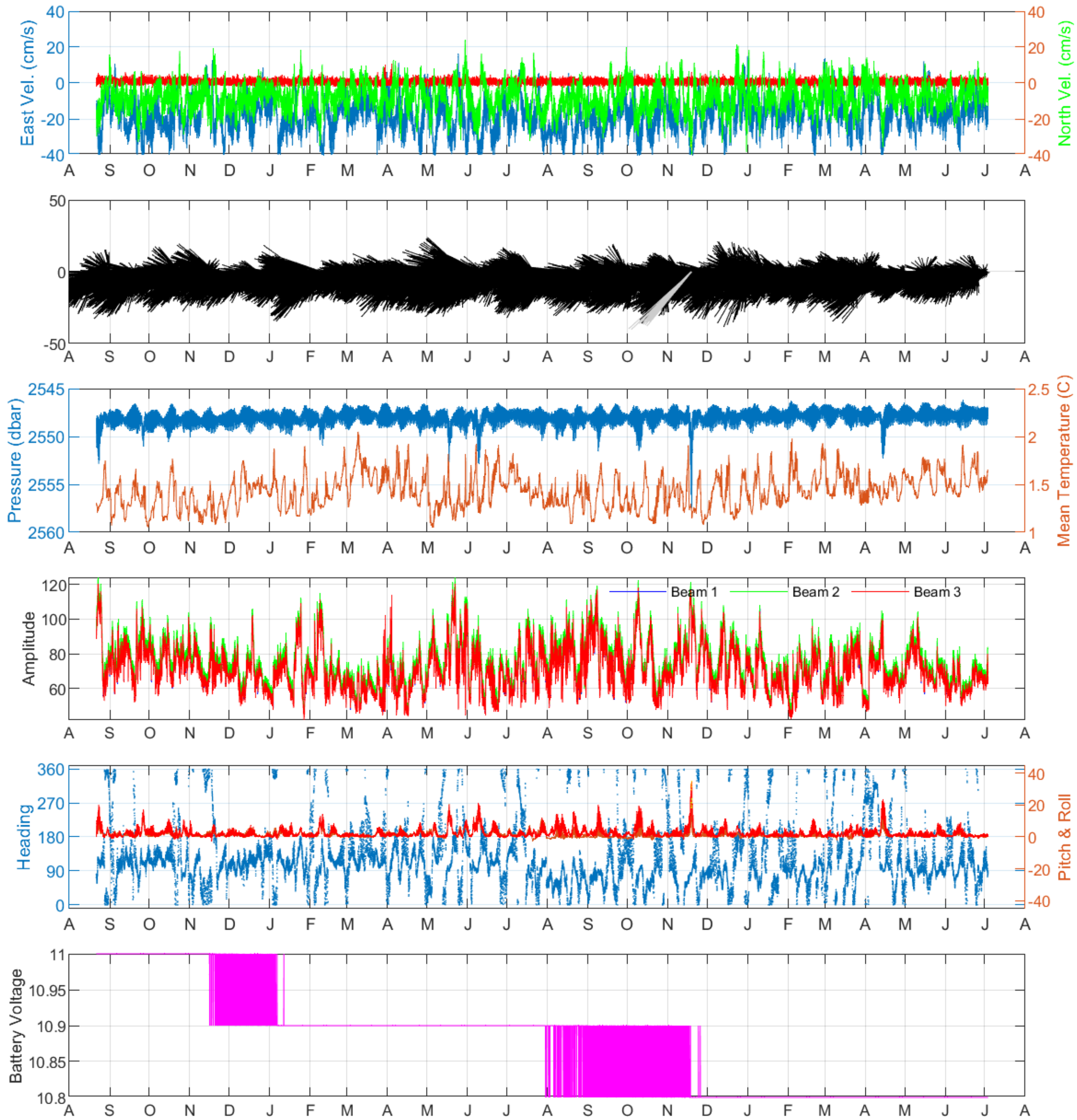
Number of measurements	32729	Serial number	AQD12481
Time of first measurement	8/21/2020	Transmit pulse length	0.75 m
Time of last measurement	7/3/2022 20:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M3-06

Percentage good data: 100%

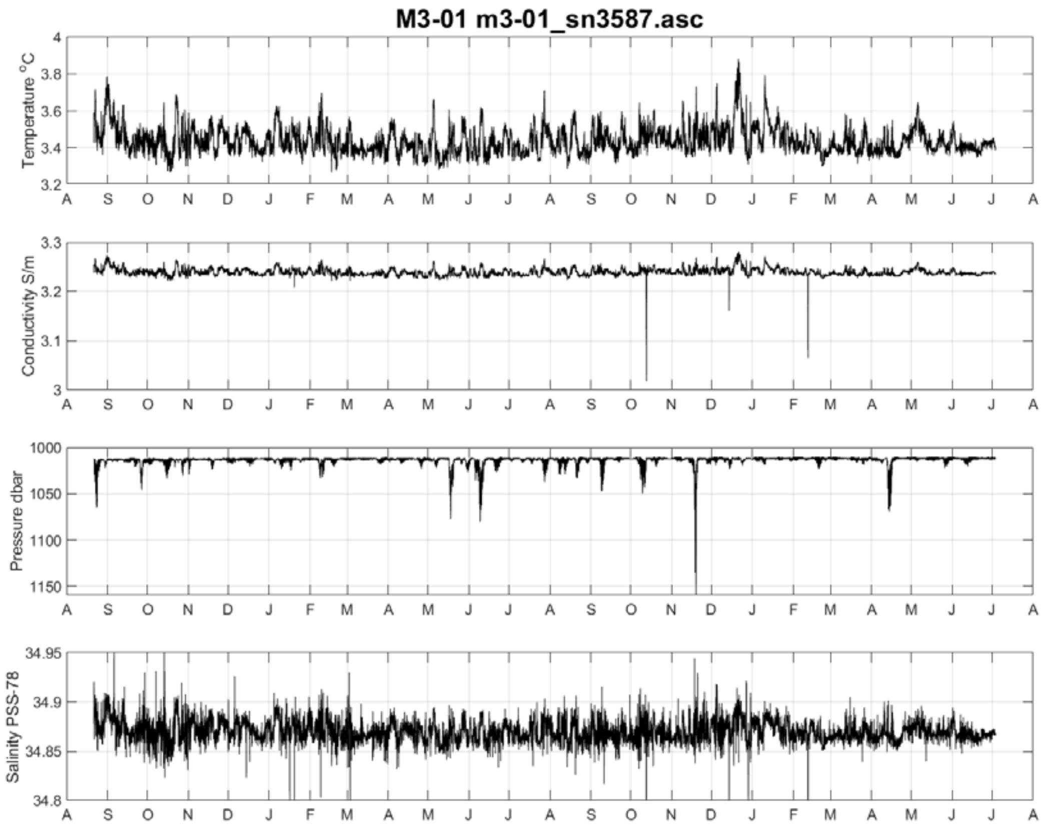
Number of measurements	32728	Serial number	AQD14476
Time of first measurement	8/21/2020	Transmit pulse length	0.75 m
Time of last measurement	7/3/2022 19:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M3-07

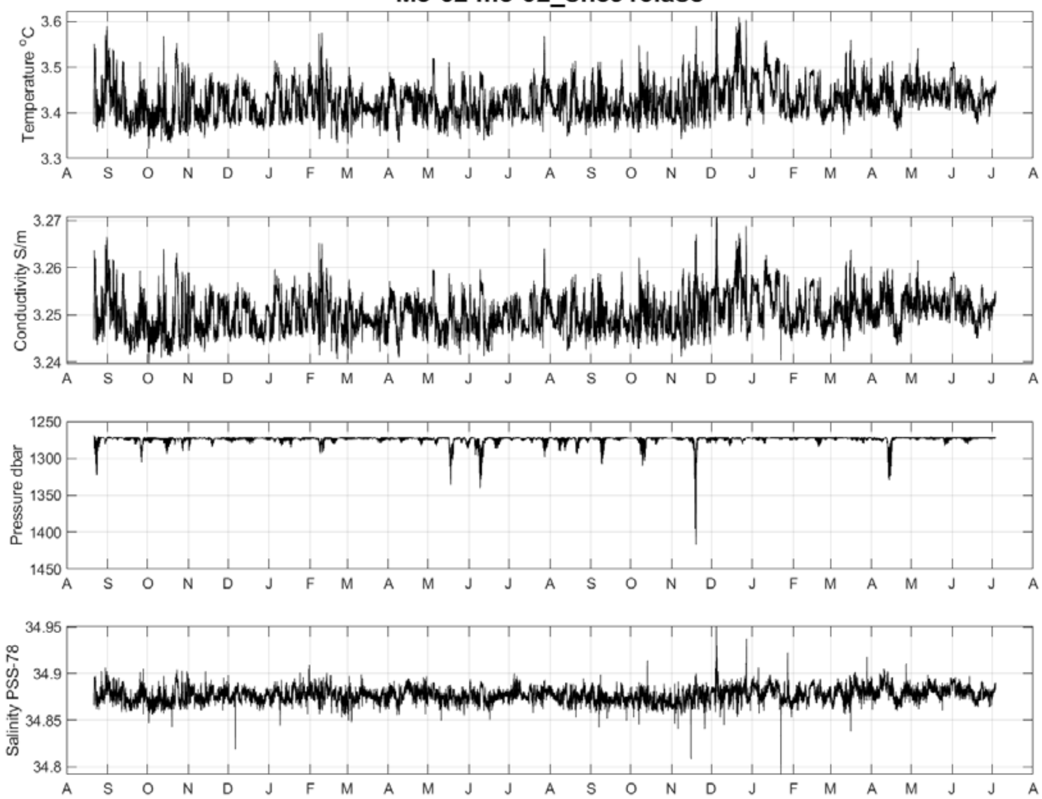
Percentage good data: 100%

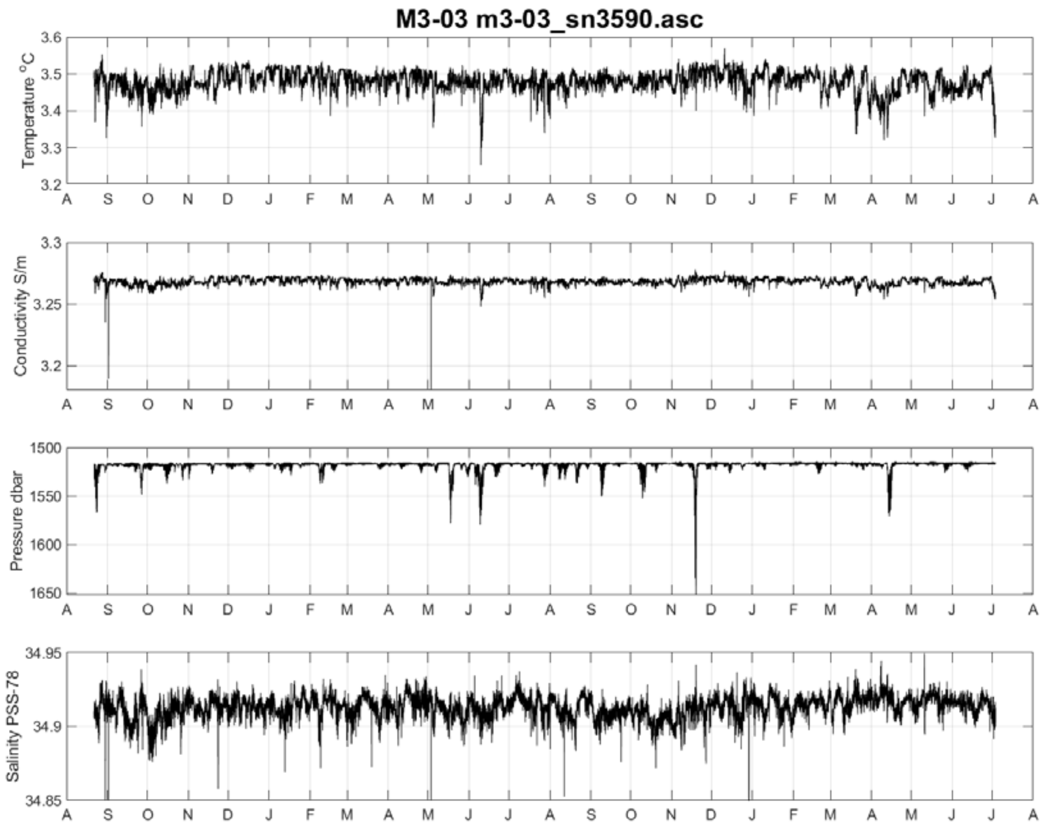
Number of measurements	32729	Serial number	AQD12456
Time of first measurement	8/21/2020	Transmit pulse length	0.75 m
Time of last measurement	7/3/2022 20:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



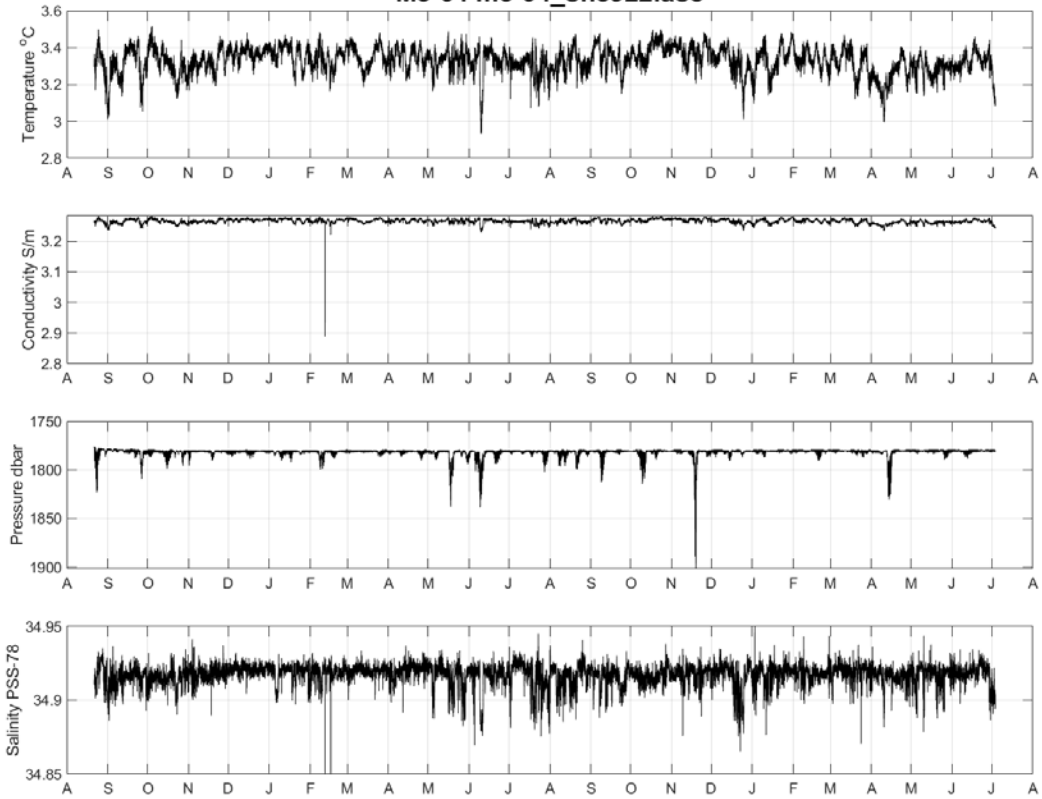
M3-01 m3-01_sn3587.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A

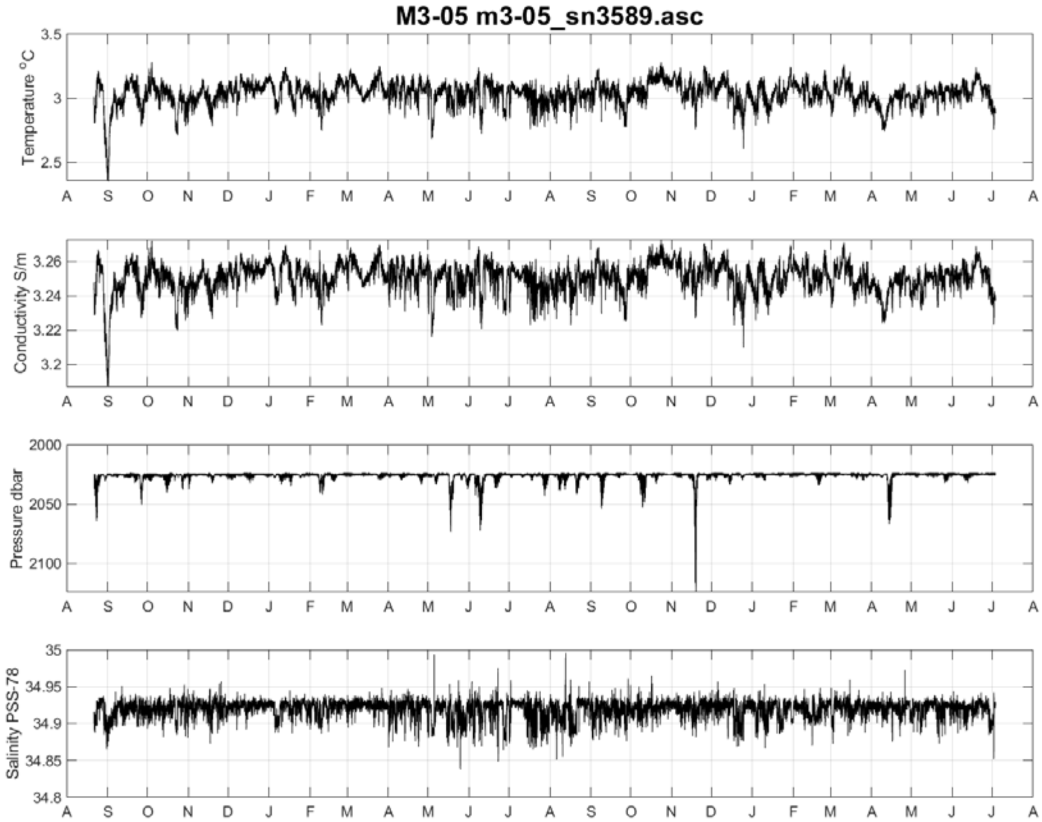
M3-02 m3-02_sn5916.asc



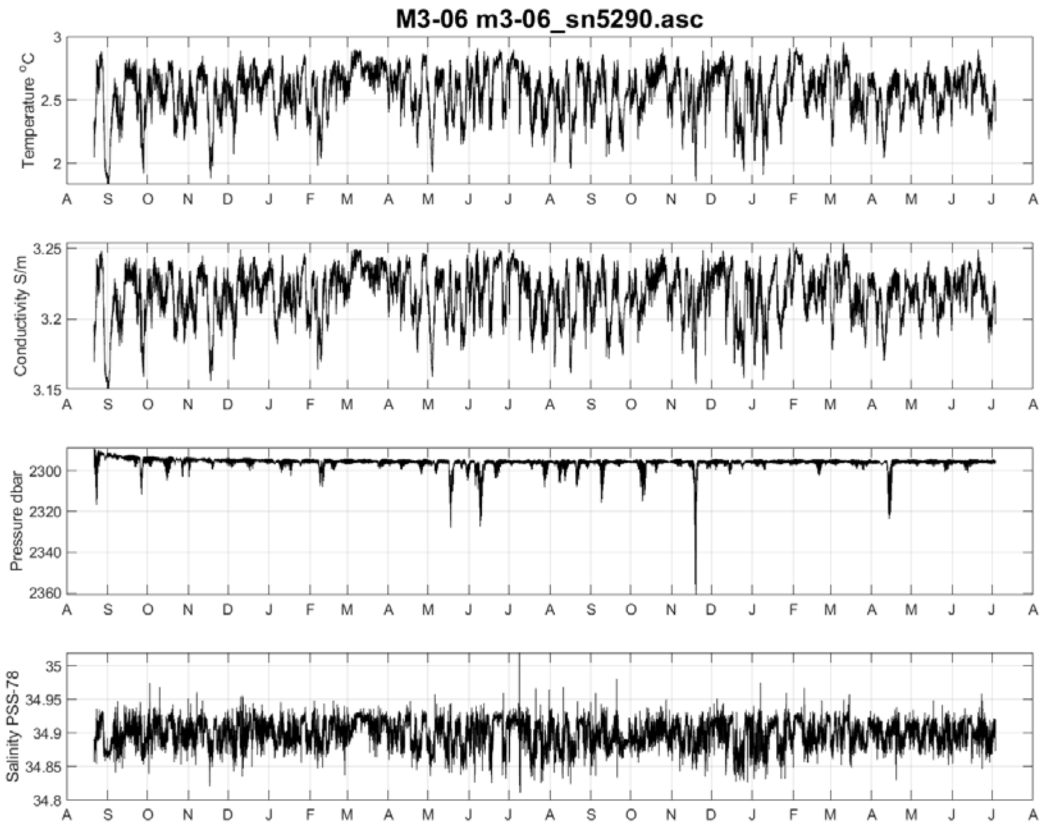

M3-03 m3-03_sn3590.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A

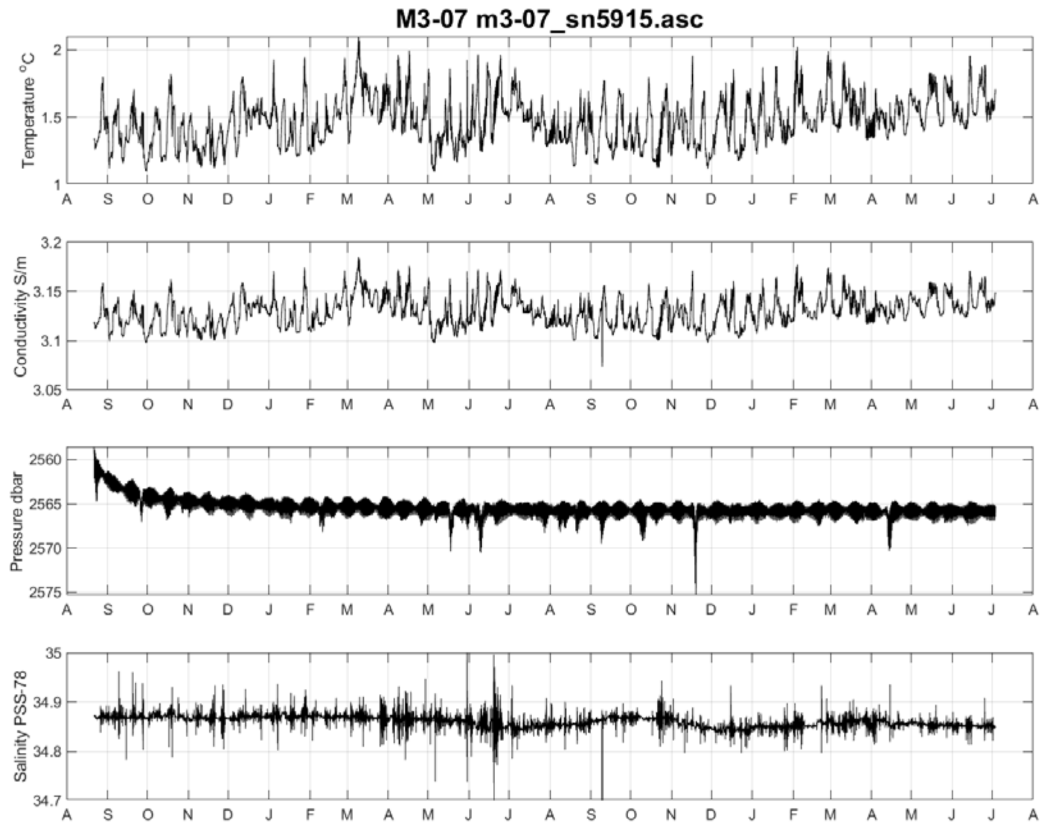
M3-04 m3-04_sn5922.asc

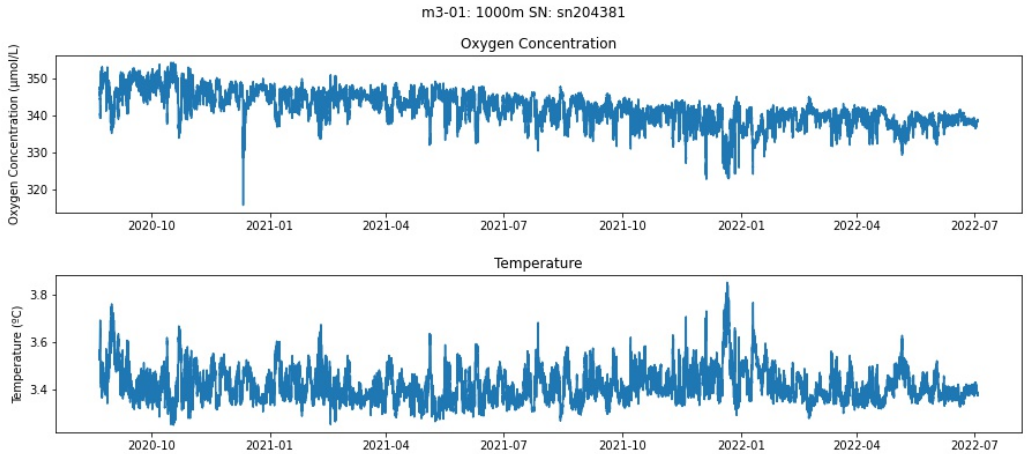


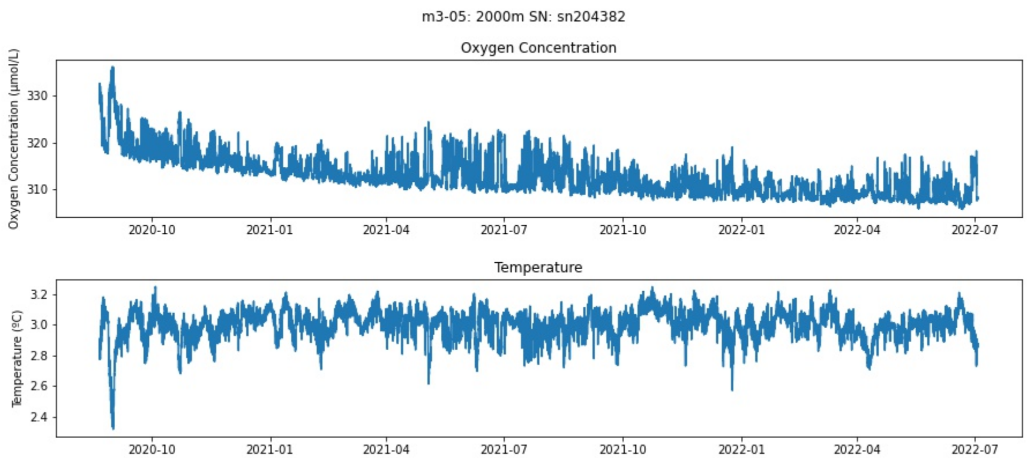


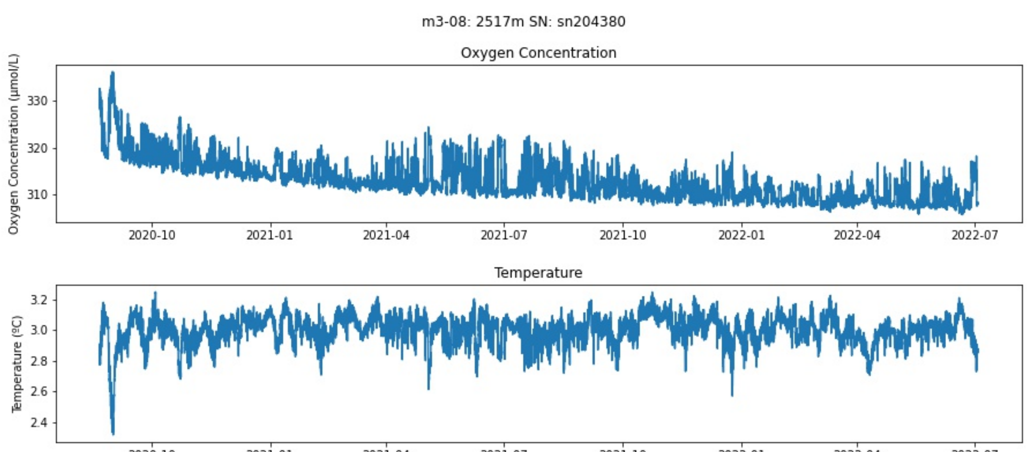
M3-05 m3-05_sn3589.asc
Temperature °C
3.5
3
2.5
Conductivity S/m
3.26
3.24
3.22
3.2
Pressure dbar
2000
2050
2100
Salinity PSS-78
35
34.95
34.9
34.85
34.8
A S O N D J F M A M J J A S O N D J F M A M J J A


M3-06 m3-06_sn5290.asc
Temperature °C
3
2.5
2
Conductivity S/m
3.25
3.2
3.15
Pressure dbar
2300
2320
2340
2360
Salinity PSS-78
35
34.95
34.9
34.85
34.8
A S O N D J F M A M J J A S O N D J F M A M J J A

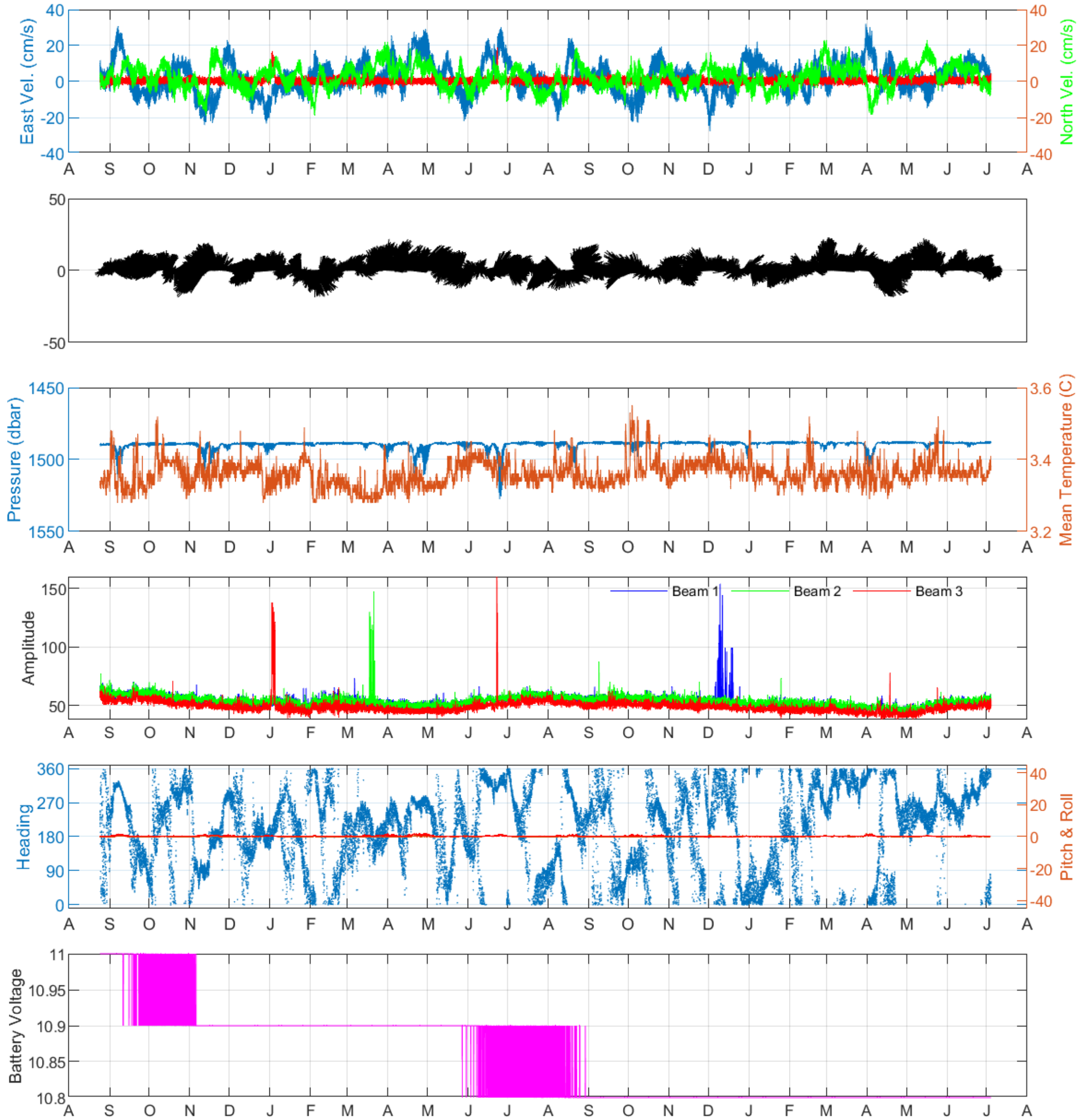

M3-07 m3-07_sn5915.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A


m3-01: 1000m SN: sn204381
Oxygen Concentration
Oxygen Concentration (µmol/L)
350
340
330
320
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07
Temperature
Temperature (ºC)
3.8
3.6
3.4
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07


m3-05: 2000m SN: sn204382
Oxygen Concentration
Oxygen Concentration (µmol/L)
330
320
310
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07
Temperature
Temperature (ºC)
3.2
3.0
2.8
2.6
2.4
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07


m3-08: 2517m SN: sn204380
Oxygen Concentration
Oxygen Concentration (µmol/L)
330
320
310
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07
Temperature
Temperature (ºC)
3.2
3.0
2.8
2.6
2.4
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07

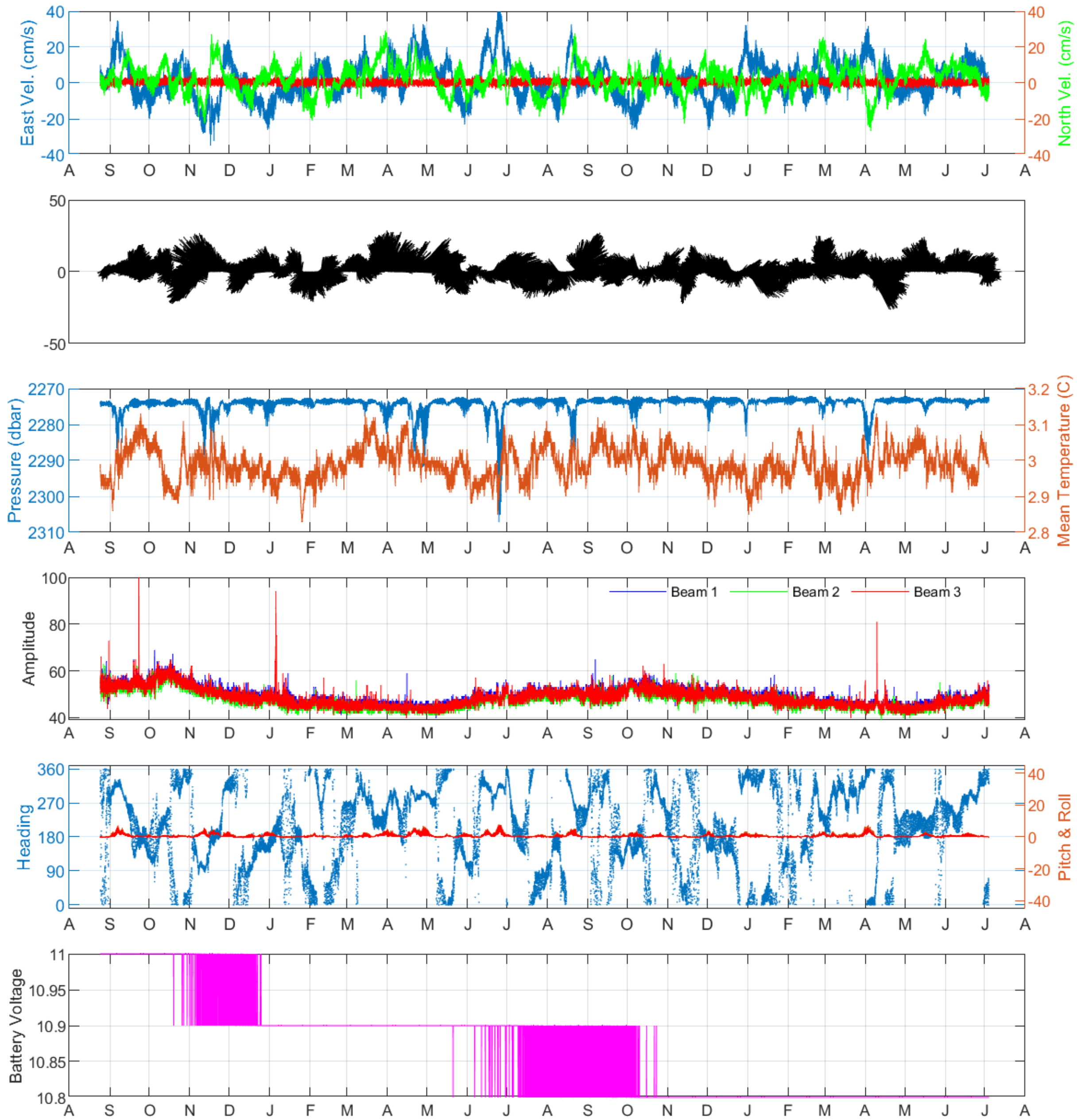
M4



M4-01

Percentage good data: 100%

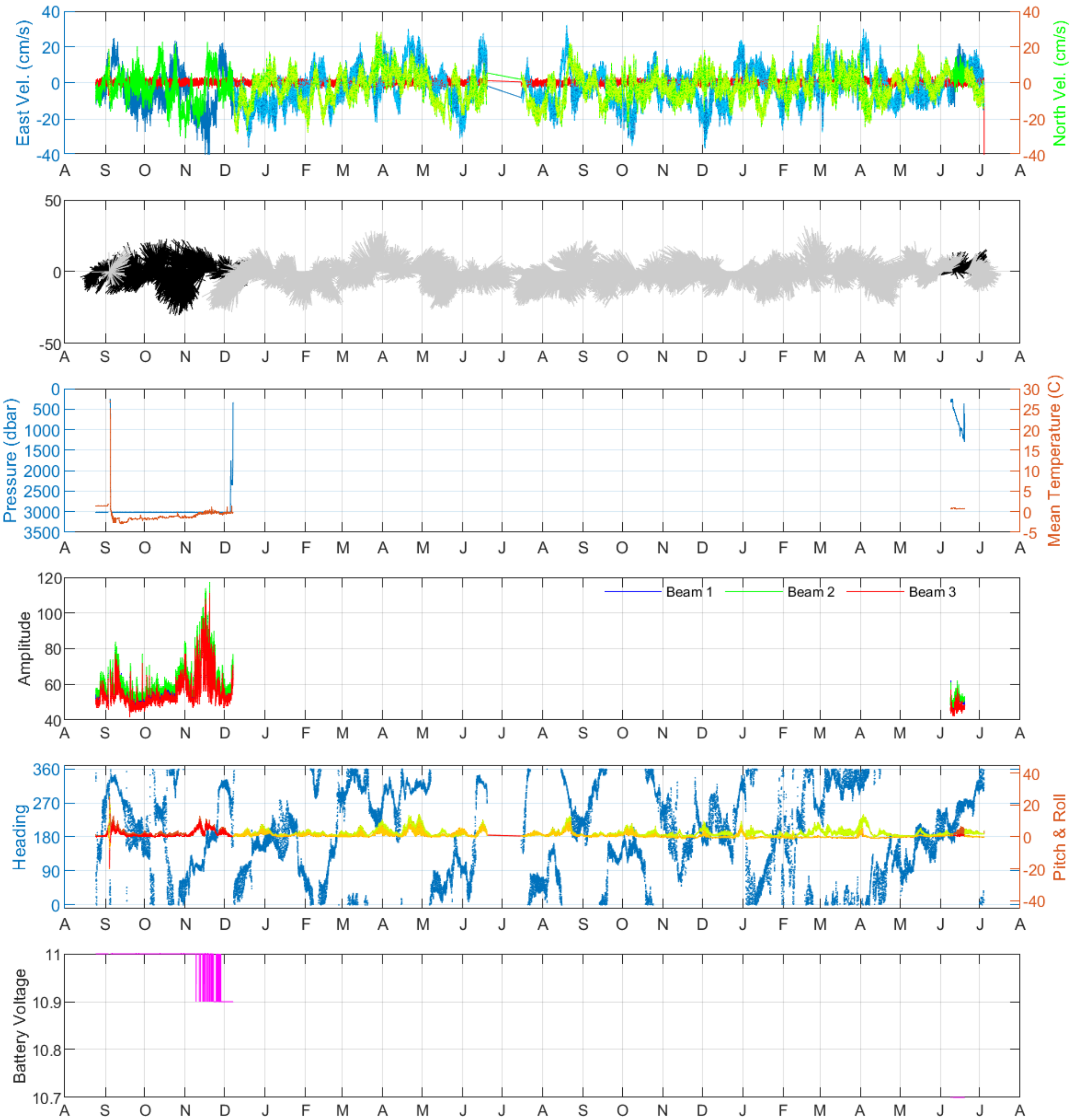
Number of measurements	32631	Serial number	AQD12474
Time of first measurement	8/24/2020	Transmit pulse length	0.75 m
Time of last measurement	7/4/2022 19:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M4-04

Percentage good data: 100%

Number of measurements	32632	Serial number	AQD12464
Time of first measurement	8/24/2020	Transmit pulse length	0.75 m
Time of last measurement	7/4/2022 19:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

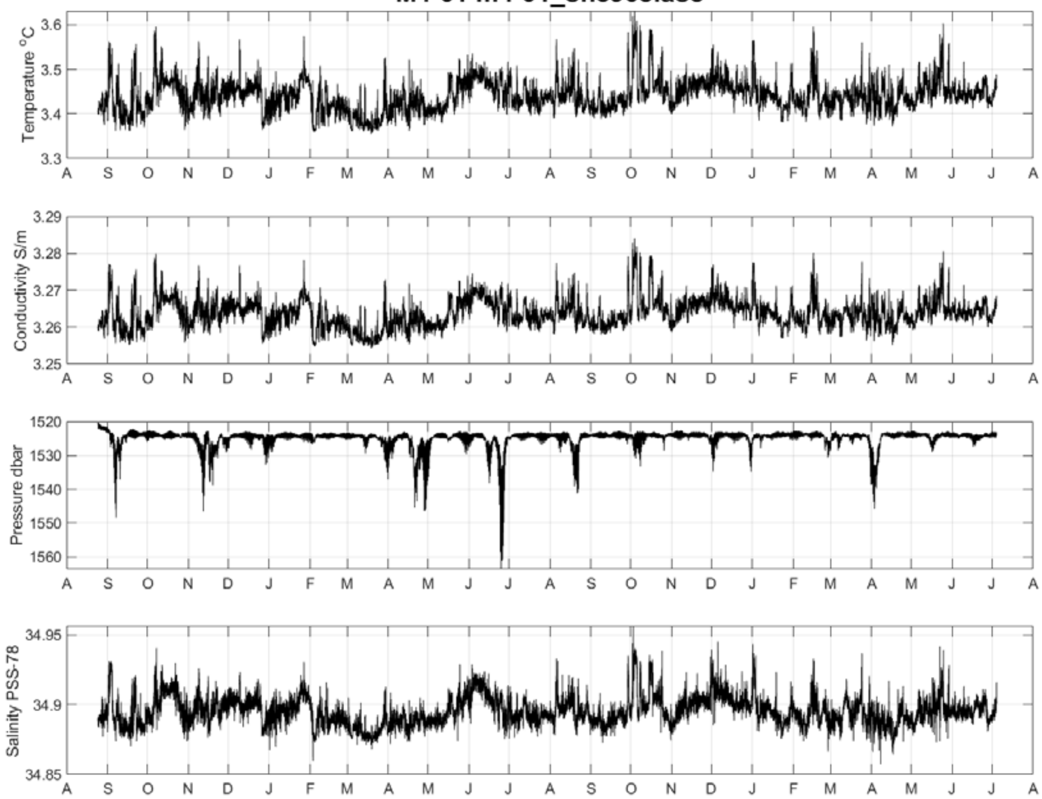


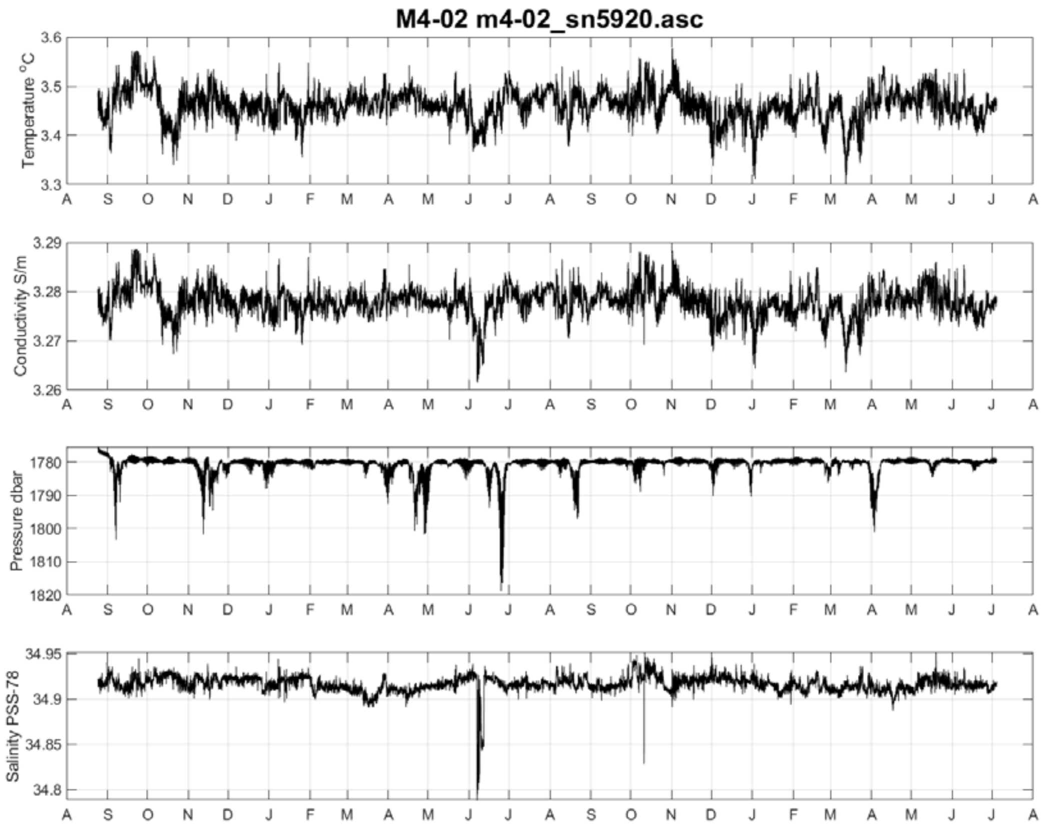
M4-07

Percentage good data: 18%

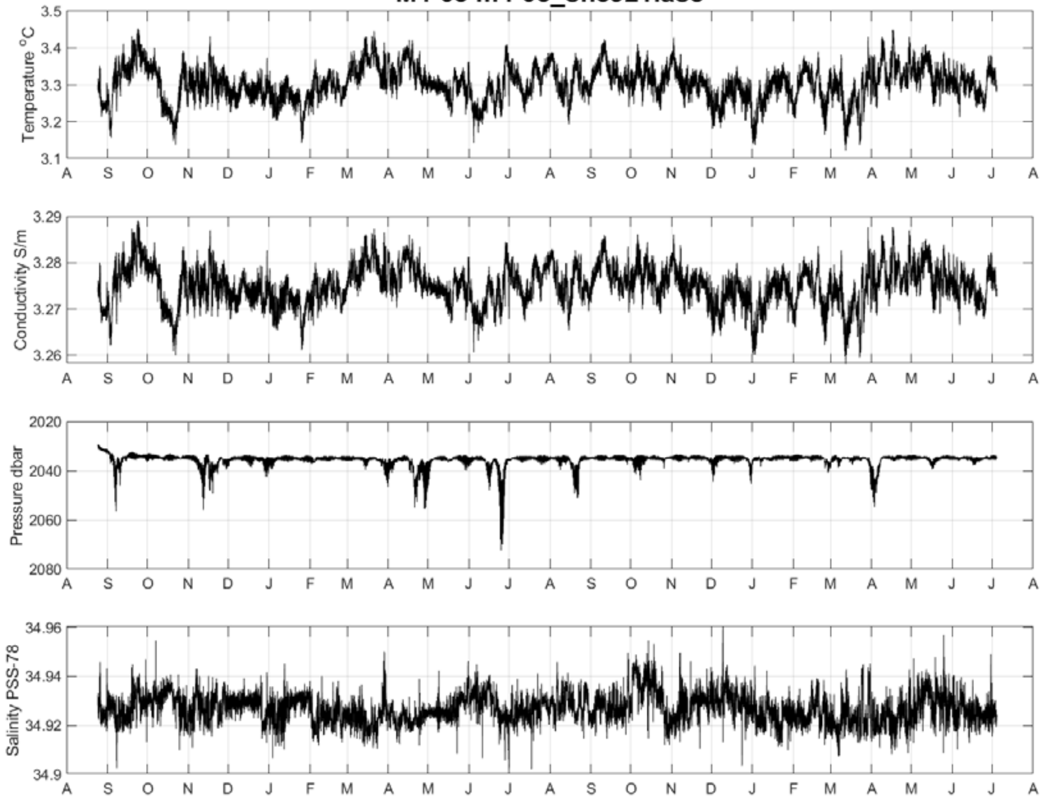
Number of measurements	31336	Serial number	AQD 9357
Time of first measurement	8/24/2020	Transmit pulse length	0.75 m
Time of last measurement	7/4/2022 19:24:38	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

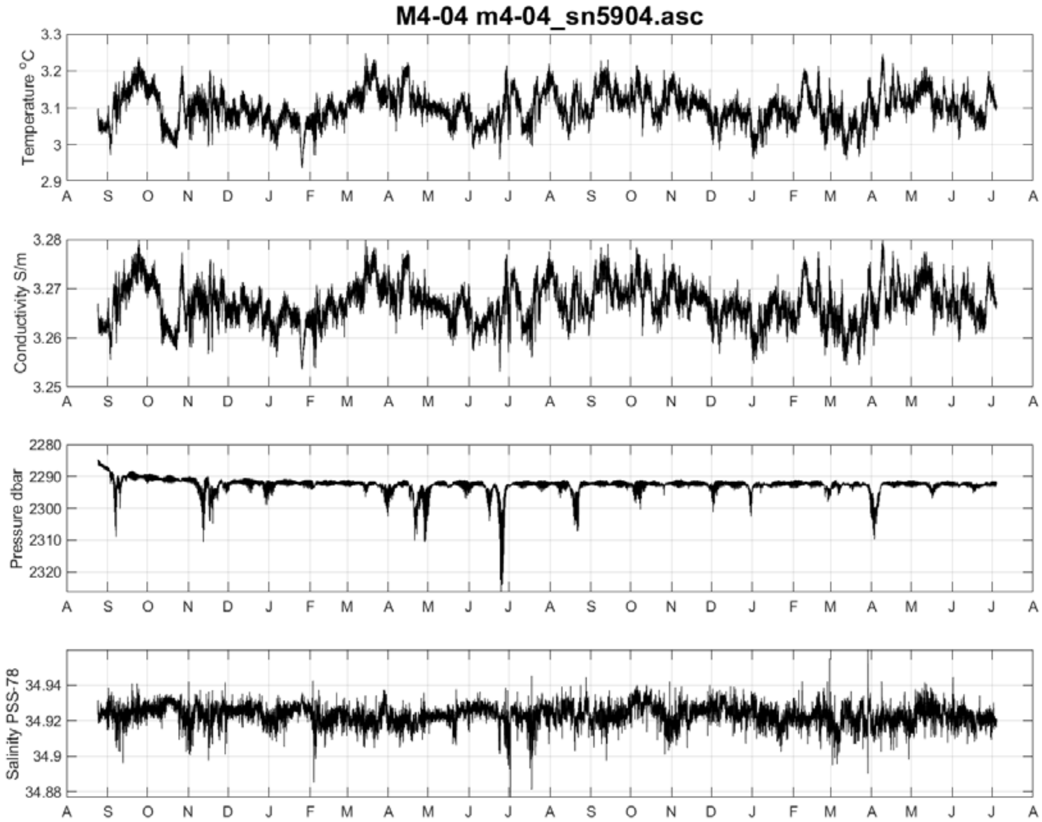
M4-01 m4-01_sn5908.asc

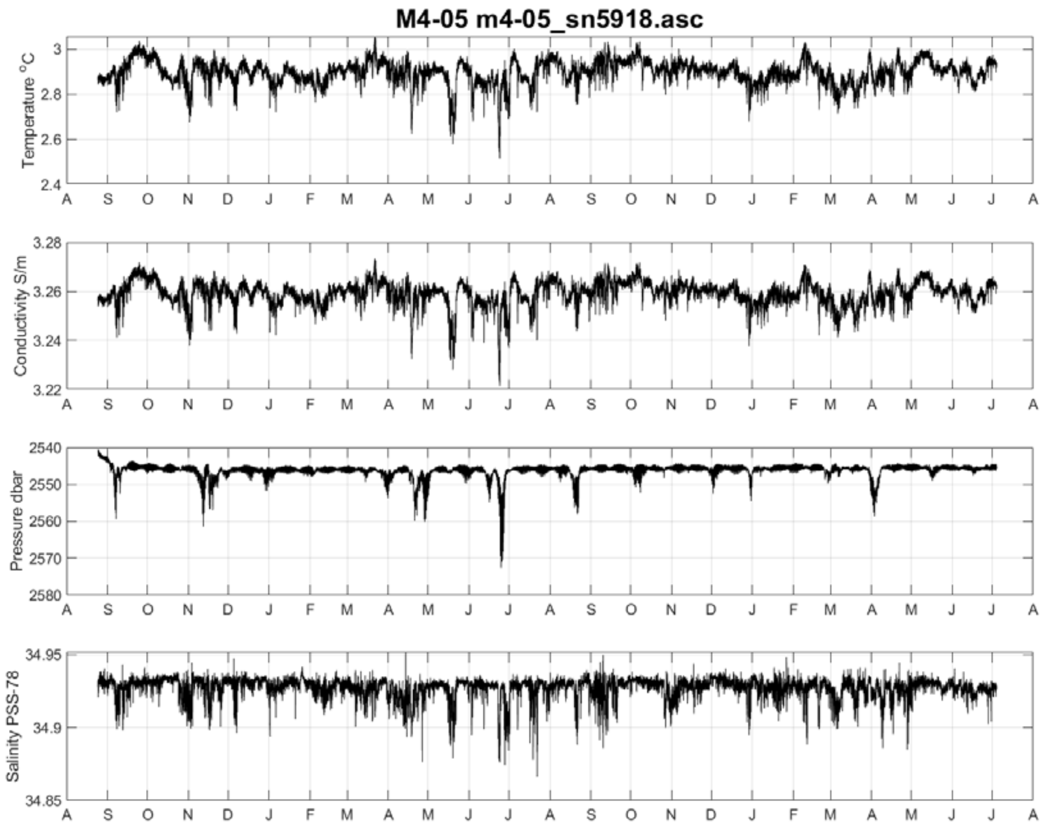


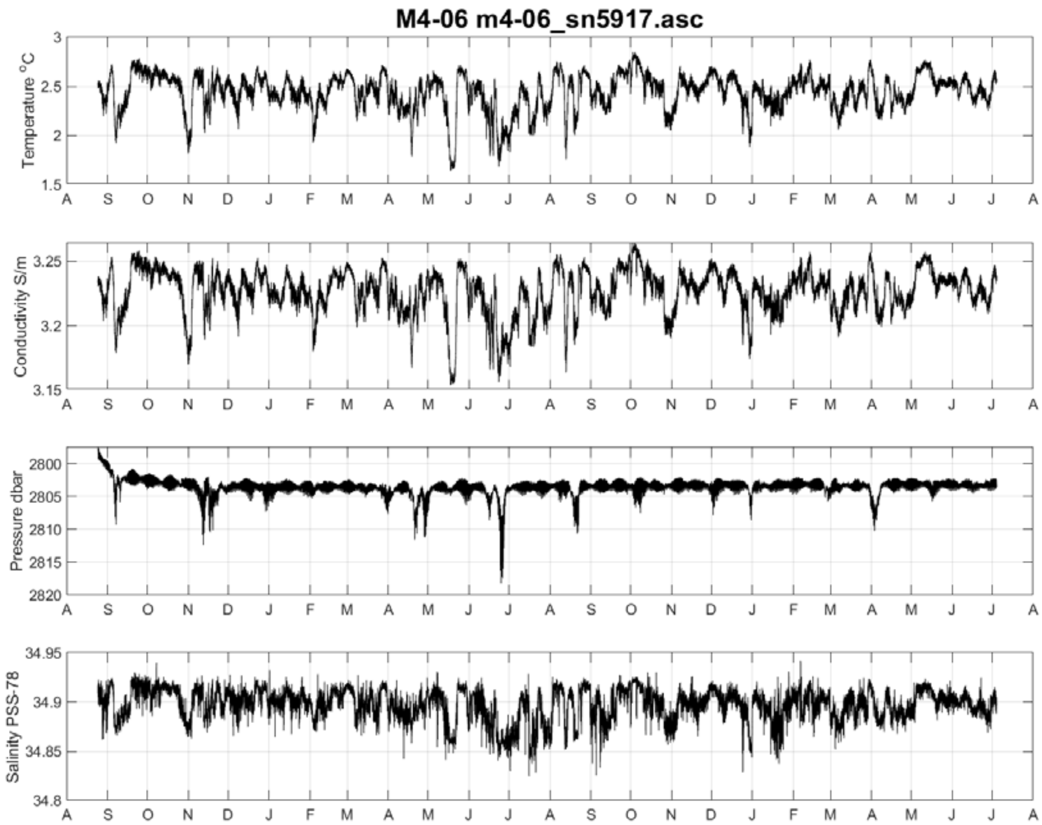

M4-02 m4-02_sn5920.asc
Temperature °C
3.6
3.5
3.4
3.3
Conductivity S/m
3.29
3.28
3.27
3.26
Pressure dbar
1780
1790
1800
1810
1820
Salinity PSS-78
34.95
34.9
34.85
34.8
A S O N D J F M A M J J A S O N D J F M A M J J A

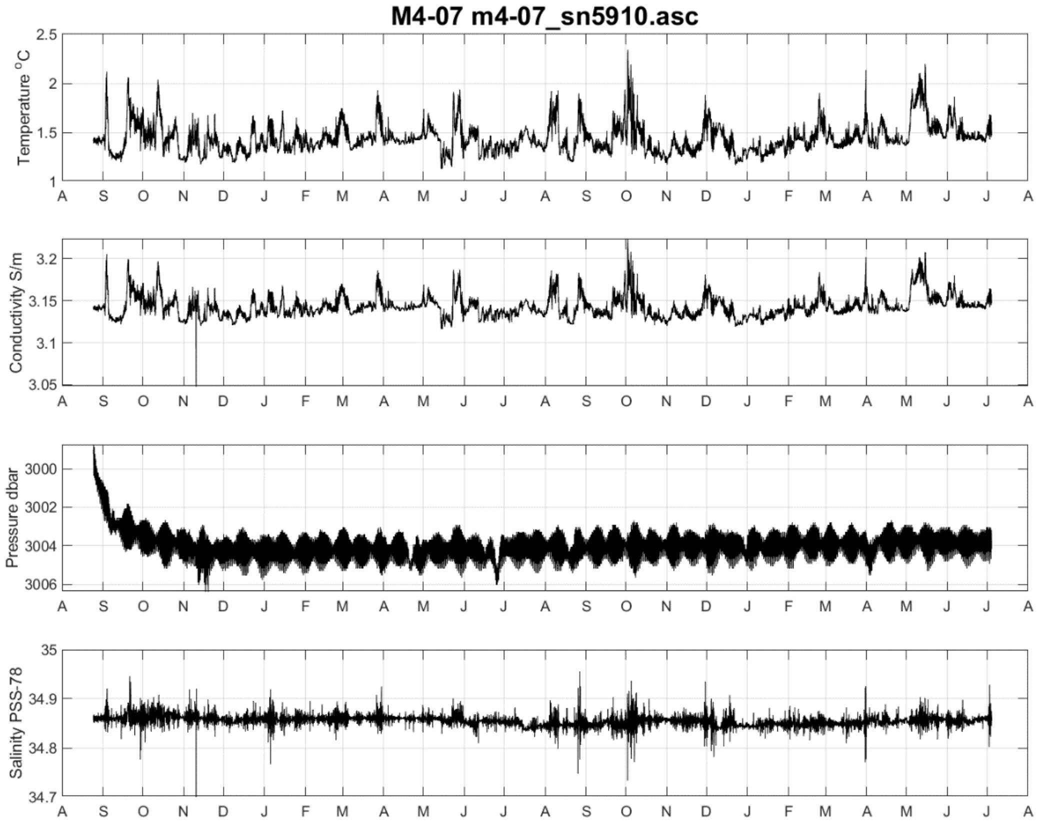
M4-03 m4-03_sn5921.asc




M4-04 m4-04_sn5904.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A


M4-05 m4-05_sn5918.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A


M4-06 m4-06_sn5917.asc
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
A S O N D J F M A M J J A S O N D J F M A M J J A


M4-07 m4-07_sn5910.asc
Temperature °C
2.5
2
1.5
1
Conductivity S/m
3.2
3.15
3.1
3.05
Pressure dbar
3000
3002
3004
3006
Salinity PSS-78
35
34.9
34.8
34.7
A S O N D J F M A M J J A S O N D J F M A M J J A

Appendix G: Hydrography report. Written by Ellen Park.

Table of Contents

AR69-01 Hydrography

CTD Profile Data

Overview

Over the course of the cruise, 23 CTD casts were completed. CTD casts were executed for one or more of the following reasons:

1. Mooring sensor calibration (OSNAP) or validation (OOI)
2. Sensor calibration dips
3. Acoustic release testing
4. Other instrument testing/debugging

For mooring sensor calibration/validation and sensor calibration dips, water samples were collected for analysis. Water samples were collected at 16 of the 23 stations. Water samples were analyzed on-board for salts and dissolved oxygen for both OSNAP and OOI CTD cats. OOI water samples collected for dissolved inorganic carbon (DIC), total alkalinity (TA), pH, nutrients, and chlorophylls will be analyzed on-land after the cruise.

CTD Maintenance

Before and after each CTD cast, the primary and secondary sensors were flushed with MilliQ water to clean sensors from biofouling, etc. Additionally, after each cast, the other sensors and the rosette were hosed down.

Other Notes

On CTD Cast 004, when the CTD went below approximately 1,800m, communication was lost, and data collection ceased. Communications were re-established with the CTD when the package reached roughly 500m on the upcast. This phenomenon had been observed by the SSSGs on prior cruises with deep casts, and various actions had been taken to remedy this problem. An uncalibrated fish was attached for the subsequent cast 005 to evaluate if the wire was the problem. The deep cast with the back-up fish was successful. As a result, the SSSGs were able to locate a missing retention ring from one of the dummied off connectors on a Y-cable with no sensor attached on the original, calibrated CTD package. The Y-cable was removed, and the original CTD fish was re-installed. On cast 006 (and all subsequent casts), no communication issues were observed.

Cast 001: Transit CTD Test Cast

Notes

- Altimeter was problematic

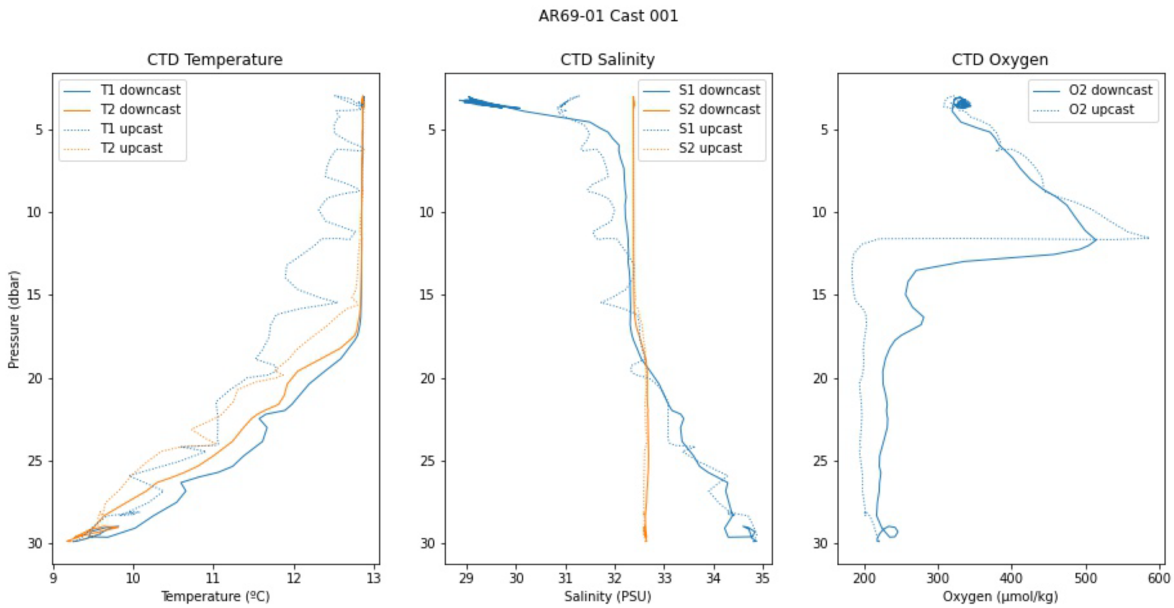


Figure H1. CTD temperature, salinity, and dissolved oxygen for cast 001. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H1. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
	No samples collected						

Cast 002: Transit CTD Test Cast

Notes

- Altimeter replaced

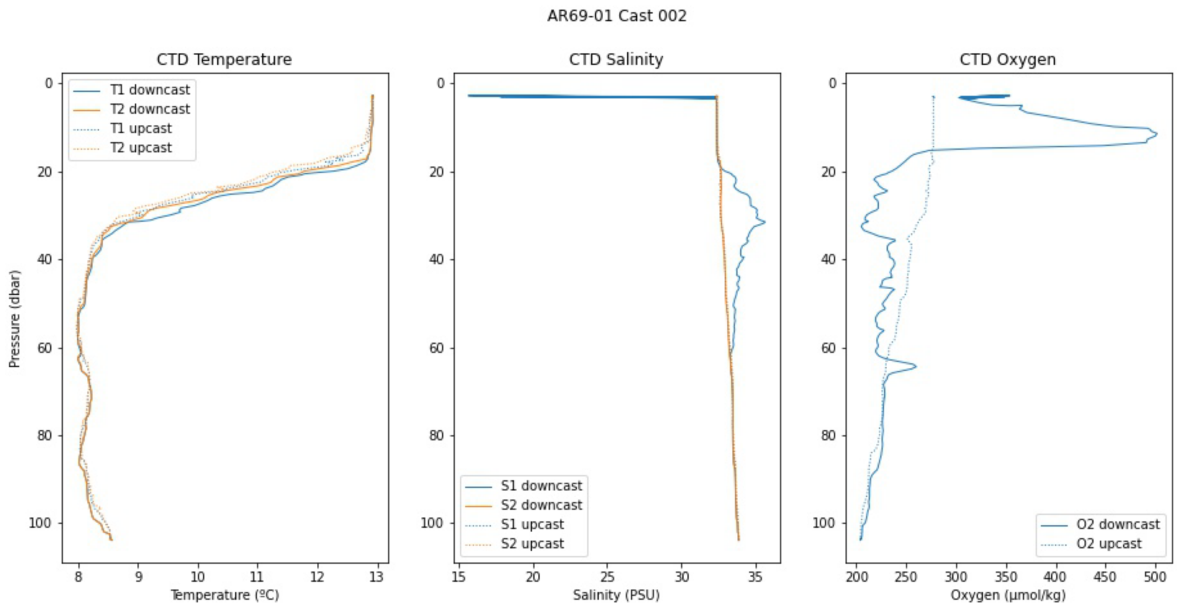


Figure H2. CTD temperature, salinity, and dissolved oxygen for cast 002. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H2. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
	No samples collected						

Cast 003: Transit Acoustic Release Test

Notes

- Acoustic releases attached to rosette

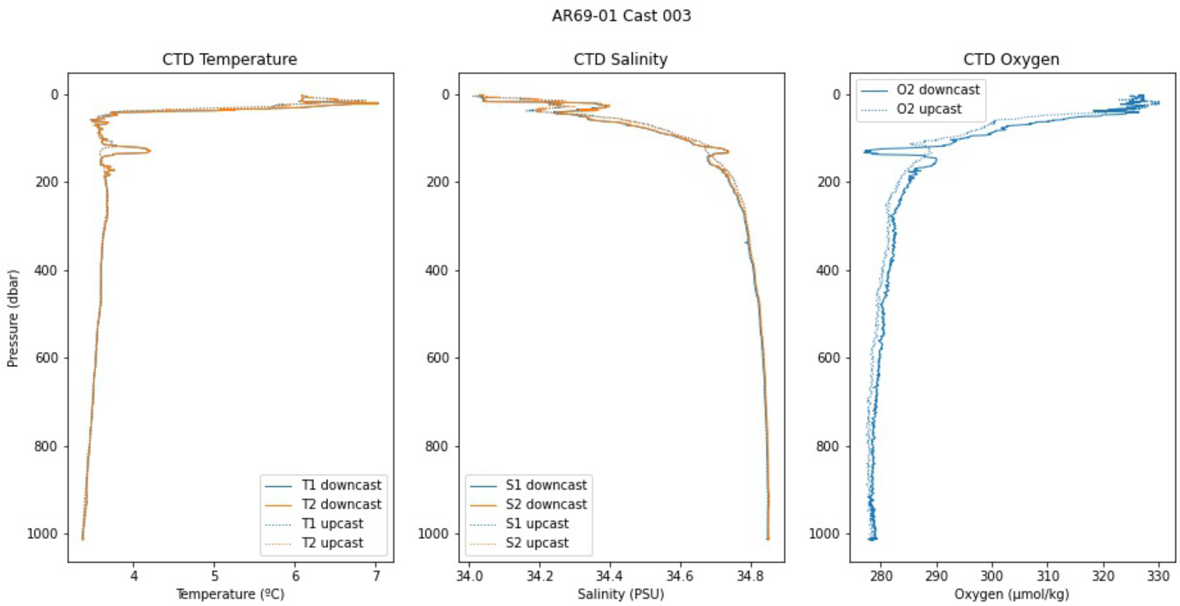


Figure H3. CTD temperature, salinity, and dissolved oxygen for cast 003. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H3. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
	All Niskins bottles fired at the surface						
	No samples collected						

Cast 004: Transit Pre-Deployment Microcat Cal Dip

Notes

- Cast aborted, communication failure with CTD at 1818 meters. Data collection ceased
- Failed calibration dips of OOI CTDMOs and OSNAP microcats

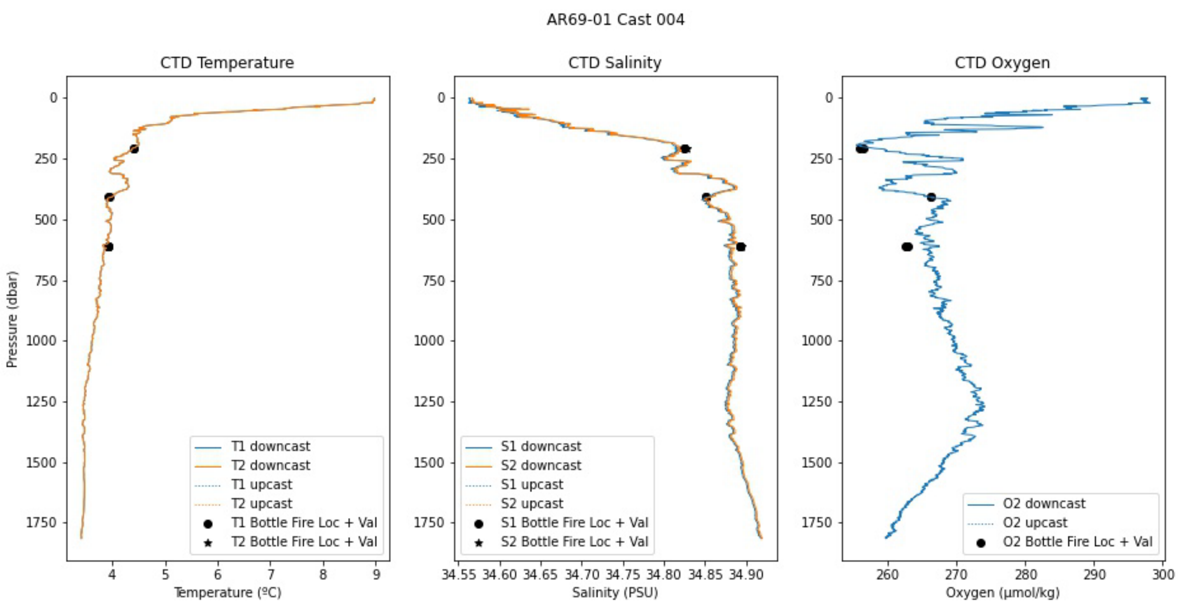


Figure H4. CTD temperature, salinity, and dissolved oxygen for cast 004. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H4. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
	No samples collected and no bottles fired because communication was lost with the CTD						

Cast 004b: Transit Pre-Deployment Microcat Cal Dip
Notes

- Upcast of Cast 004; communication with CTD re-established at ~ 600 meters
- Failed calibration dips of OOI CTDMOs and OSNAP microcats
- 10-minute soak at deepest depth

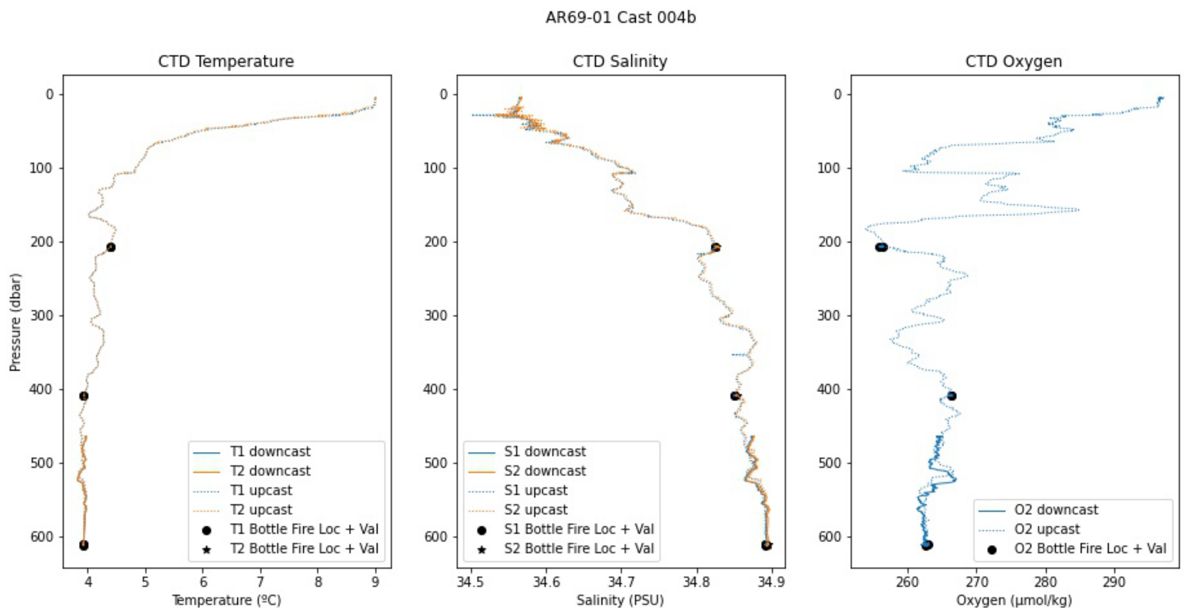


Figure H5. CTD temperature, salinity, and dissolved oxygen for cast 004b. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H5. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	604	C		X			
2	604	C		X			
3	604	C		X			
4	604	C		X			
5	400			X			
6	400			X			
7	200			X			
8	**200**			**X**			

Cast 005: Transit Acoustic Release Test

Notes

- Tested CTD with old fish with uncalibrated sensors to see if communication could be maintained at depth
- Oxygen sensor hooked up to the wrong voltage channel
- Acoustic releases attached

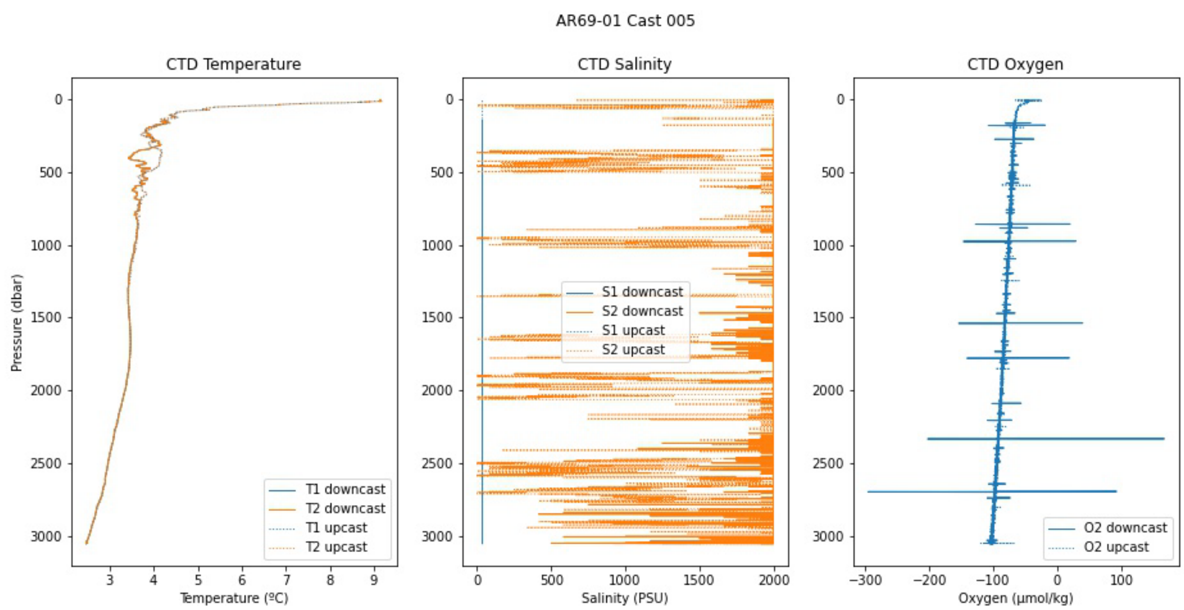


Figure H6. CTD temperature, salinity, and dissolved oxygen for cast 005. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H6. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
	No samples collected						

Cast 006: Transit Acoustic Release Test

Notes

- Between cast 005 and 006, found a faulty cable in the original CTD. Replaced cable and put original (calibrated) fish back on the rosette
- Acoustic releases attached

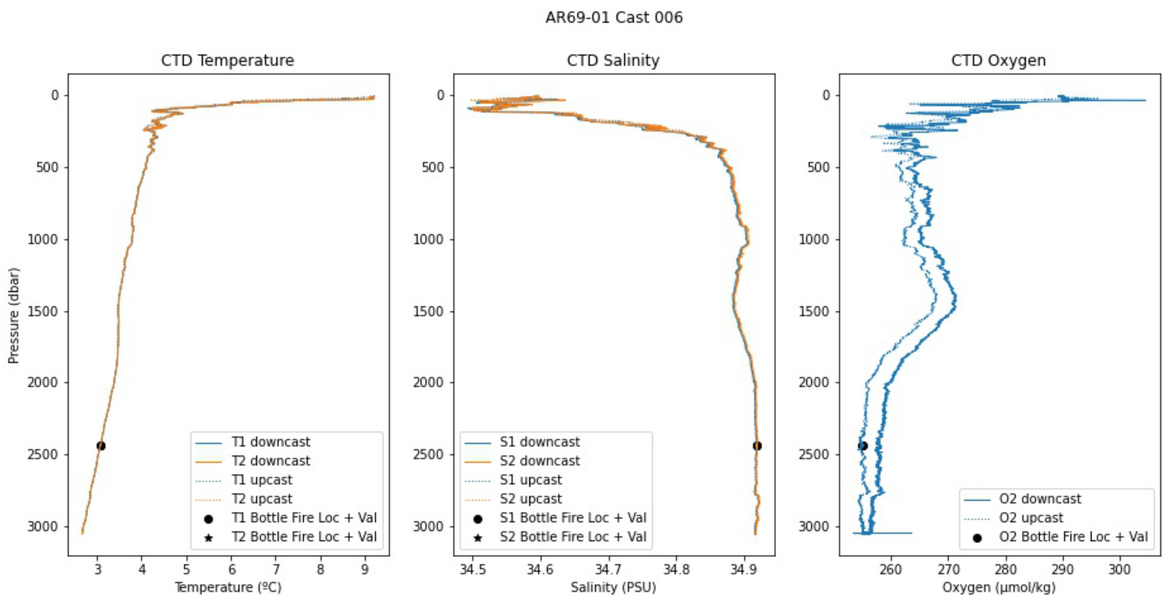


Figure H7. CTD temperature, salinity, and dissolved oxygen for cast 006. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H7. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

<table>
<tr><th rowspan="2">Niskin</th><th rowspan="2">Nominal Depth</th><th rowspan="2">Flags</th><th rowspan="2">Oxygen</th><th rowspan="2">Salts</th><th colspan="3">Other</th></tr>
<tr><th>DIC/TA/pH</th><th>Nutrients</th><th>Chlorophyll</th></tr>
<tr><td>1</td><td>2400</td><td colspan="6" rowspan="2">Tested Niskin firings, no samples taken</td></tr>
<tr><td>2</td><td>2400</td></tr>
</table>

Cast 007: Transit Pre-Deployment Microcat and Optode Cal Dip

Notes

- OSNAP microcat and optode cal dip
- 10-minute cal dip soak at 6 depths
    - 4 deep depths for microcats
    - 4 depths following recommendations from I. Le Bras (see Optodes section)

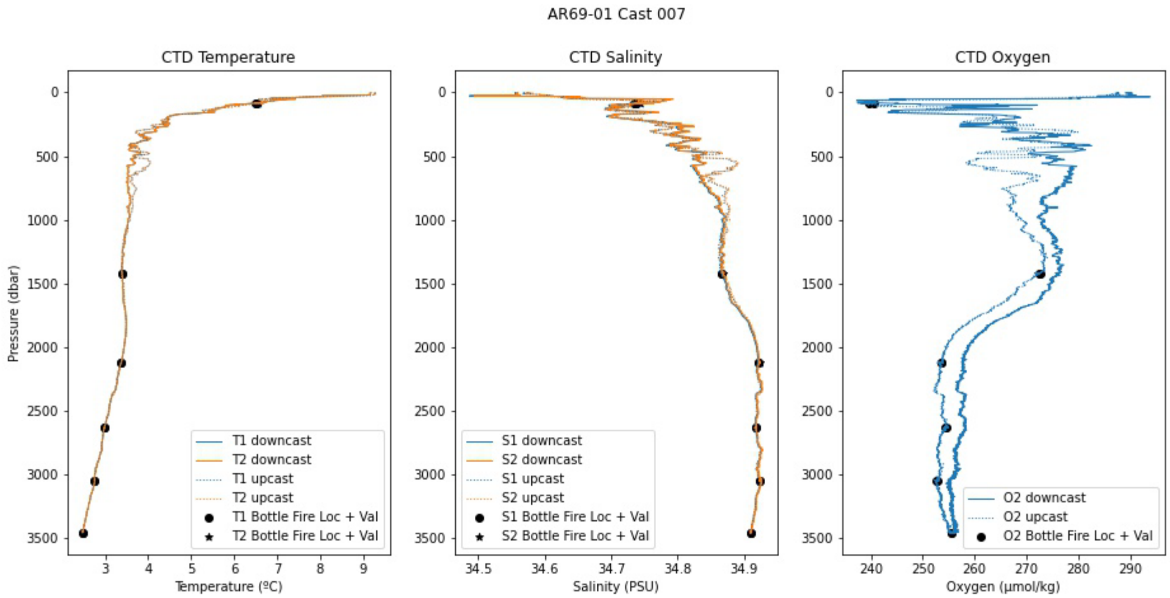


Figure H8. CTD temperature, salinity, and dissolved oxygen for cast 007. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H8. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	3400	C	XX	X			
2	3400	C	X				
3	2999	C		X			
4	2999	C					
5	2600	C		X			
6	2600	C					

7	2100	C	XX	X			
8	2100	C	X				
9	1400	C	XX	X			
10	1400	C	X				
11	75	C	XX	X			
12	75	C	X				

Cast 008: Transit Pre-Deployment Microcat Cal Dip

Notes

- OSNAP microcat cal dips
- 10-minute soak at 4 deep depths

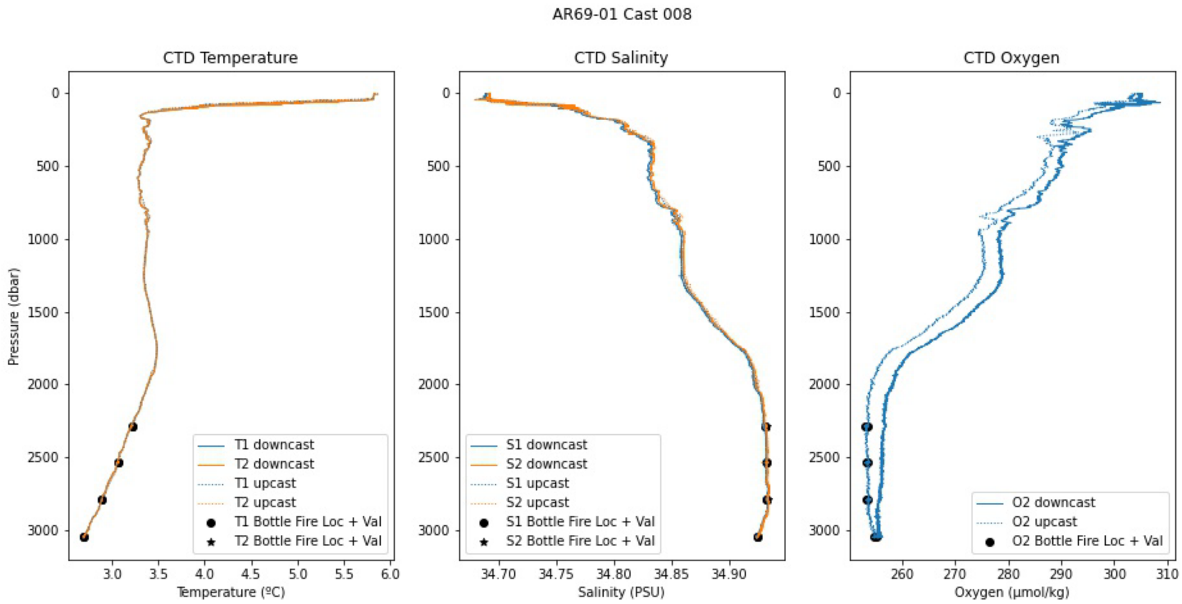


Figure H9. CTD temperature, salinity, and dissolved oxygen for cast 008. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H9. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	3000	C		X			
2	3000	C					
3	2750	C		X			
4	2750	C					
5	2500	C		X			
6	2500	C					
7	2250	C		X			
8	2250	C					

Cast 009: OOI Glider CTD and Acoustic Release Test

Notes

- Acoustic releases attached
- 20-minute soak at 1000 m for acoustic release test
- Followed OOI sampling protocol with duplicate oxygen samples collected from the same bottle at 3 depths

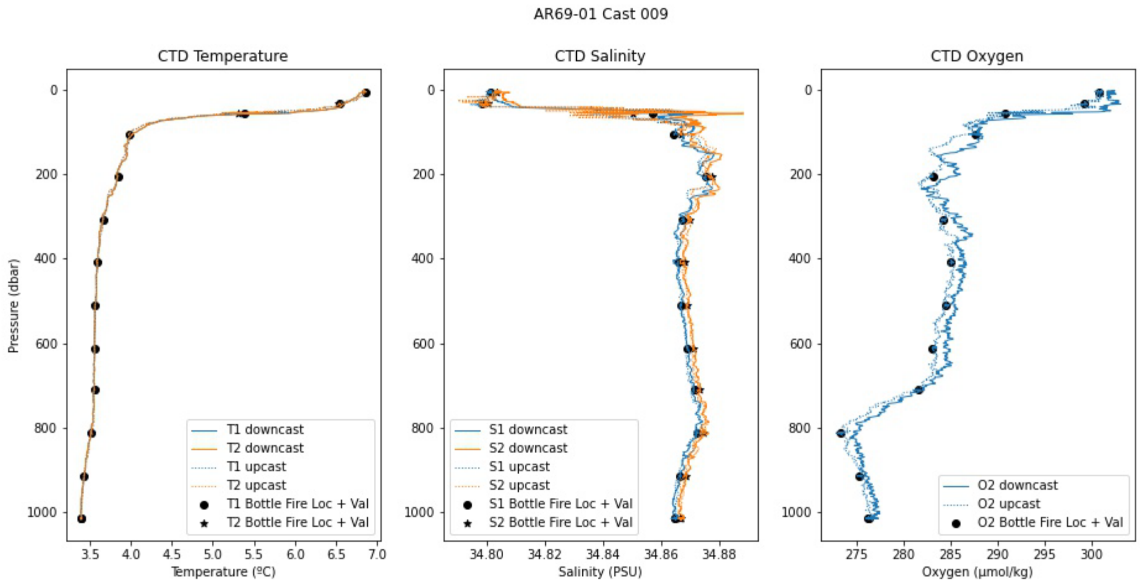


Figure H10. CTD temperature, salinity, and dissolved oxygen for cast 009. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H10. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	1000		XX	X			
2	1000		X				
3	900		X	X			
4	800		X	X			
5	700		X	X			
6	600		X	X			
7	500		XX	X			

8	400		X	X			
9	300		X	X			
10	200		X	X		X	
11	100		X	X		X	XX
12	50		XX	X		X	X
13	30		X	X		X	X
14	sfc		X	X		X	XX

Cast 010: OSNAP M3 CTD Cast

Table H11. M3 instrument depths

Nominal Instrument Depth (m)	Microcat	Optode	Aquadopp
1000	X	X	X
1250	X		
1500	X		X
1750	X		
2000	X	X	X
2250	X		X
2517	X	X	X

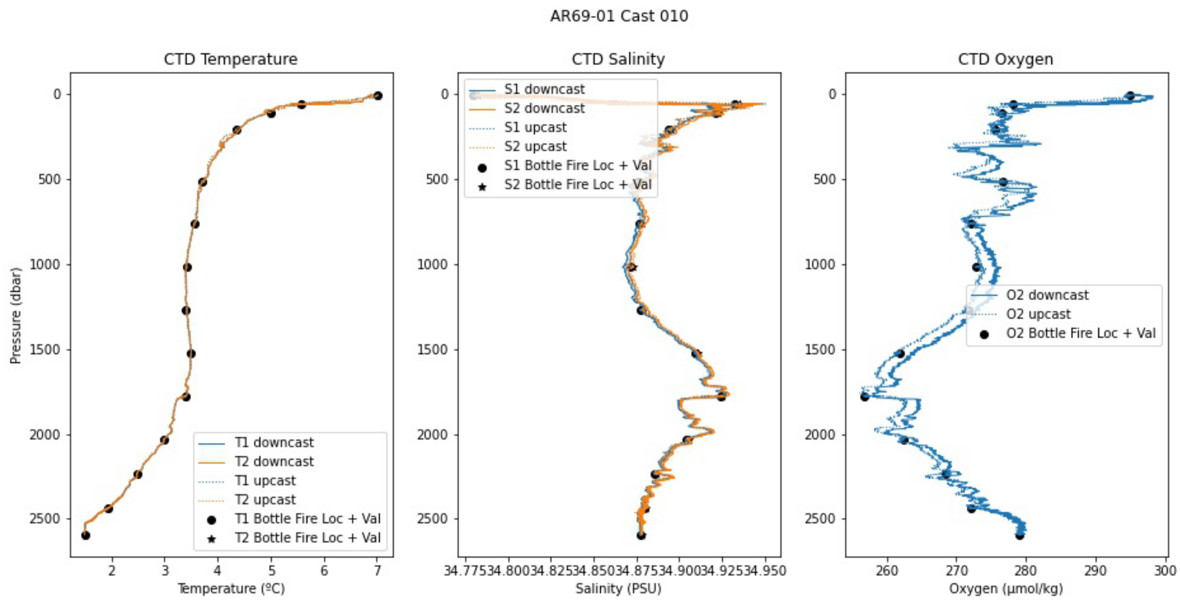


Figure H11. CTD temperature, salinity, and dissolved oxygen for cast 010. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H12. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2550	~I(S, O_2)	XX	X			
2	2400			X			
3	2200	~I(S)		X			
4	2000	I(S, O_2)	XX	X			
5	1750	I(S)	XX	X			
6	1500	I(S)		X			
7	1250	I(S)		X			
8	1000	I(S, O_2)	XX	X			
9	750			X			
10	500		XX	X			
11	200			X			
12	100			X			
13	50		XX	X			
14	sfc			X			

Cast 011: OSNAP M2 CTD Cast

Table H13. M2 instrument depths

Nominal Instrument Depth (m)	Microcat	Optode	Aquadopp
1000	X	X	X
1250	X		
1500	X		X
1750	X		
2000	X	X	X
2191	X		X
2383	X	X	X

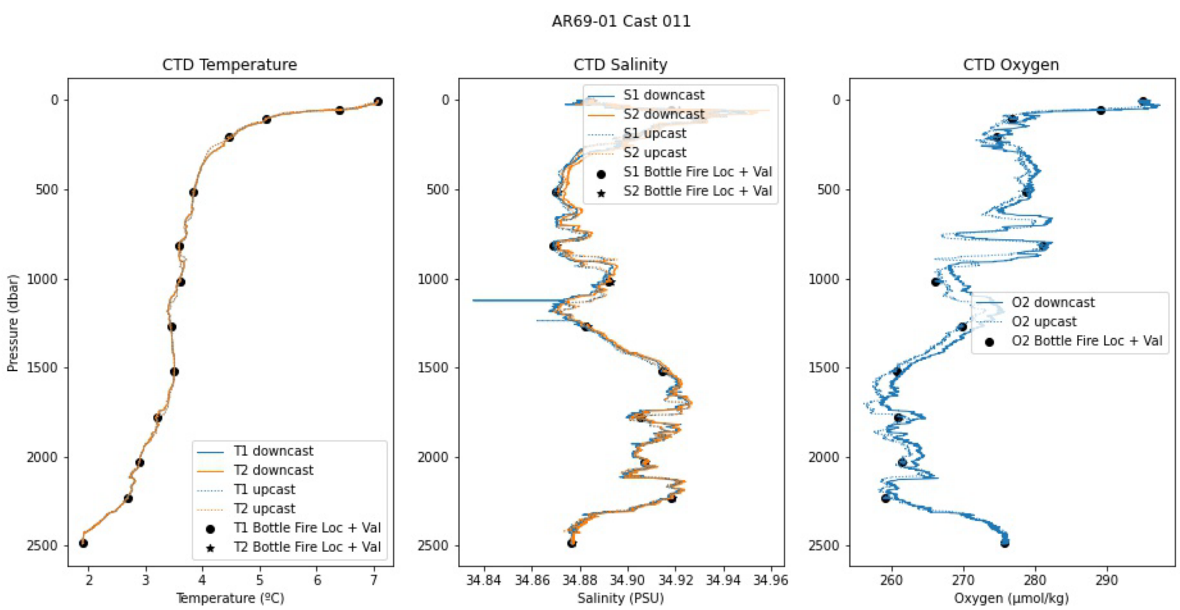


Figure H12. CTD temperature, salinity, and dissolved oxygen for cast 011. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H14. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2450	~I(S,O_2)	XX	X			
2	2200	I(S,O_2)	XX	X			
3	2000	I(S)		X			
4	1750	I(S)		X			
5	1500	I(S,O_2)	XX	X			
6	1250	I(S)		X			
7	1000	I(S)		X			
8	800		XX	X			
9	500			X			
10	200		XX	X			
11	100			X			
12	50		XX	X			
13	sfc			X			

Cast 012: OOI SUMO CTD Cast

Notes

- Followed OOI sampling protocol with duplicate oxygen samples collected from the same bottle at 5 depths

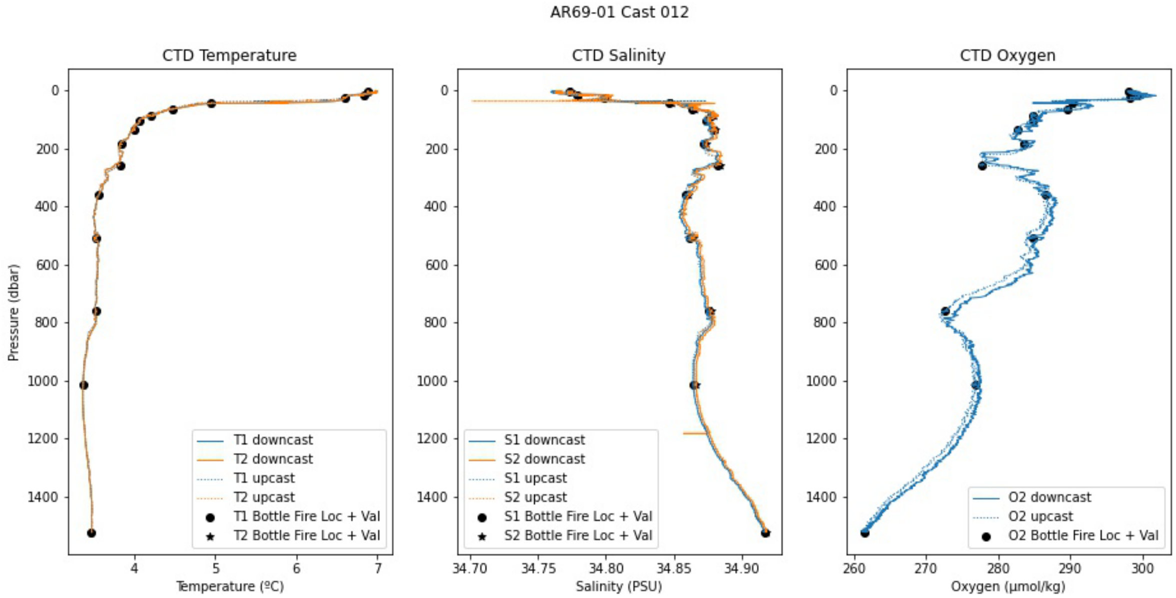


Figure H13. CTD temperature, salinity, and dissolved oxygen for cast 012. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H15. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					pH, DIC/TA	Nutrients	Chlorophyll
1	1500		XX				
2	1000		X				
3	750		XX				
4	500		X				
5	350		XX				
6	250		XX				
7	180		X				
8	130		X		N/A, X	X	X

9	100		X		X, X		
10	80		X		N/A, X	X	X
11	60		X				
12	40		X		N/A, X	X	X
13	20		XX		X, X		
14	12		X		X, X	X	X
15	sfc		X		X, X	X	X

Cast 013: OOI HYPM CTD Cast

Notes

- Followed OOI sampling protocol with duplicate oxygen samples collected from the same bottle at 5 depths

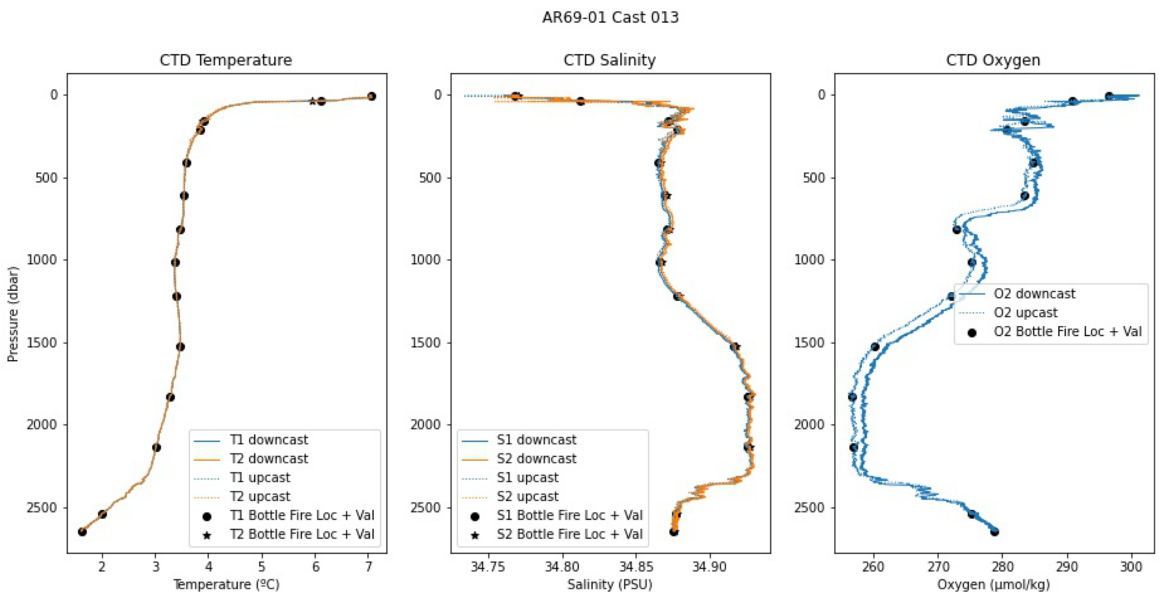


Figure H14. CTD temperature, salinity, and dissolved oxygen for cast 013. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H16. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2600		XX	X			
2	2500		X	X			
3	2100		XX	X			
4	1800		X	X			
5	1500		X	X			
6	1200		XX	X			
7	1000		X	X			

8	800		X	X			
9	600		X	X			
10	400		XX	X			
11	200		X	X			
12	150		X	X			X
13	33		XX	X			X
14	sfc		X	X			X

Cast 014: OOI FLMB CTD Cast and Acoustic Release Test

Notes

- Followed OOI sampling protocol with duplicate oxygen samples collected from the same bottle at 5 depths
- Acoustic releases attached

Table H17. OSNAP instrument depths on OOI FLMB mooring. Bottom depth: 2823 m.

Nominal Instrument Depth (m)	Microcat	Optodes	Aquadopp
1000 m of bottom	X		X
700 m of bottom	X		X
400 m off bottom	X		X
100 m off bottom	X		X

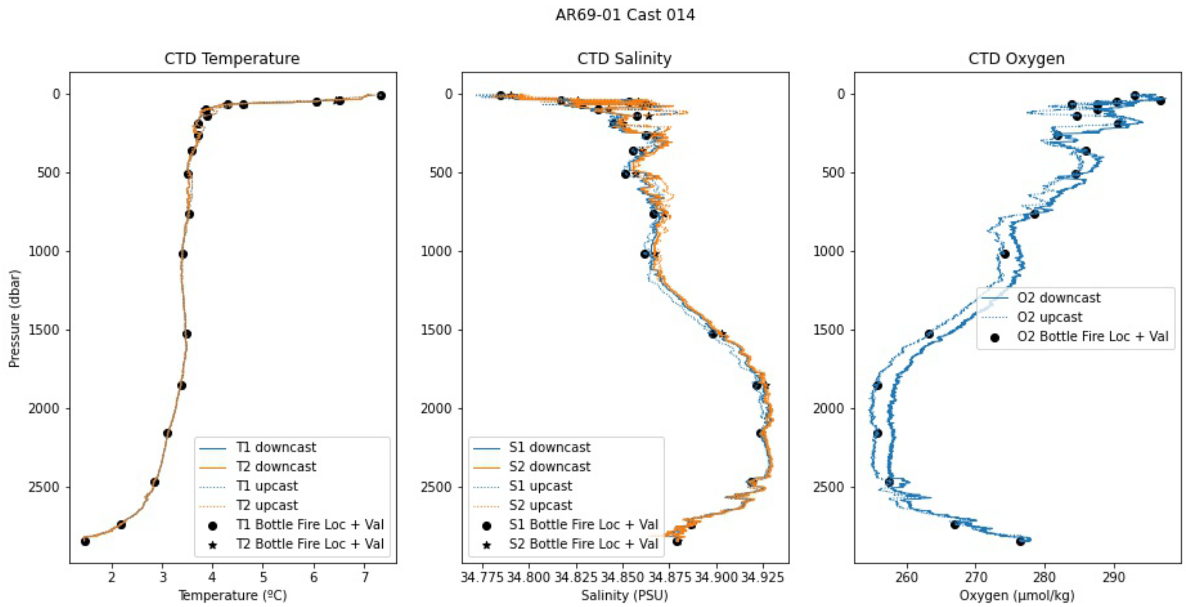


Figure H15. CTD temperature, salinity, and dissolved oxygen for cast 014. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H18. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2800		XX	X			
2	2700		X	X			
3	2430		X	X			
4	2130		XX	X			
5	1830		X	X			
6	1500		X	X			
7	1000		XX	X			
8	750		X	X			
9	500		XX	X			
10	350		X	X			
11	250		X	X			
12	180		X	X			
13	130		X	X		X	
14	90		X	X			
15	60		X	X			
16	56		X	X			X
17	40		X	X			
18	30		XX	X	X, X		XX
19	sfc		X	X		X	X

Cast 015: Acoustic Release Test at OOI FLMB

Notes

- Acoustic releases attached
- 15-minute soak at maximum depth (1000 m)

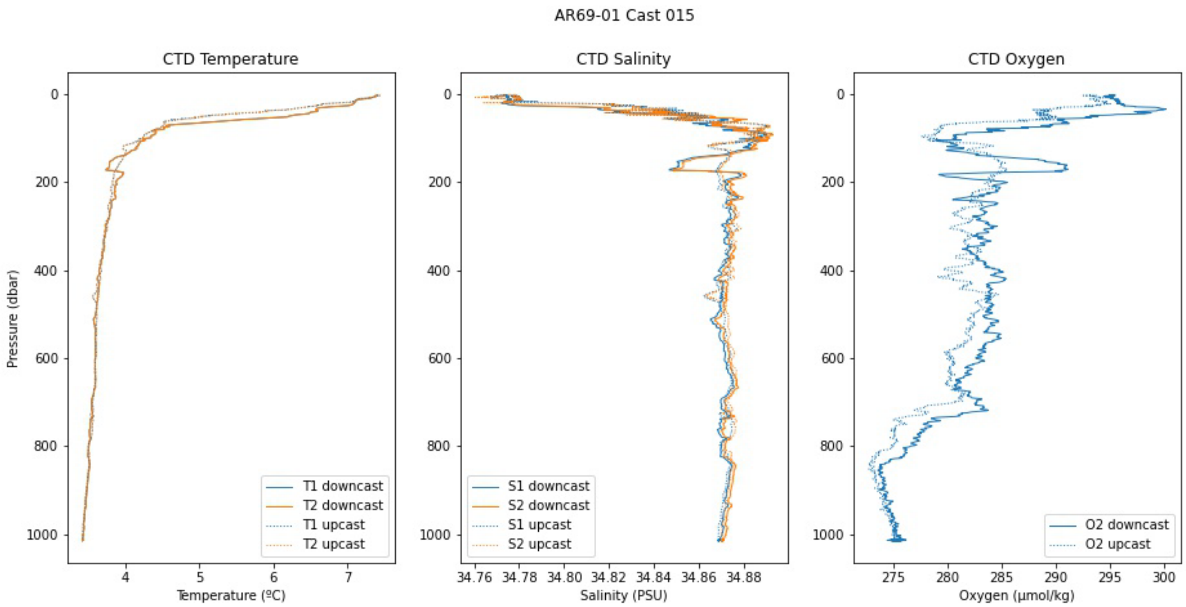


Figure H16. CTD temperature, salinity, and dissolved oxygen for cast 015. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H19. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
	No samples collected						

Cast 016: OSNAP M4 CTD Cast and Acoustic Release Test

Notes

- Both CTD sensors became contaminated partway through the downcast; CTD temperature and conductivity differences between the primary and secondary sensors became quite different
- Acoustic releases attached

Table H20. M4 instrument depths

Nominal Instrument Depth (m)	Microcat	Optode	Aquadopp
1500	X		X
1750	X		
2000	X		
2250	X		X
2500	X		
2750	X		
2945	X		X

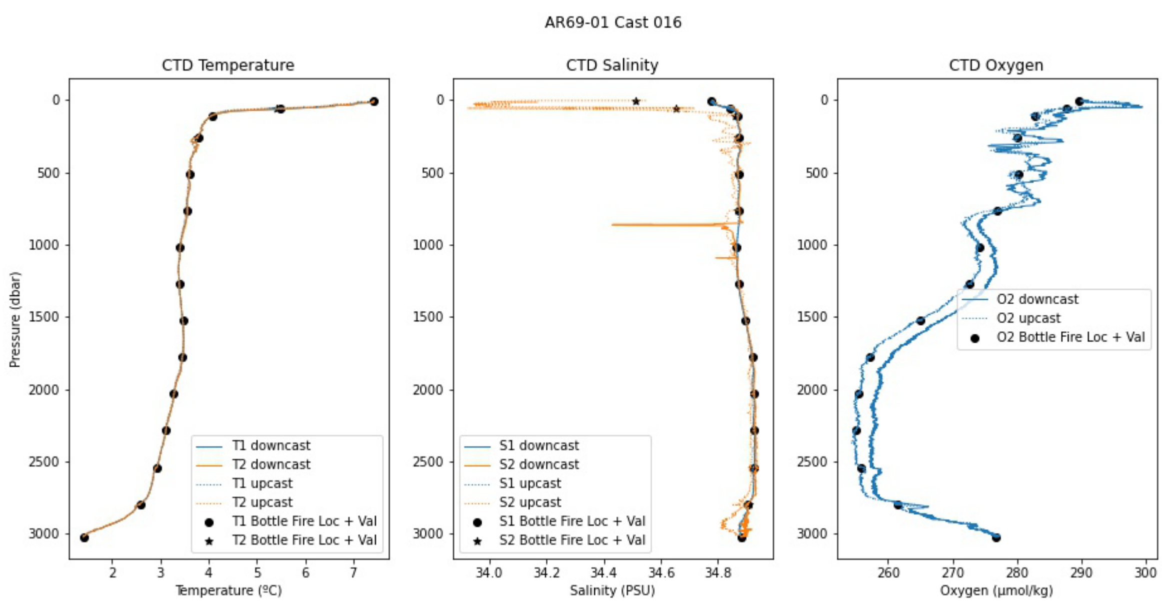


Figure H17. CTD temperature, salinity, and dissolved oxygen for cast 016. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H21. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2970	~I(S)		X			
2	2750	I(S)		X			
3	2500	I(S)		X			
4	2250	I(S)		X			
5	2000	I(S)		X			
6	1750	I(S)		X			
7	1500	I(S)		X			
8	1250			X			
9	1000			X			
10	750			X			
11	500			X			
12	250			X			
13	100			X			
14	50			X			
15	sfc			X			

Cast 017: OSNAP M1 CTD Cast and Acoustic Release Test

Notes

- Acoustic releases attached

Table H22. M1 instrument depths

Nominal Instrument Depth (m)	Microcat	Optode	Aquadopp
50	X	X	X
300	X		
500	X	X	X
750	X		
1000	X	X	X
1250	X		
1500	X		X
1750	X	X	X
2046	X	X	X

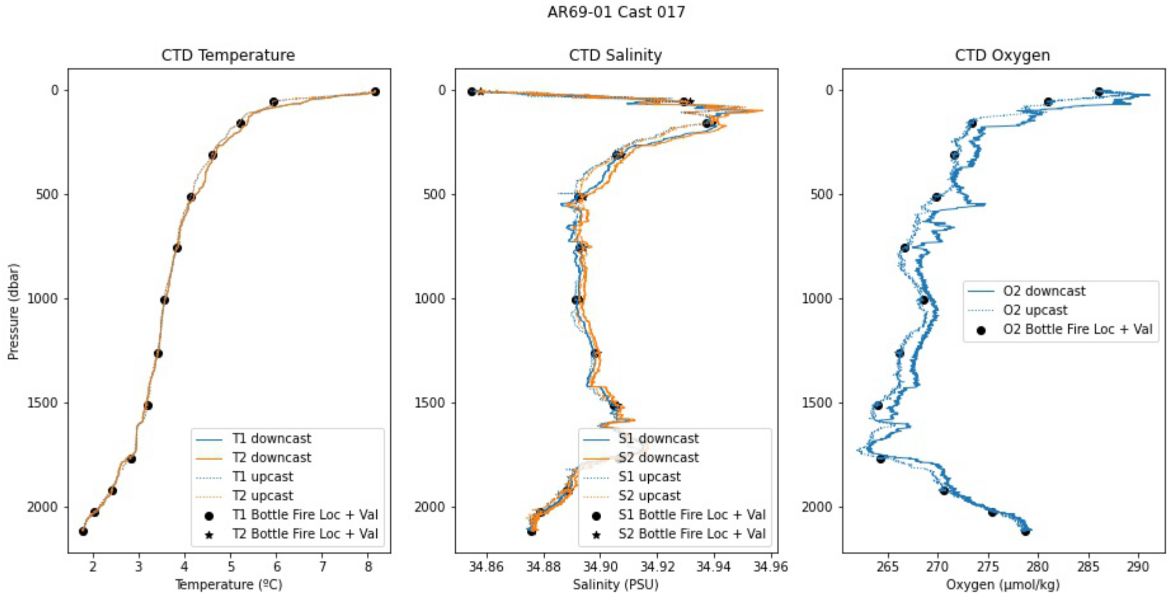


Figure H18. CTD temperature, salinity, and dissolved oxygen for cast 017. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H23. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2090	~I(S,O_2)	XX	X			
2	2000		XX	X			
3	1900			X			
4	1750	I(S,O_2)	XX	X			
5	1500	I(S)		X			
6	1250	I(S)		X			
7	1000	I(S,O_2)	XX	X			
8	750	I(S)		X			
9	500	I(S,O_2)	XX	X			
10	300	I(S)		X			
11	150		XX	X			
12	50	I(S,O_2)	XX	X			
13	sfc			X			

Cast 018: Post-Deployment Microcat and Optode Cal Dip at OOI M1

Notes

- OSNAP microcat and optode cal dip
- 10-minute cal dip soak at 6 depths
    - 4 deep depths for microcats
    - 4 depths following recommendations from I. Le Bras (see Optodes section)

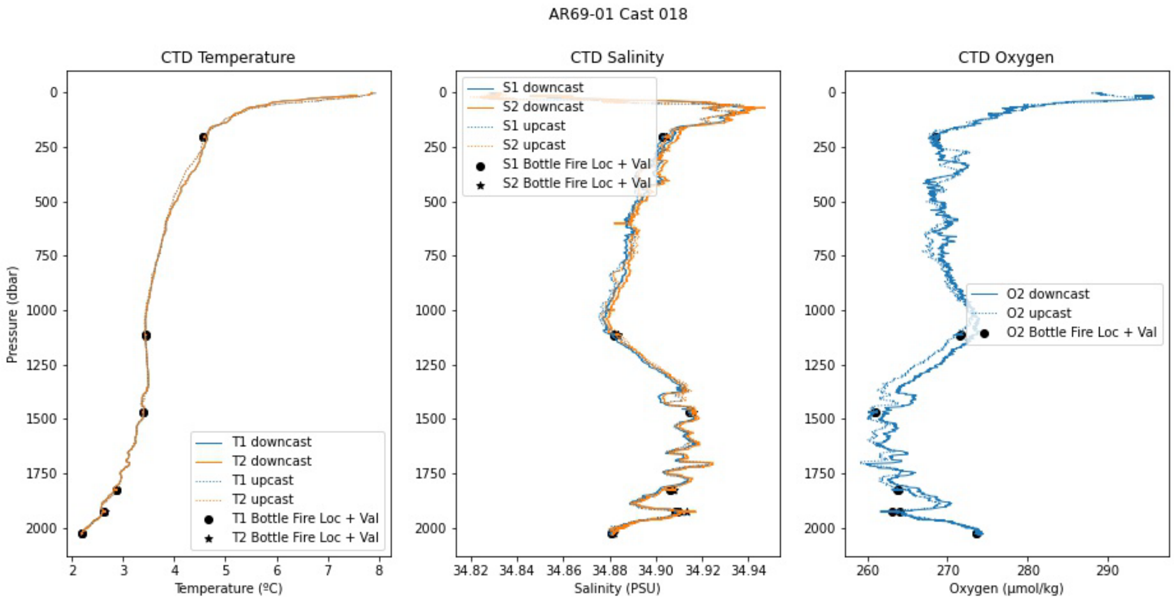


Figure H19. CTD temperature, salinity, and dissolved oxygen for cast 018. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H24. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2000	C	XXX	X			
2	2000	C					
3	1900	C		X			
4	1900	C					
5	1800	C		X			

6	1800	C					
7	1450	C	XXX	X			
8	1450	C					
9	1100	C	XXX	X			
10	1100	C					
11	200	C	XXX	X			
12	200	C					

Cast 019: OOI FLMA CTD Cast

Notes

- Followed OOI sampling protocol with duplicate oxygen samples collected from the same bottle at 4 depths

Table H25. OSNAP instrument depths on OOI FLMA mooring. Bottom depth: 2686 m.

Nominal Instrument Depth (m)	Microcat	Optodes	Aquadopp
1000 m of bottom	X		X
700 m of bottom	X		X
400 m off bottom	X		X
100 m off bottom	X		X

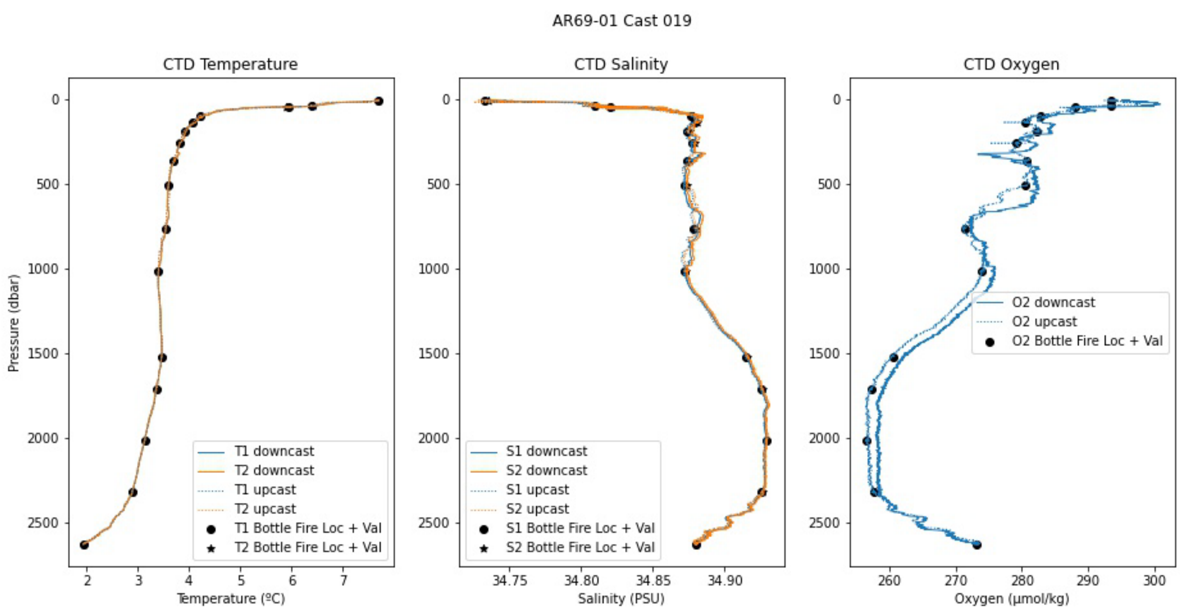


Figure H20. CTD temperature, salinity, and dissolved oxygen for cast 019. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H26. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2590		XX	X			
2	2290		X	X			
3	1990		XX	X			
4	1690		X	X			
5	1500		X	X			
6	1000		X	X			
7	750		XX	X			
8	500		X	X			
9	350		X	X			
10	250		X	X			
11	180		X	X			
12	130		X	X		X	
13	90		X	X			
14	40		X	X			X
15	30		XX	X	X, X	X	XX
16	sfc		X	X			X

Cast 020: OSNAP Post-Deployment Microcat Cal Dip

Notes

- OSNAP microcat cal dips
- 10-minute soak at 4 deep depths

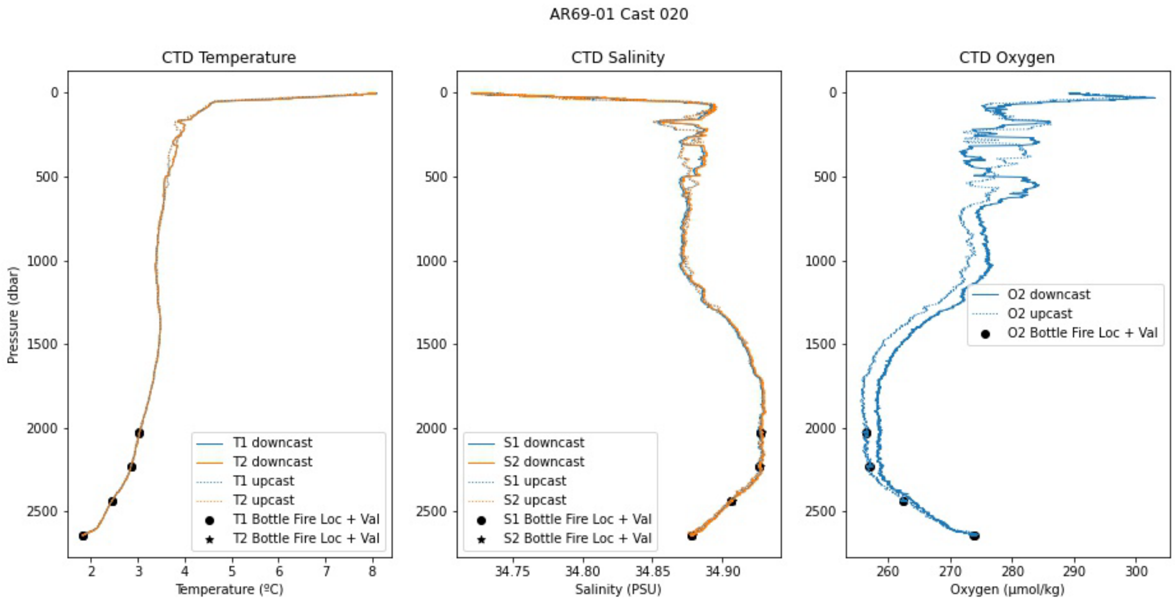


Figure H21. CTD temperature, salinity, and dissolved oxygen for cast 020. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H27. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2600	C		X			
2	2600	C					
3	2400	C		X			
4	2400	C					
5	2200	C		X			
6	2200	C					
7	2000	C		X			
8	2000	C					

Cast 021: OSNAP Post-Deployment Microcat and Optode Cal Dip

Notes

- OSNAP microcat and optode cal dip
- 10-minute cal dip soak at 6 depths
    - 4 deep depths for microcats

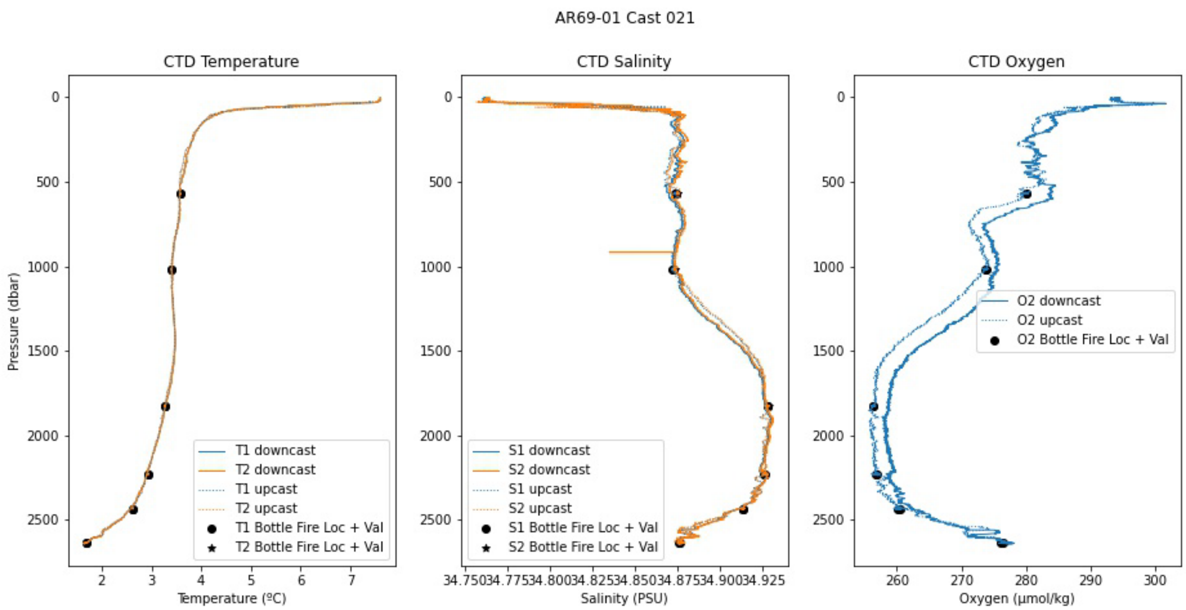


Figure H22. CTD temperature, salinity, and dissolved oxygen for cast 021. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H28. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2600	C	XXX	X			
2	2600	C					
3	2400	C		X			
4	2400	C					

5	2200	C		X			
6	2200	C					
7	1800	C	XXX	X			
8	1800	C					
9	1000	C	XXX	X			
10	1000	C					
11	560	C	XXX	X			
12	560	C					

Cast 022: OSNAP Post-Deployment Microcat Cal Dip

Notes

- OSNAP microcat cal dip → microcats (CTMOs) from OOI's FLMA and FLMB moorings
- 10-minute soak at 4 deep depths

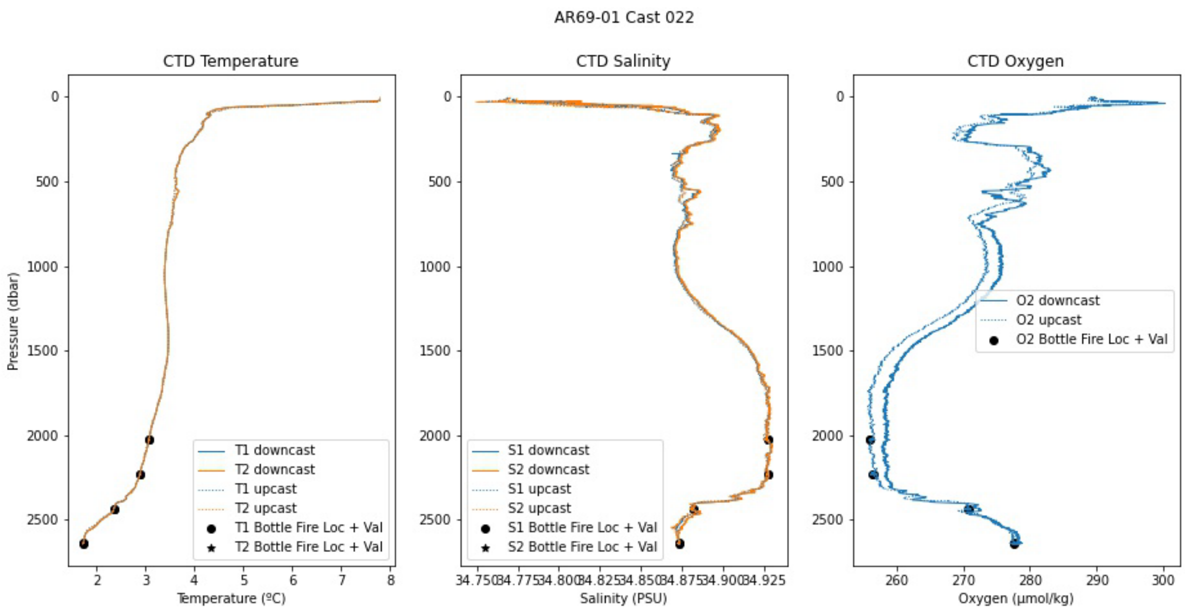


Figure H23. CTD temperature, salinity, and dissolved oxygen for cast 022. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H29. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
1	2600	C		X			
2	2600	C					
3	2400	C		X			
4	2400	C					
5	2200	C		X			
6	2200	C					
7	2000	C		X			
8	2000	C					

Cast 023: L-ADCP Test CTD Cast

Notes

- L-ADCP test after installment on rosette

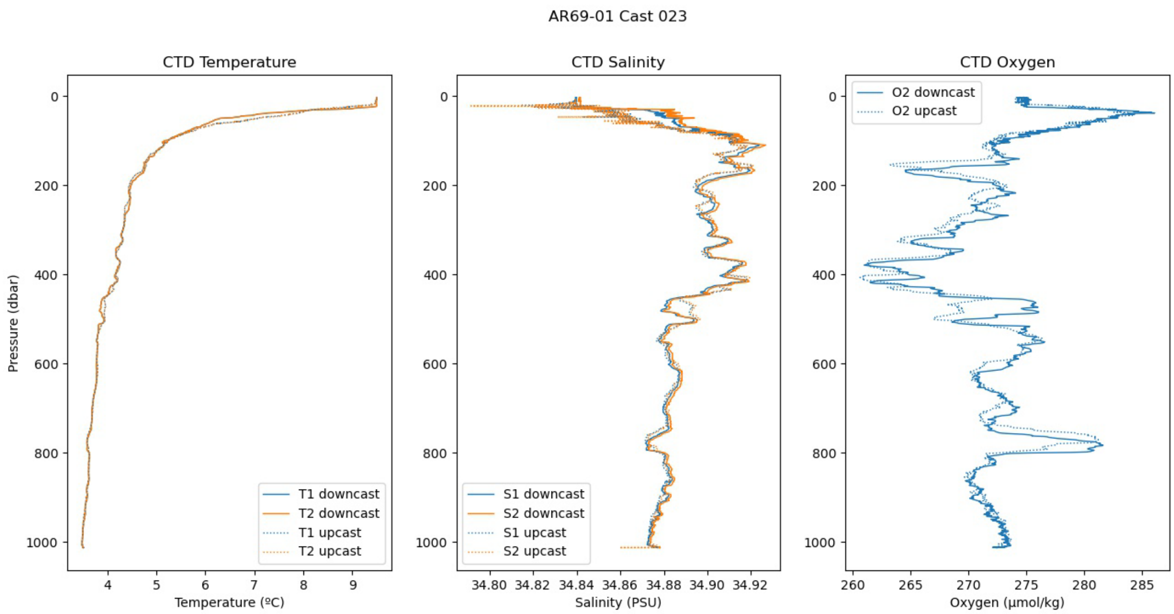


Figure H24. CTD temperature, salinity, and dissolved oxygen for cast 023. Solid lines indicate the downcast, and dashed lines indicate the upcast. Blue indicates the primary sensor, and orange indicates the secondary sensor.

Table H30. CTD Niskin bottle fire depths and sampled parameters at each depth. Notes: X indicates number of samples taken. C indicates calibration dip soak. I indicates instrument depth (S = microcat, O_2 = optode, ~ approximate depth).

Niskin	Nominal Depth	Flags	Oxygen	Salts	Other		
					DIC/TA/pH	Nutrients	Chlorophyll
	No samples collected						

Preliminary CTD Data Evaluation

Overview

In order to ensure high-quality hydrographic data were collected throughout the duration of the cruise, the CTD data were evaluated and compared to the salt and oxygen analyzed onboard. Differences between the primary and secondary temperature and conductivity channels were examined in real-time as the CTD cast was conducted and afterwards to evaluate the quality of the data and whether or not biofouling had occurred. Recommendations from L. McRaven's "CTD biofouling impact on CTD data and usability" were followed (see Evaluating CTD Conductivity and Temperature Performance). Acceptable data were compared to water sample measurements of salinity and oxygen to determine (preliminary) sensor calibrations (see CTD sensor comparison).

Evaluating CTD Conductivity and Temperature Performance

To evaluate the conductivity and temperature sensor performance, the difference between the primary and secondary sensors were calculated for both the downcast and upcast. Typically, the difference was minimal on the downcast and larger/nosier on the upcast. Throughout the duration of the cruise, a potential pressure drift was observed in the temperature difference between the primary and secondary sensors with depth. During cast 016, the difference between the primary and secondary sensors was quite large, suggesting that something had gotten stuck in the flow tubes. The sensors were well-rinsed after the CTD cast and again prior to cast 017. The issue resolved for cast 017 and subsequent casts. Code provided by L. McRaven was used to generate the figures in this section.

Primary vs. Secondary Sensors: Conductivity and Temperature

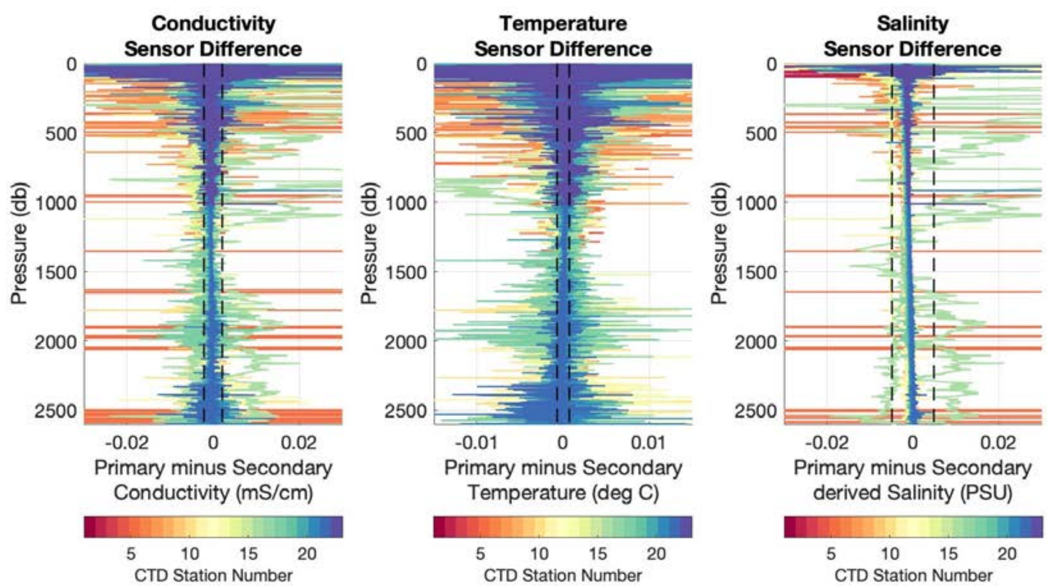


Figure H25. Difference between the primary and secondary CTD conductivity, temperature, and salinity for data collected from all hydrographic casts (001-0023). Both the downcast and upcast are shown here.

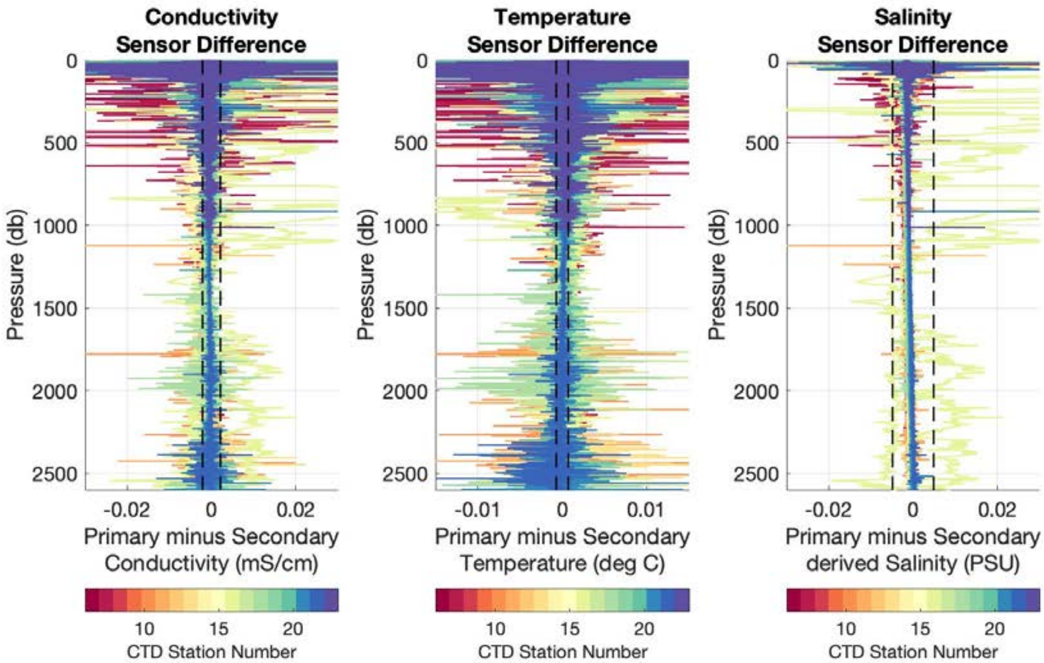


Figure H26. Difference between the primary and secondary CTD conductivity, temperature, and salinity for data collected from a subset of hydrographic casts (006-0023). Both the downcast and upcast are shown here. These are all casts after the CTD package issue was resolved.

Primary vs. Secondary Sensors: Density

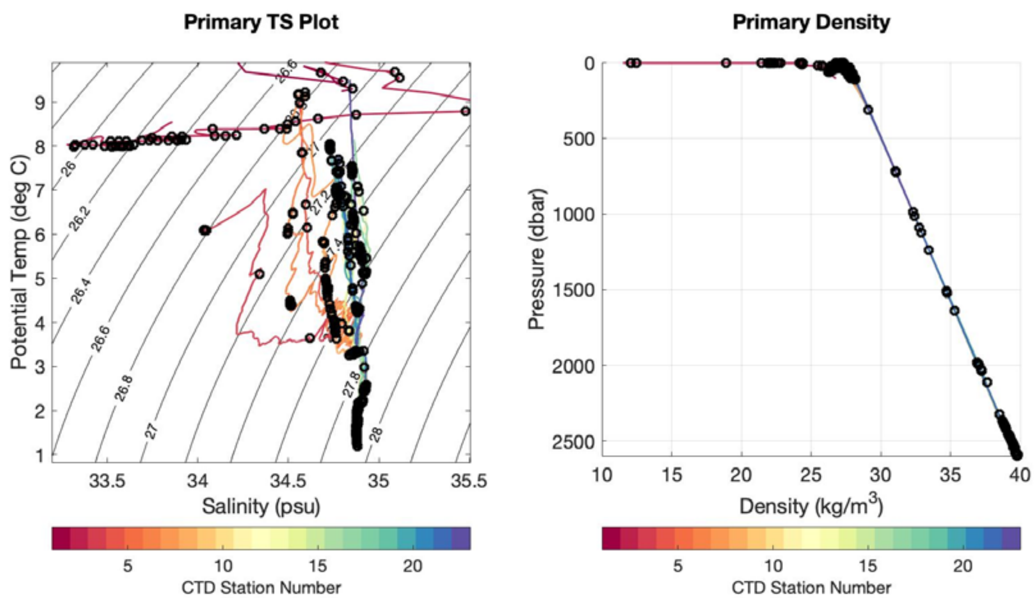


Figure H27. CTD Potential density calculated from the primary temperature and conductivity sensors for all casts (001-0023). Both the downcast and upcast data are included here. Circled datapoints indicate density inversions in the profiled data.

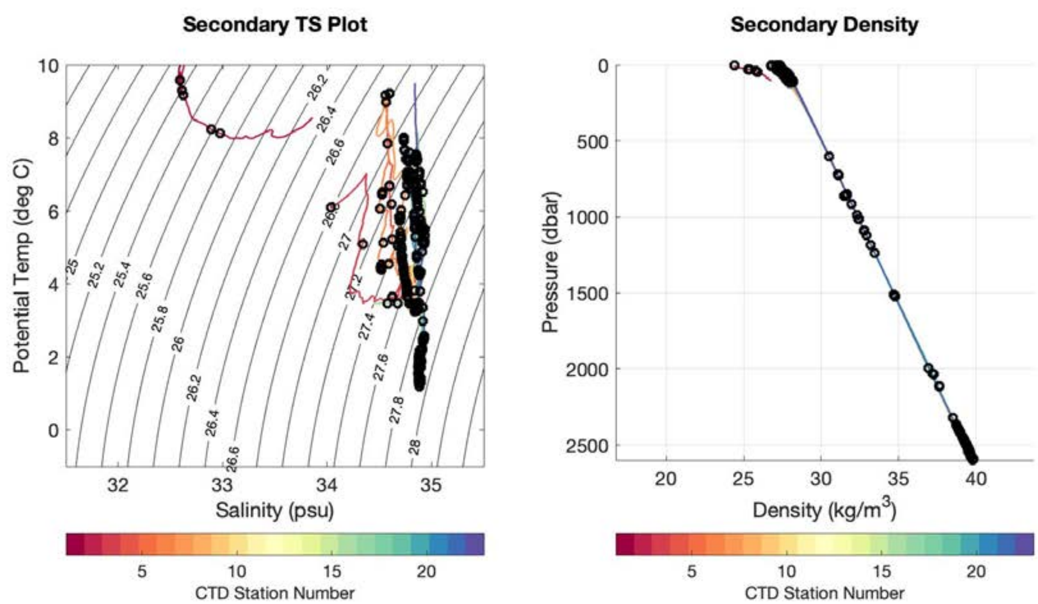


Figure H28. CTD Potential density calculated from the secondary temperature and conductivity sensors for all casts (001-0023). Both the downcast and upcast data are included here. Circled datapoints indicate density inversions in the profiled data.

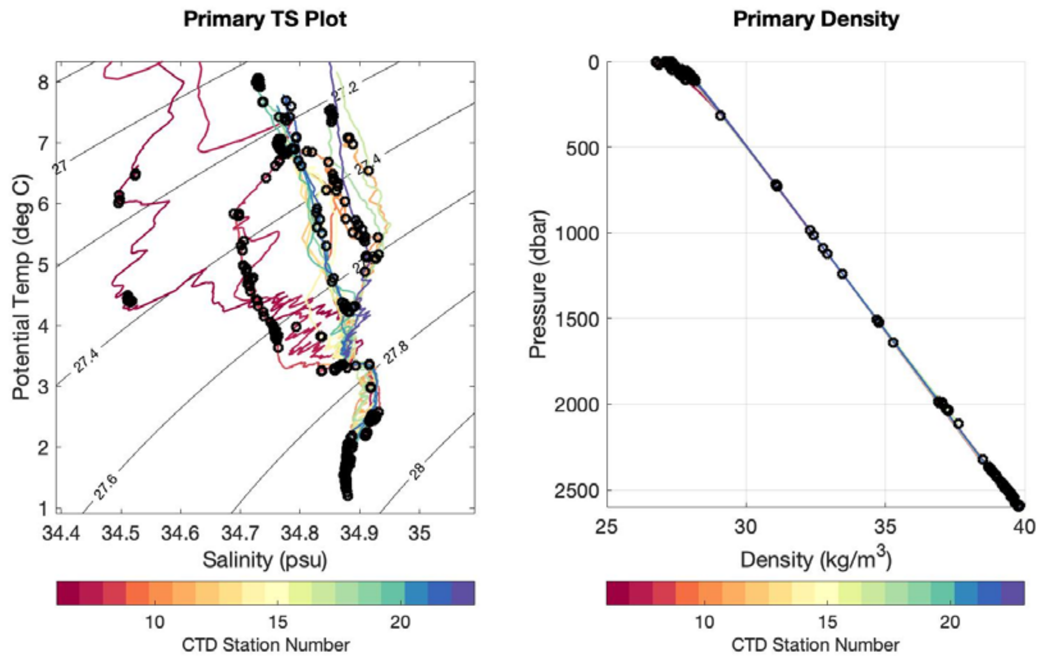


Figure H29. CTD Potential density calculated from the primary temperature and conductivity sensors for a subset of casts (006-0023). Bothe the downcast and upcast data are included here. Circled datapoints indicate density inversions in the profiled data. These are all casts after the CTD package issue was resolved.

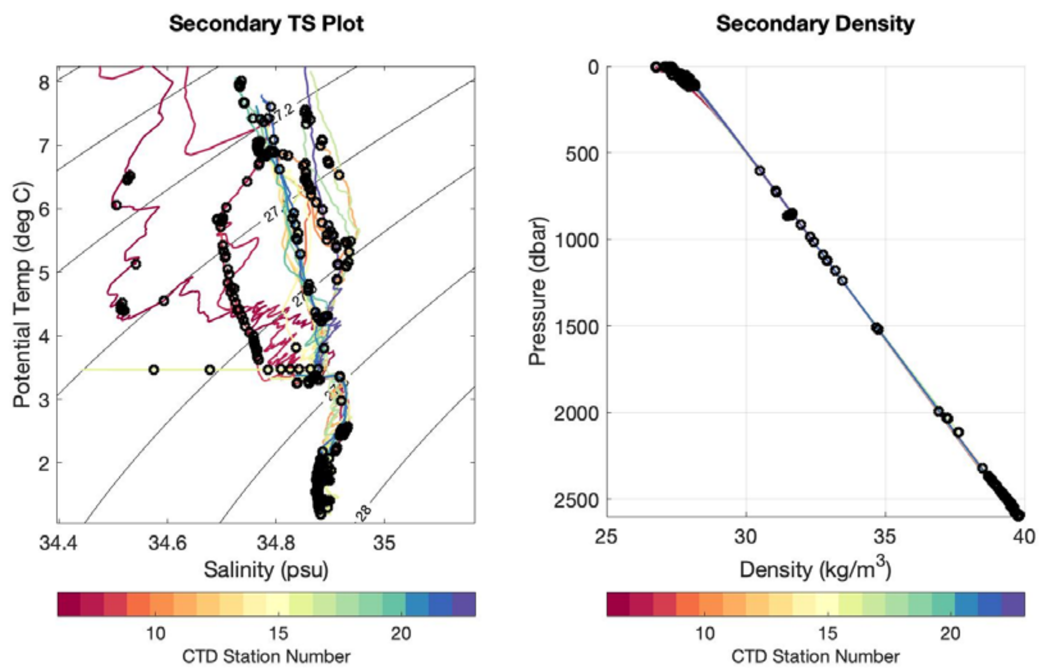


Figure H30. CTD Potential density calculated from the secondary temperature and conductivity sensors for a subset of casts (006-0023). Bothe the downcast and upcast data are included here. Circled datapoints indicate density inversions in the profiled data. These are all casts after the CTD package issue was resolved.

T-S Diagrams

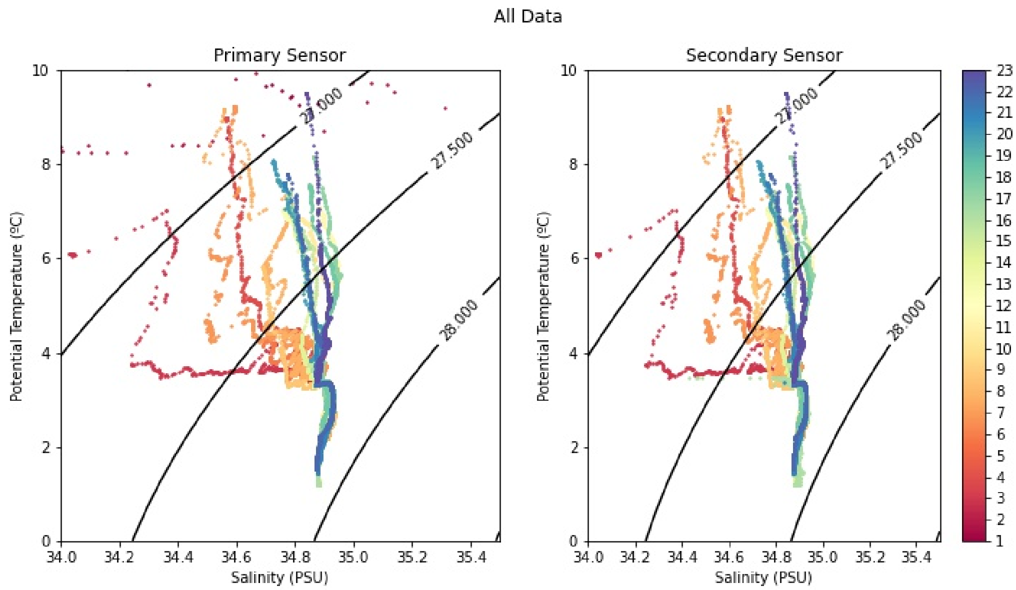


Figure H31. Potential temperature-salinity diagrams using only the downcast data from all casts (001-023) for the primary and secondary temperature and salinity sensors. Colors indicate cast number.

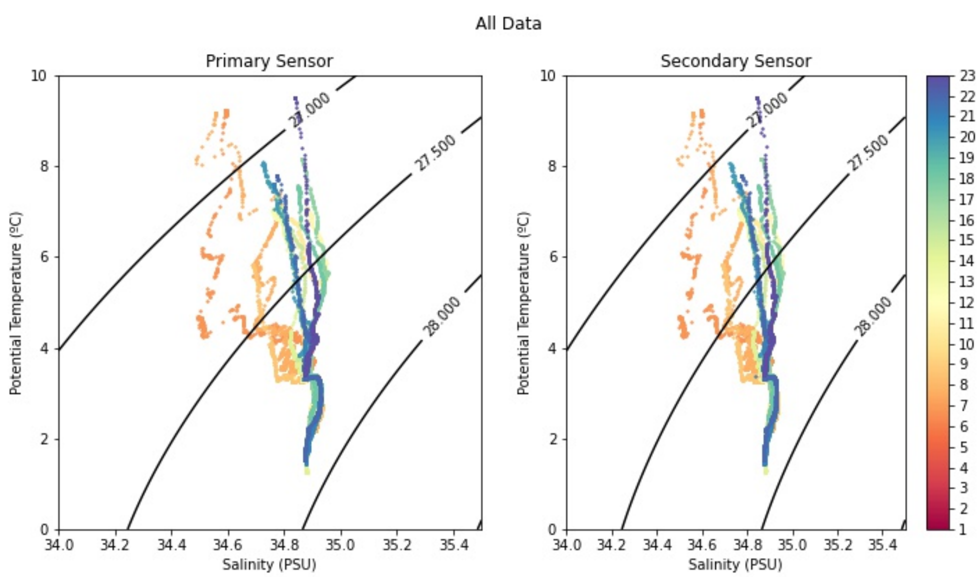


Figure H32. Potential temperature-salinity diagrams using only the downcast data from a subset of casts for the primary and secondary temperature and salinity sensors. Colors indicate cast number. This figure exclude data from casts 001-005 and 0016. These are all casts after the CTD package issue was resolved and one cast (016) with biofouling/sensor malfunction.

CTD Sensor Comparison

Salinity

Here the difference between the salt samples and the CTD bottle samples can be observed. Typically, the salt samples measured a higher salinity than the CTD (see Figure H33).

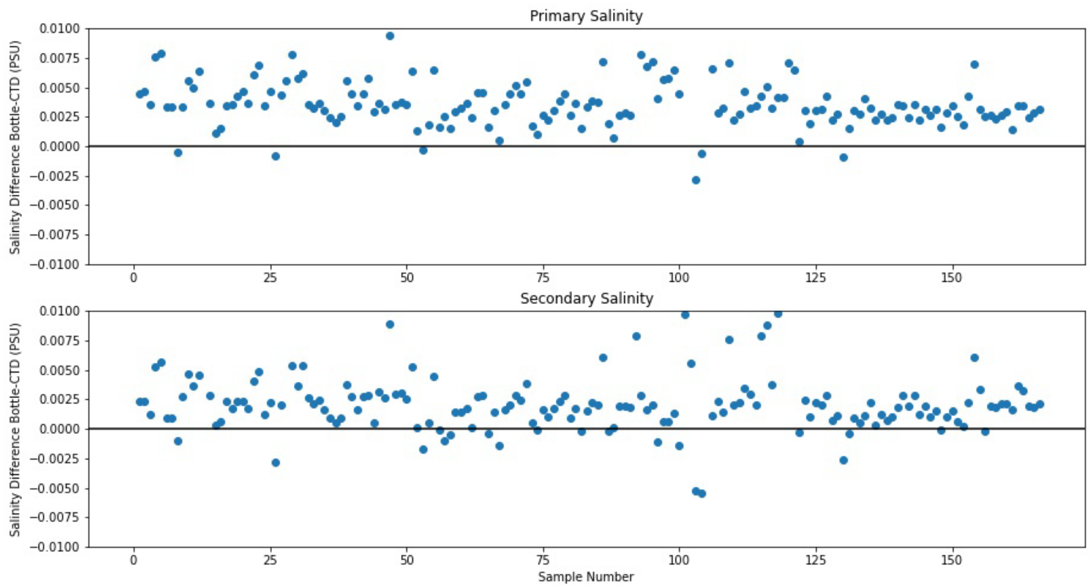


Figure H33. Difference between the salt samples collected from the CTD Niskins and the CTD's primary and secondary conductivity sensors. The x-axis indicates the sample collection order.

Oxygen

SBE-43 oxygen sensors typically drift and measure lower oxygen concentrations than those measured using Winkler titrations. 171 Winkler oxygen samples were collected and analyzed during this cruise. Here, a preliminary analysis of the data shows that the SBE-43 data should be re-calibrated using the winkler oxygen data collected on board.

Methods

All Winkler oxygen data were converted to µmol/kg using in-situ density calculated from primary temperature and salinity sensors. The difference between the Winkler oxygen and CTD oxygen were almost all greater than zero. Outliers where the difference was less than zero were removed for the ordinary least square (OLS) regressions. A simple gain calibration was performed. The residuals showed a pressure dependence. Therefore, the analysis was performed again to account for the pressure affect to improve the OLS fit.

Gain Calibration Equation

$$[O_2]_{wink} = A[O_2]_{CTD} \quad \text{(H1)}$$

Table H31. Preliminary OLS regression coefficient, correlation coefficient, and root mean squared error (RMSE) for the gain calibration regression following the form of equation H1.

	A	R^2	RMSE (µmol/kg)
Values	1.0537 ± 0.00083	1.000	2.922

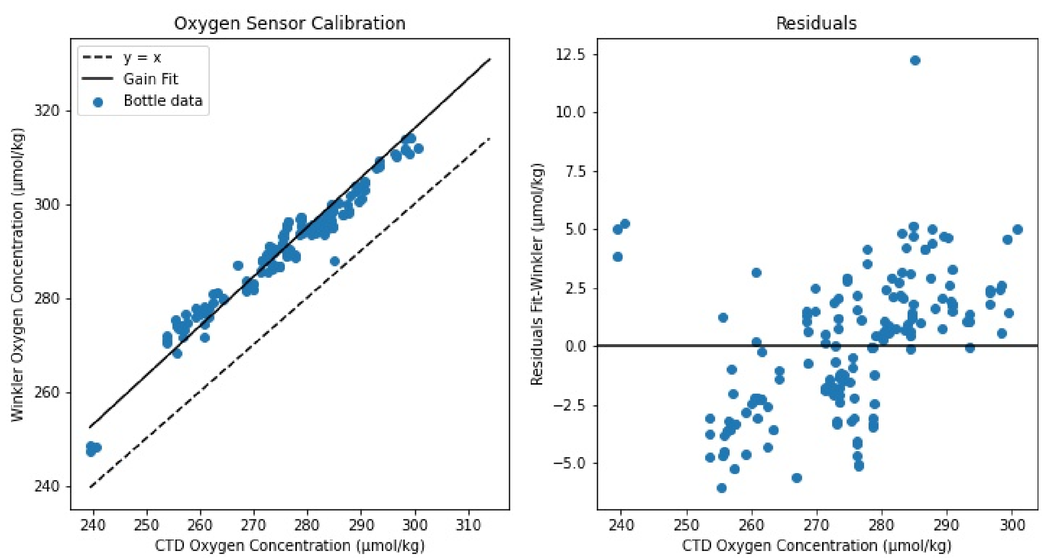


Figure H34. (left) Preliminary SBE43 oxygen calibration using Winkler oxygen samples. An OLS regression was performed using a gain correction following the form of equation H1. (right) Residuals from OLS fit.

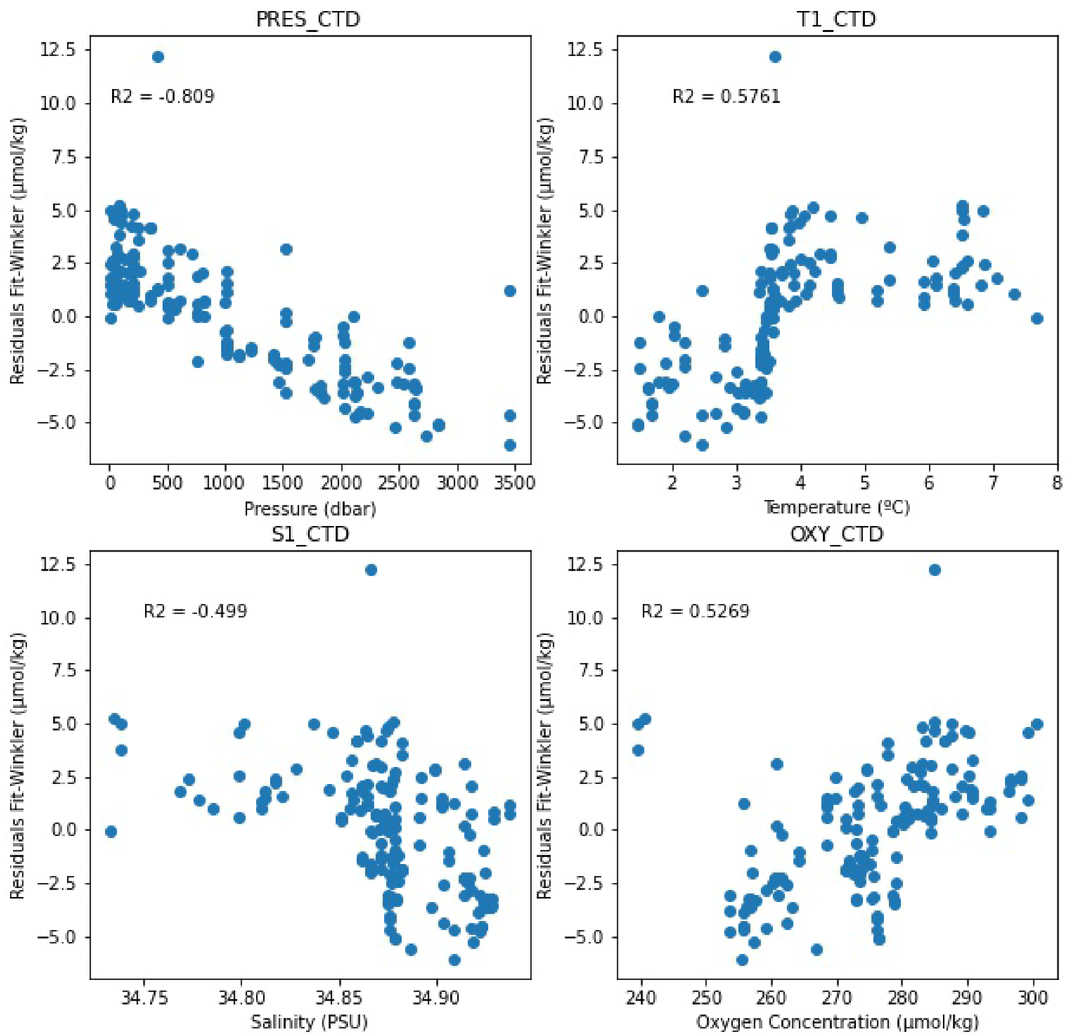


Figure H35. Residuals of OLS gain model fit vs other hydrographic parameters and correlation coefficient between the residuals and each parameter. PRES_CTD = CTD pressure, T1_CTD = temperature from the CTD's primary sensor, S1_CTD = salinity from the CTD's primary sensor, OXY_CTD = CTD dissolved oxygen.

Gain Calibration with Pressure Correction Equation

$$[O_2]_{wink} = A[O_2]_{CTD} + BP_{ctd} \quad \text{(H2)}$$

Table H32. Preliminary OLS regression coefficient, correlation coefficient, and root mean squared error (RMSE) for the gain calibration regression with a pressure correction following the form of equation H2.

	A	B (µmol/kg-dbar)	R^2	RMSE (µmol/kg)
Values	1.0445 ± 0.00072	0.002449 ± 0.00014	1.000	1.710

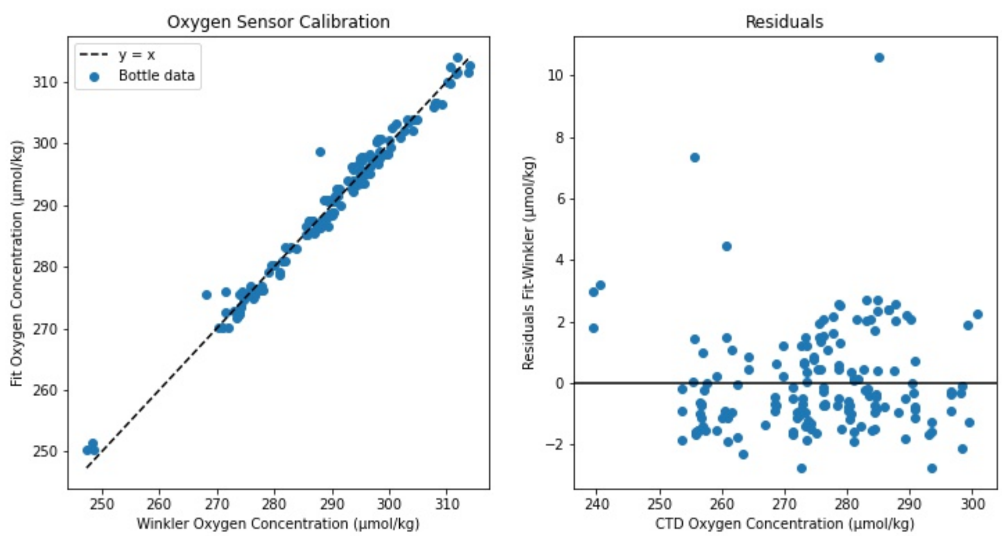


Figure H36. (left) OLS gain model with a pressure correction fit oxygen concentration vs. Winkler oxygen concentration. (right) Residuals from OLS fit.

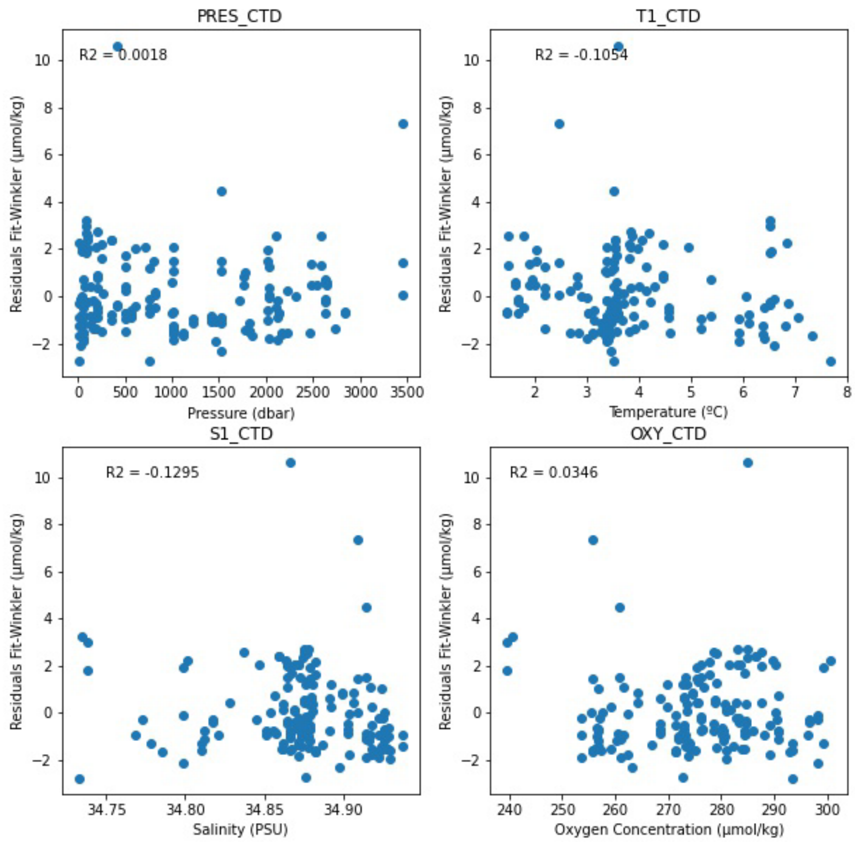


Figure H37. Residuals of OLS gain model with a pressure correction fit vs other hydrographic parameters and correlation coefficient between the residuals and each parameter. PRES_CTD = CTD pressure, T1_CTD = temperature from the CTD's primary sensor, S1_CTD = salinity from the CTD's primary sensor, OXY_CTD = CTD dissolved oxygen.

RBR Optodes

Overview

On this cruise, 11 RBR Concerto optodes were turned over during mooring recovery and deployment of M1 (5), M2 (3), and M3 (3). Additionally, 5 RBR Duette optodes (belonging to H. Palevsky) were calibration-dipped in preparation for deployment on a later cruise this year (AR69-03). For additional details on optode handling and deployment details, see "Moored O2 instrument recovery and deployment instructions" (I. Le Bras, 2022).

Optode Handling

Storage

All optodes were stored with their caps on. A wet kimwipe was placed inside the cap to keep the foil moist during storage

Calibration Dips and Cleaning

Pre-deployment handling:

The 5 RBR Duette optodes were the only fresh optodes onboard. Prior to their calibration dip (Cast 007), these optodes were soaked in freshwater.

Post-deployment handling:

The 11 RBR Concerto optodes were cal-dipped after their recovery and prior to their re-deployment. These instruments were cleaned after recovery to remove biofouling from the housing. After the calibration dip, the foil was cleaned from biofouling prior to redeployment.

All instruments were rinsed in freshwater after each calibration dip.

Calibration Dips

Instruments were attached to the outside of the CTD rosette using ratchet straps, hose clamps, and zip ties (see Figure 38).

Optodes were soaked for 10-minutes at 4 selected depths that were chosen following the sampling location recommendations of I. Le Bras. The goal was to capture 4 stable oxygen extrema. Based on the water masses in the region, the target depths were the following:

1. Oxygen maximum near the bottom → Denmark Strait Overflow Water
2. Oxygen minimum between ~1,500-2,400 m → Northeast Atlantic Deep Water (NEADW)
3. Oxygen maximum between ~1,000-1,500 m → Labrador Sea Water
4. Oxygen minimum near the surface

Triplicates samples were taken from that same bottle at each optode soak depth.

Figure H38. RBR optode Duette (left, photo by E. Park) and Concerto (right, photo by H. Furey) and setup for calibration dips

CTD Oxygen Sampling

For all other OSNAP CTD casts, duplicate oxygen samples were taken at selected sampling depths. Oxygen samples were collected at depths where OSNAP optodes were deployed and at a select (approximately 3-5) other depths. These additional depths were selected based on the profile to capture oxygen extrema and over a range of pressures. For OOI CTD casts, OOI's oxygen sampling strategy, which only does single oxygen samples at each depth, was followed. However, at approximately 3-5 feature depths, duplicate oxygen samples were collected at these sites, as well.

Other Notes

RBR optode data presented in the following section should be interpreted with caution. These sensors only measure temperature, in addition to dissolved oxygen. Additional processing is likely needed to correctly convert from phase to oxygen concentration (µmol/kg) at depth.

Preliminary Optode Caldip Results

Eleven RBR Concertos, 5 RBR Duettes, and 1 SBE37 SMP-ODO optode were cal-dipped on this cruise. See prior section for a summary on calibration dip methods. All optode data collected were compared to the uncalibrated CTD oxygen data and the Winkler oxygen samples collected and analyzed onboard. Each oxygen measurement method used different units. All data were converted to µmol/kg for preliminary analysis (see Tables X and X).

Table H33. Asset oxygen concentration units and conversion methods

Asset	Default Unit	Unit Conversion
CTD	µmol/kg	N/A
RBR	µmol/L	Down sampled CTD potential density [µmol/L]*[1000L/m^3]*[1/density]
SBE37-DO	µmol/kg	N/A
Winklers	mL/L	See "Converting from mL/L to µmol/kg"

Table H34. Asset oxygen saturation units and conversion methods

Asset	Default Unit	Unit Conversion
CTD	µmol/kg measured and saturation	[measured/saturation]*100
RBR	%	N/A
SBE37-DO	%	N/A
Winklers	mL/L	Converted to µmol/kg and used CTD bottle file oxygen saturation concentration at each depth to calculate [measured/saturation]*100

Converting from mL/L to µmol/kg

C_{O2}[µmol/L] = 44.6596 C_{O2}[mL/L]

C_{O2}[µmol/kg] = 44,659.6/rho C_{O2}[mL/L]

Notes on methods

- CTD record is in seconds since start of cast
    - 3 second adjustment for oxygen to account for flow delay
- Converted optode time stamps into seconds from start of CTD cast
- Optodes generally had larger timesteps between measurements than the CTD record so down sampled the CTD record using linear interpolation to match-up optode and CTD record
- Compared matched CTD and optode record from 10 minutes minus the time of the second bottle closing

NOTE: RBR optode data presented in the following section should be interpreted with caution. These sensors only measure temperature, in addition to dissolved oxygen. Additional processing is likely needed to correctly convert from phase to oxygen concentration (µmol/kg) at depth.

Pre-deployment

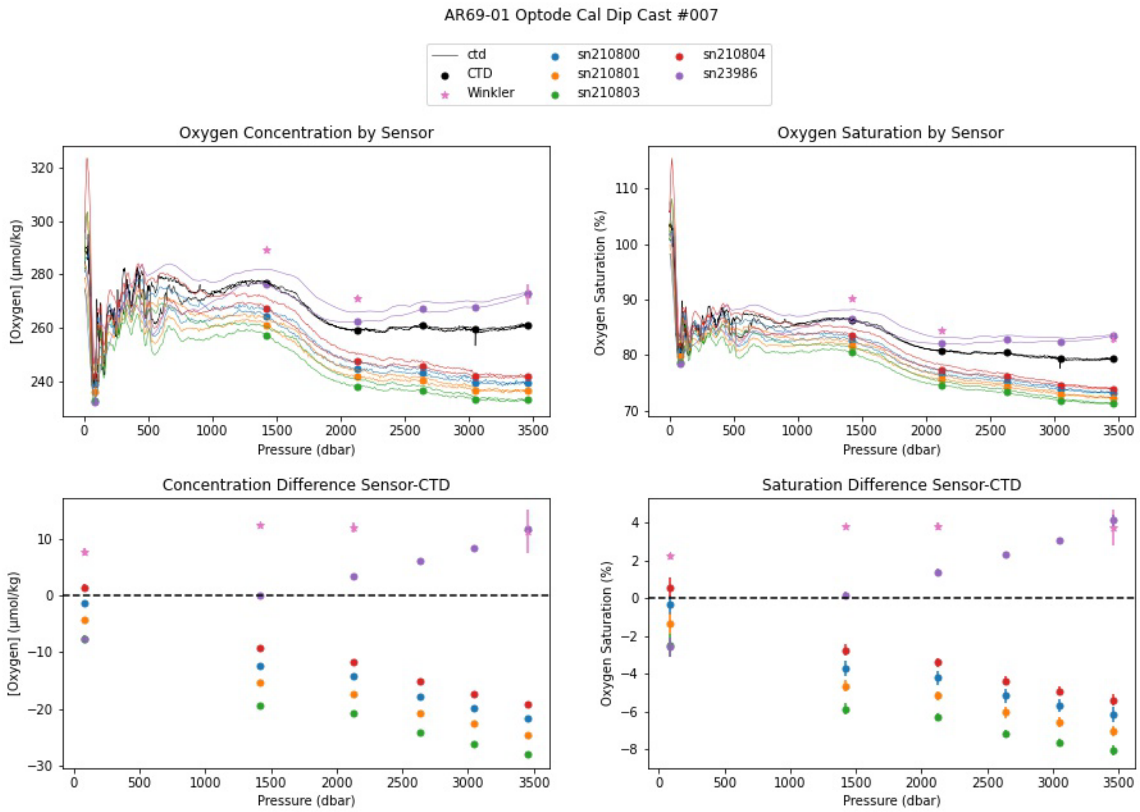


Figure H39. Oxygen concentrations from the pre-deployment cal-dip 007 from the CTD, optodes, and Winkler oxygen samples. The absolute concentration and oxygen saturation were analyzed at each soak depth where samples were collected.

Post—deployment

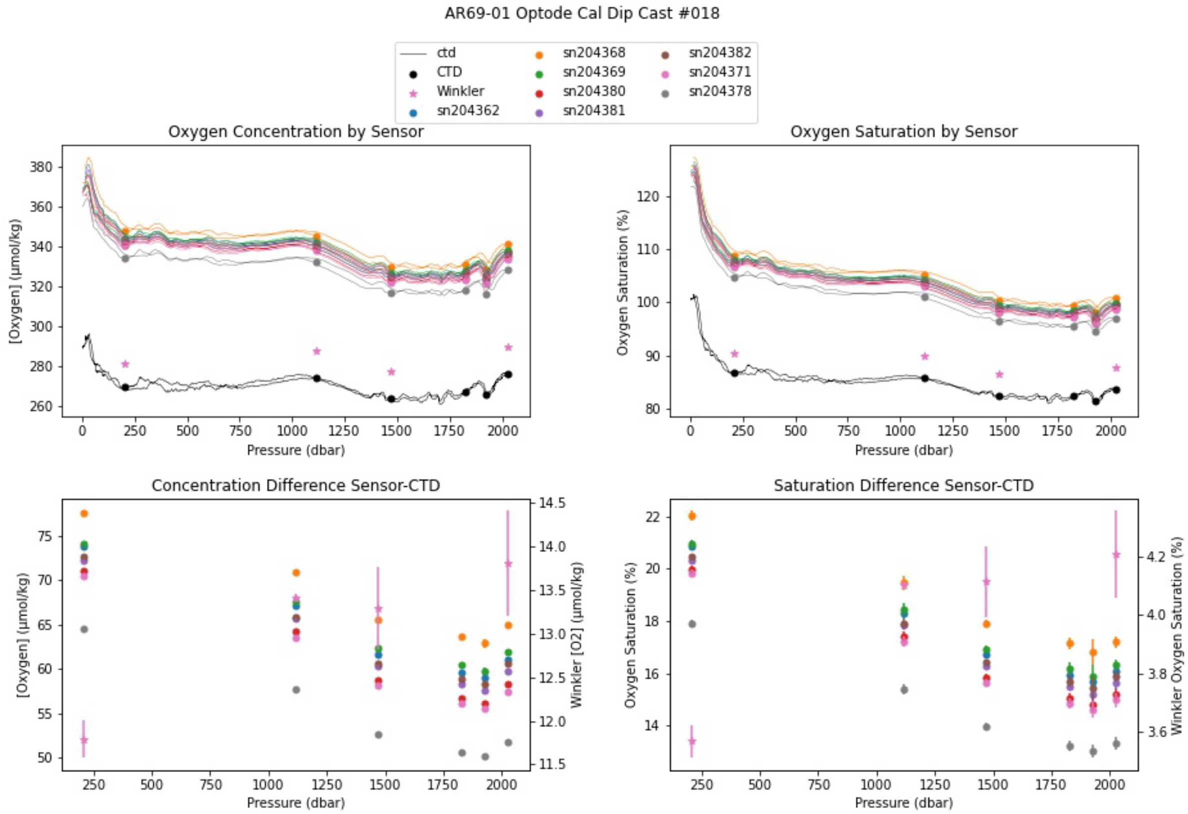


Figure H40. Oxygen concentrations from the pre-deployment cal-dip 018 from the CTD, optodes, and Winkler oxygen samples. The absolute concentration and oxygen saturation were analyzed at each soak depth where samples were collected.

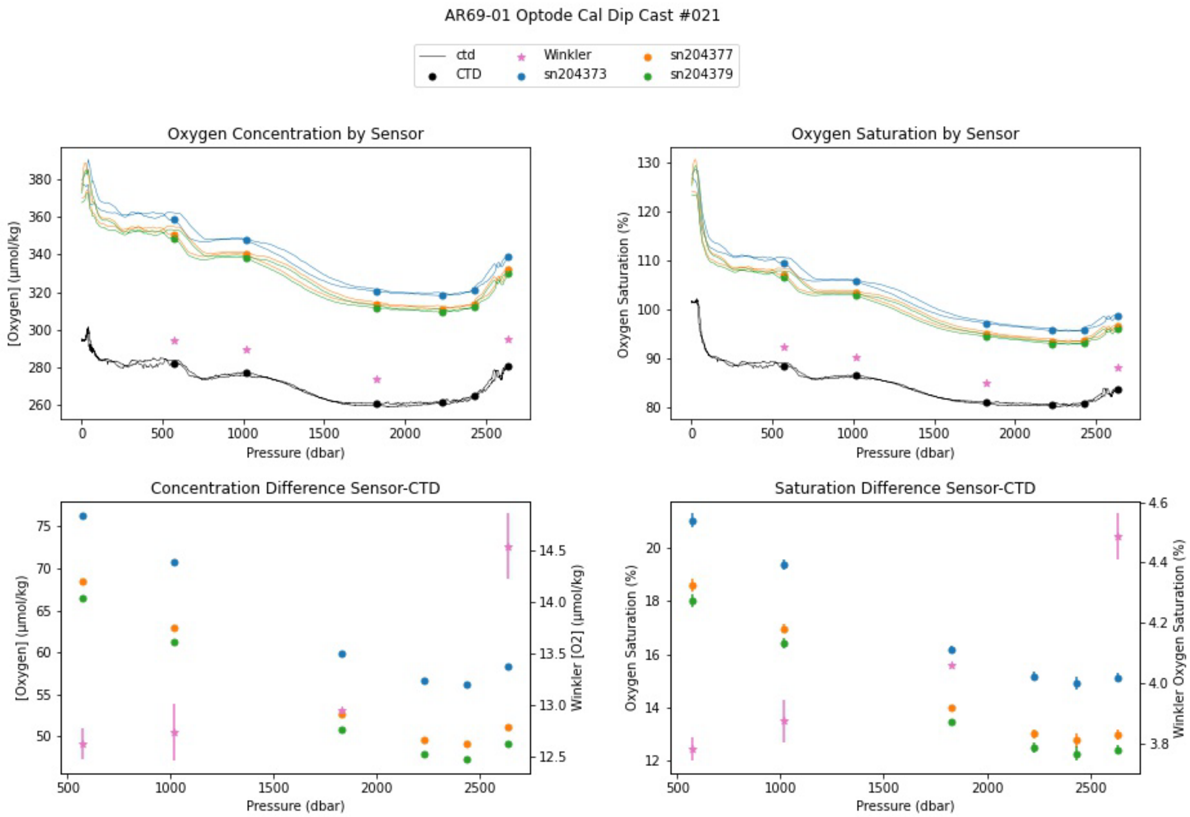


Figure H41. Oxygen concentrations from the pre-deployment cal-dip 021 from the CTD, optodes, and Winkler oxygen samples. The absolute concentration and oxygen saturation were analyzed at each soak depth where samples were collected.