OSNAP GDWBC Cruise Report

R/V Neil Armstrong, AR8401

02 June – 02 July 2024

Woods Hole to Reykjavik

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Abstract

This cruise report documents the sixth deployment and fifth recovery 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 third 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 AR3001, and a WHOI-led turnarounds happened in 2020 and 2022, cruises AR4601, AR6901.

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, to test acoustic releases, and to calibrate the mooring microcats and optodes. This was the third time that this array included optodes, which were recovered, calibrated, and re-deployed for Isabela Le Bras (WHOI).

1. Personnel

Science

Sheri White, WHOI, Chief Scientist, Lead OOI scientist
Chris Basque, WHOI, MOE technician
John Jordon, WHOI, MOE technician
Jennifer Batryn, WHOI, OOI technician
Dan Bishop, WHOI, OOI technician
Daniel Bogorff, WHOI, OOI technician
Mike Robinson, WHOI, OOI technician
Rebecca Travis, WHOI, OOI technician
Leah Houghton, WHOI, OOI hydrographer
Peter Dooley, NOAA, Marine Mammal Survey
Heather Furey, WHOI, Lead OSNAP scientist
Adam Houk, WHOI, OSNAP technician
Meg Yoder, Boston College, OSNAP hydrography/BGC hydrography
Emma Brown, Boston University, BGC hydrography
Ayden Schirmacher, Boston University, BGC hydrography
Sonya Brugger, WHOI, SSSG
Emily Cheung, WHOI, SSSG

Crew

Mike Singleton, Captain
Chris Mannka, Chief Mate
Chrissy Hogan, Second Mate
Ella Strano, Third Mate
Pete Liarikos, Bosun
Kevin Roth, AB
Keenan Foley, AB
Tim Atkins, AB
Piotr Marczak, Chief Engineer
William Bentley, First Assistant Engineer
Matt McGlynn, Second Assistant Engineer
Jacob Miller, Third Assistant Engineer
Kyle Covert, Oiler
John Alvarez, Oiler
Dean Pansano, Oiler
Bren Maris, Electrician
Harry Burnett, Chief Steward
Kenneth Briggs, Cook
Thomas Leong, Mess Attendant

(All photos taken by H. Furey)

2. Overview of OOI and OSNAP work

The R/V *Armstrong* left Woods Hole, Massachusetts on 02 June 2024 and steamed to the OOI Irminger Sea array area. OSNAP personnel H. Furey and A. Houk worked on OSNAP instrument preparation, including optode and microcat pre-deploy calibration dips and acoustic release tests. We completed pre-recovery CTD validation casts, recovered and deployed four OSNAP moorings in the East Greenland DWBC region. After moorings were recovered, we completed post-calibration casts for all microcats and optodes. During OSNAP-GDWBC2024, we targeted identical mooring sites as in 2022. Figure 1 shows the cruise track.

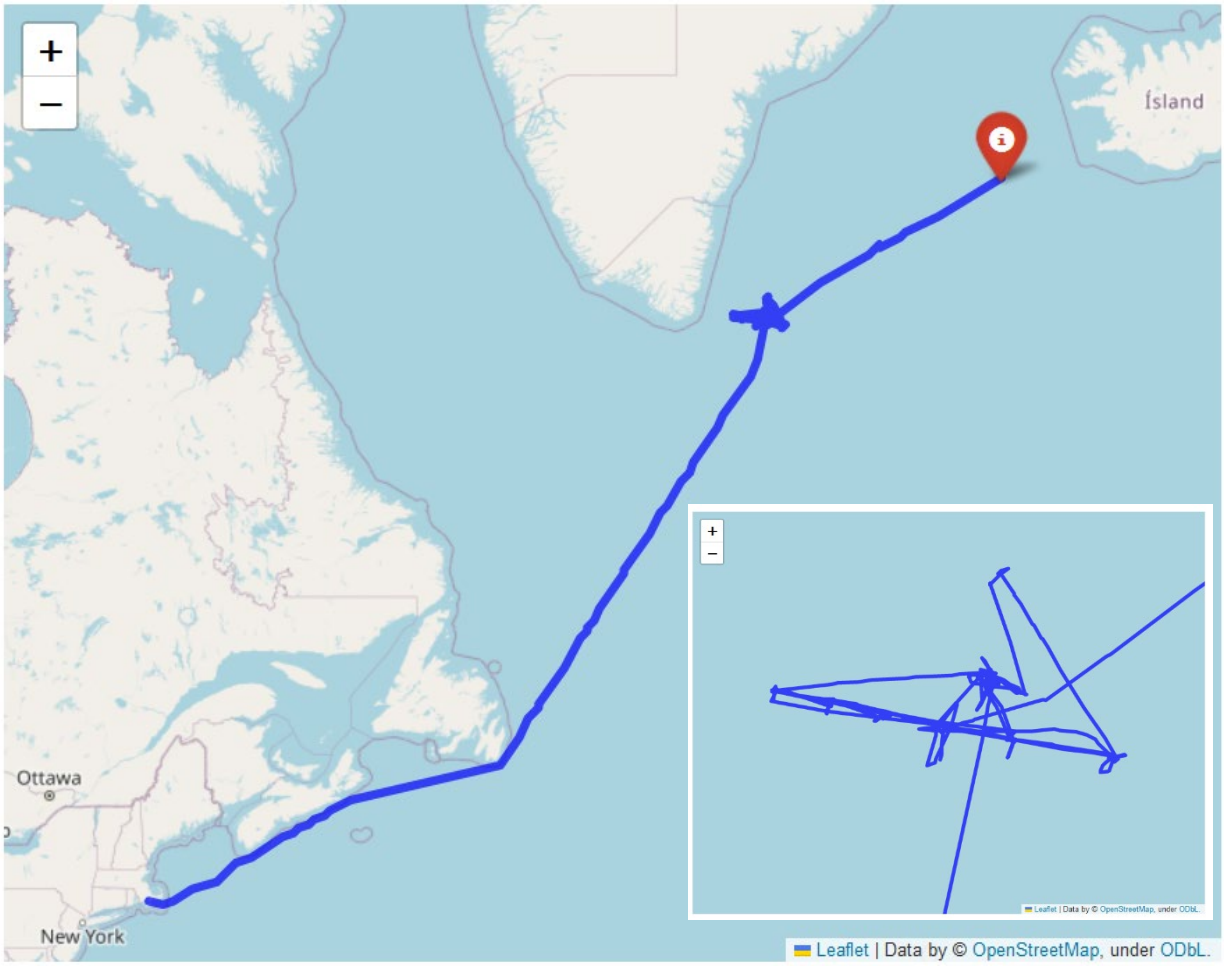
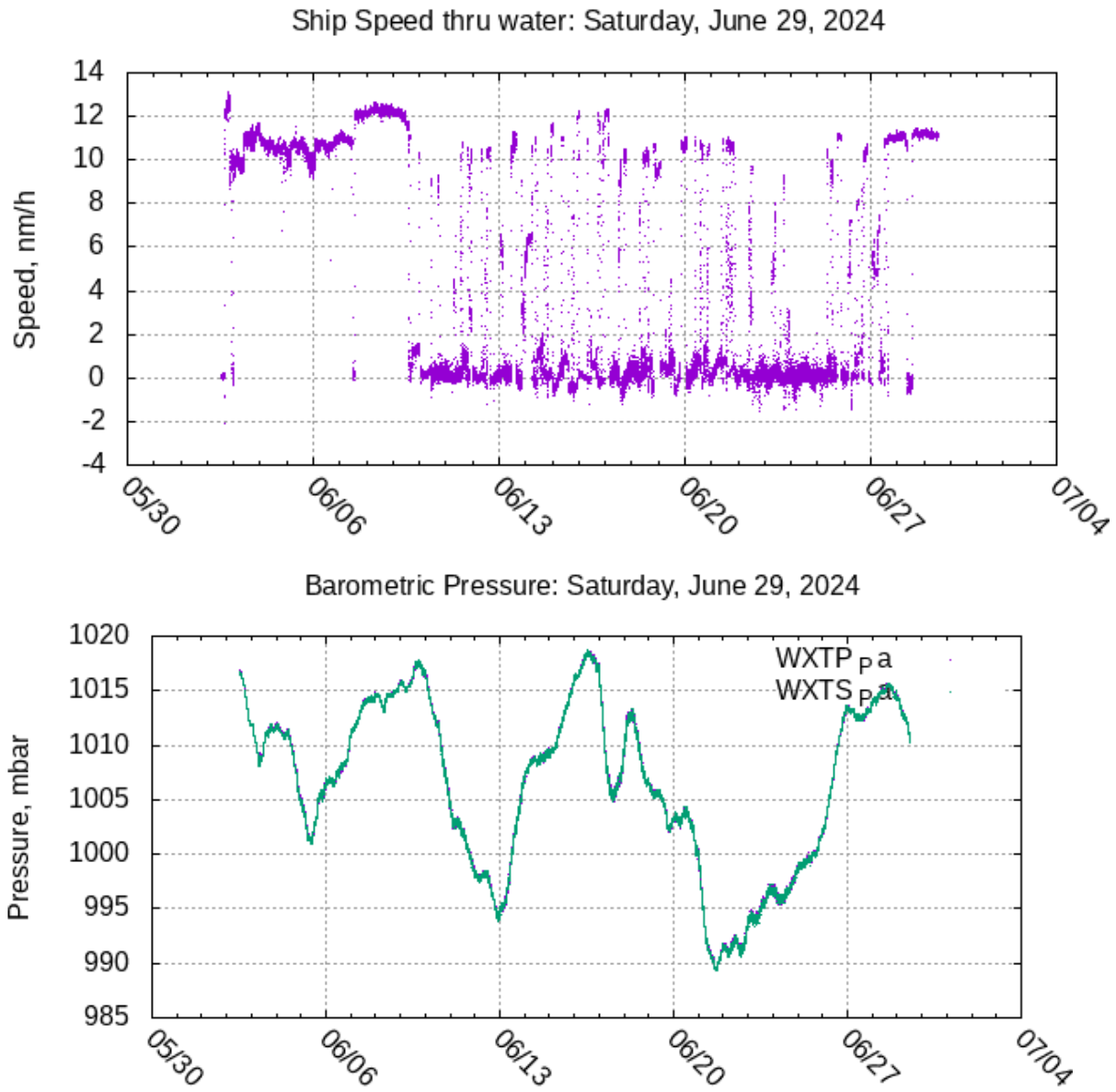
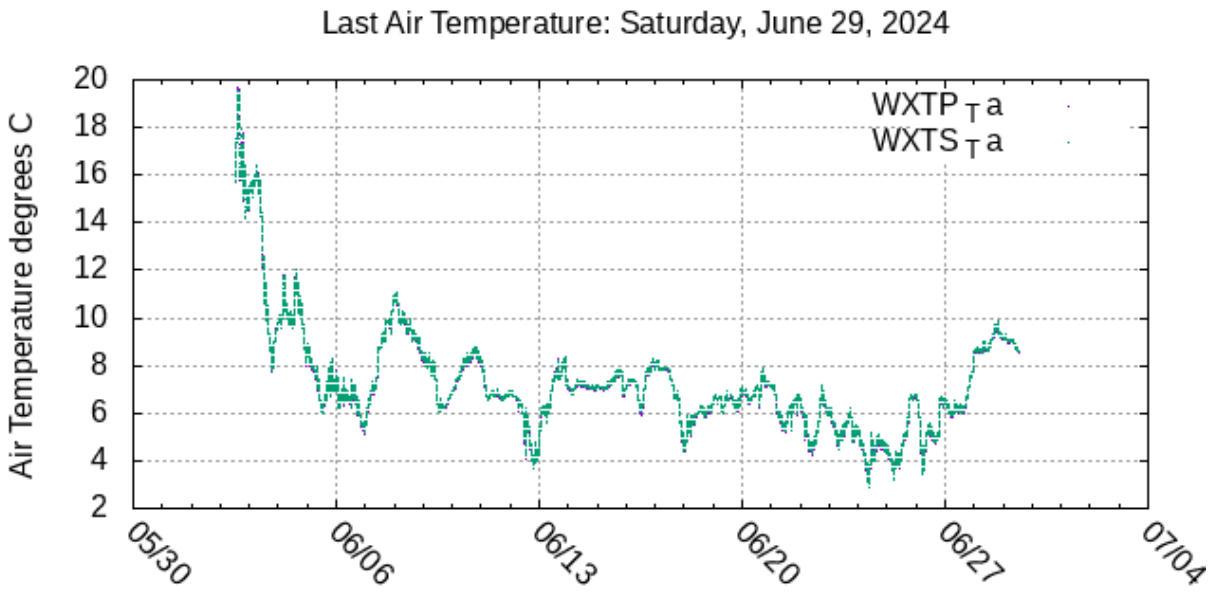


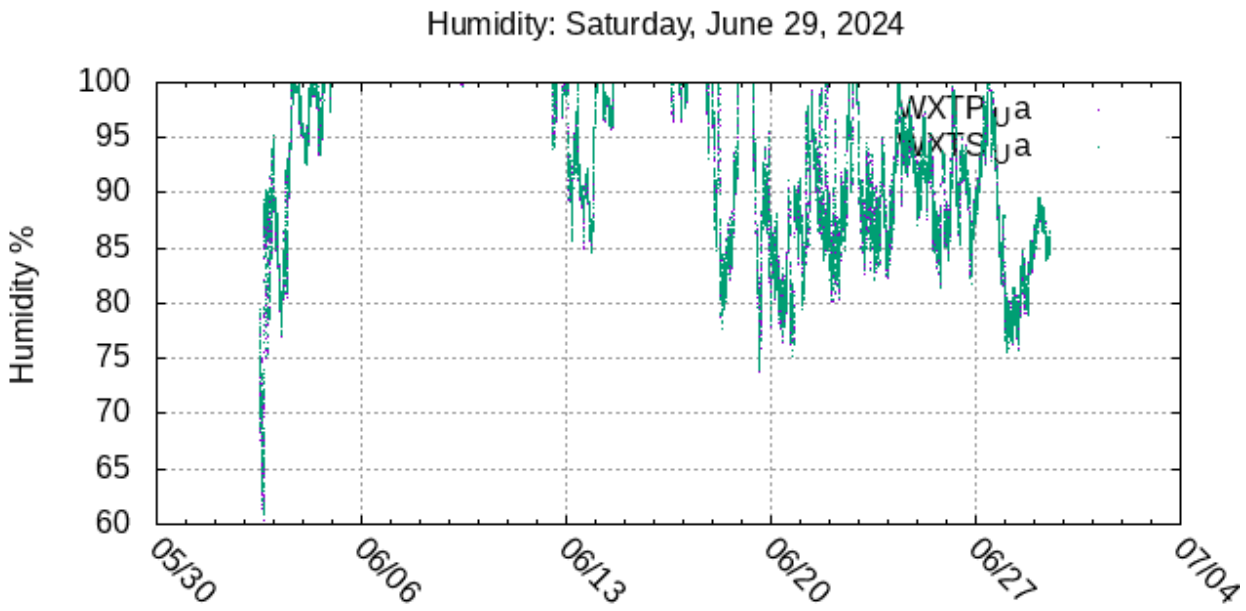
Figure 1. Overall cruise track for AR84-01, and zoom-in on study region, Woods Hole to Reykjavik, 02 June-02 July 2024.

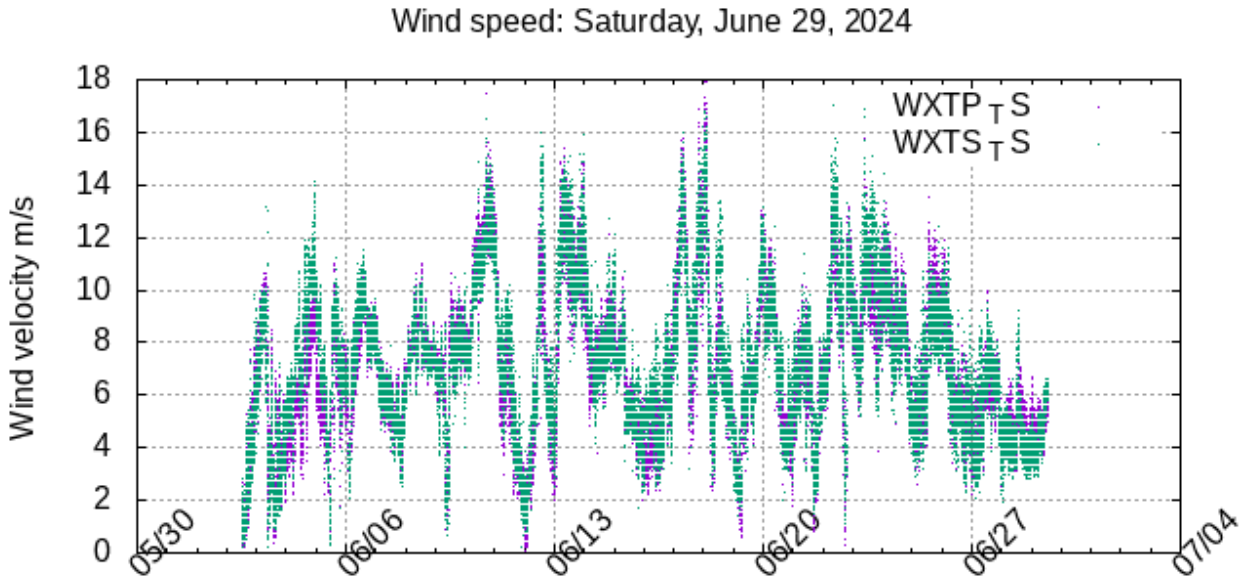
Once arriving at the work site, the weather inconsistency meant that we could not forecast work more than one or sometimes two days ahead. During rough weather periods we relied on getting releases tested and instruments calibrated during CTD casts – one CTD winch broke (17 June 2024), we simply hove to during rough weather periods. Figure 2 shows

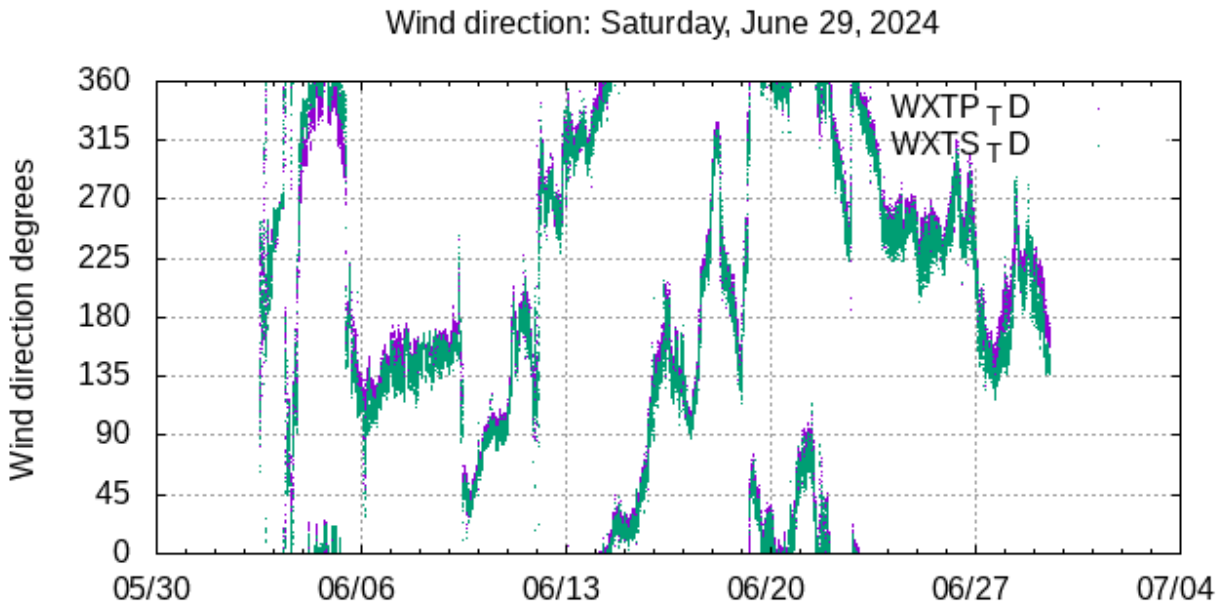
ship's speed through water, wind speed, wind direction, air temperature, barometric pressure, humidity, rain intensity, and sea-surface temperature during the cruise period.




Last Air Temperature: Saturday, June 29, 2024
Air Temperature degrees C
20
18
16
14
12
10
8
6
4
2
05/30
06/06
06/13
06/20
06/27
07/04
WXTP_Ta
WXTS_Ta


Humidity: Saturday, June 29, 2024
Humidity %
100
95
90
85
80
75
70
65
60
05/30
06/06
06/13
06/20
06/27
07/04
WXTP_Ua
WXTS_Ua


Wind speed: Saturday, June 29, 2024
Wind velocity m/s
18
16
14
12
10
8
6
4
2
0
05/30
06/06
06/13
06/20
06/27
07/04
WXTP_T S
WXTS_T S


Wind direction: Saturday, June 29, 2024
Wind direction degrees
360
315
270
225
180
135
90
45
0
05/30
06/06
06/13
06/20
06/27
07/04
WXTP_T D
WXTS_T D

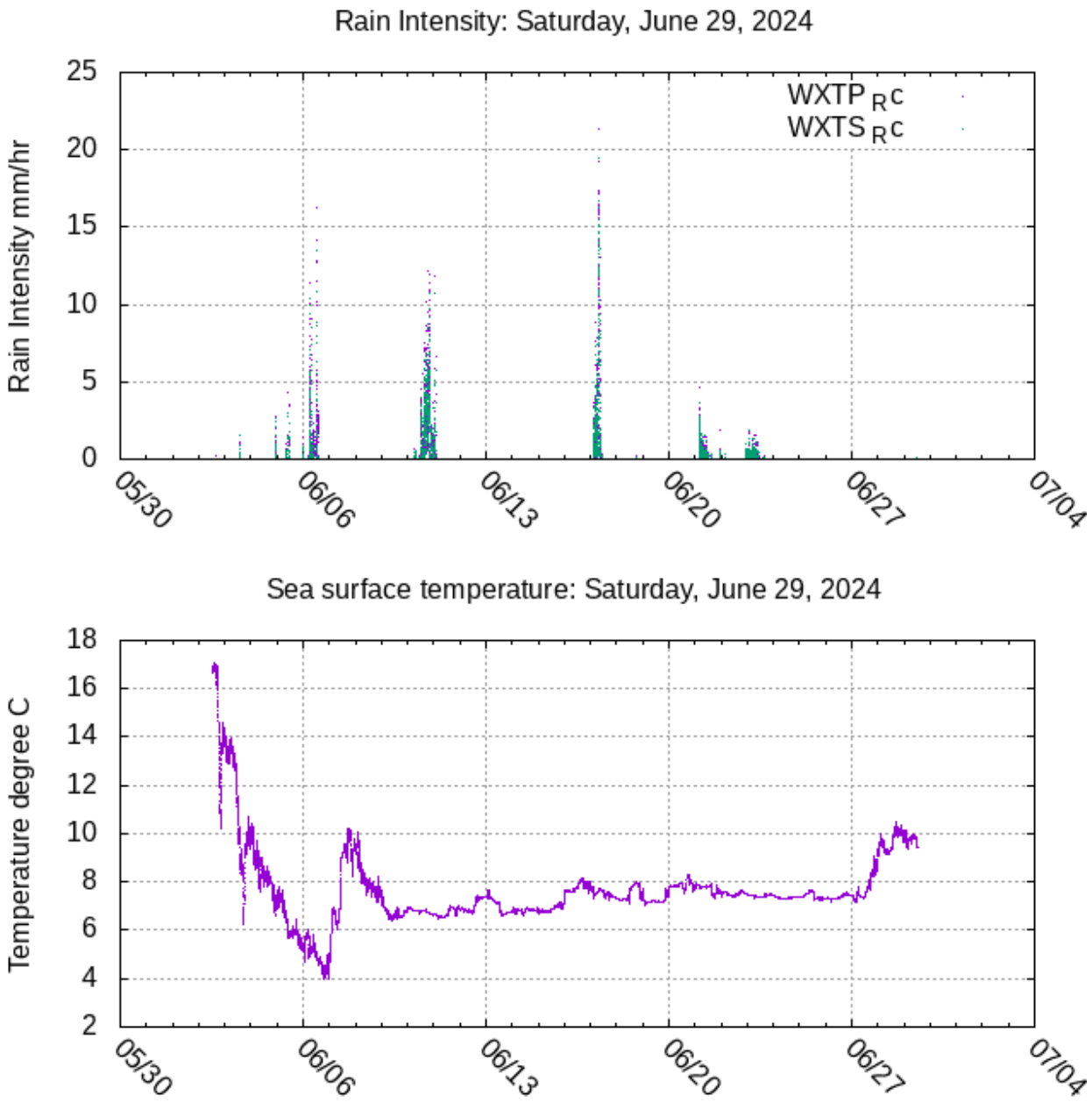


Figure 2. Weather conditions measured on the bow mast of the R/V *Armstrong* during AR8401. Shown are ship's speed through water, wind speed, wind direction, air temperature, barometric pressure, humidity, rain intensity, and sea-surface temperature for the in-port period prior to departure (XX June), and for the cruise period (until XX July).

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. Workflow 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. An additional consideration was that the OSNAP microcat and spare optodes and OOI microcat calibration casts had to be performed before recovery. The general plan was to deploy all OOI moorings, turn 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 recovered mooring components. However, we got all OOI moorings deployed and a couple OOI moorings recovered (including SUMO), before turning to OSNAP work. Once on OSNAP, we had a few long days of validation CTDs, multiple recoveries, caldip CTDs, and mooring deployments. We hove to for a storm, and the remainder of work was a patchwork of OOI and OSNAP. A few events affected workflow. First, a new permit form was required by the Danish Government to sample water in Greenland EEZ – this permit was not secured before leaving port, and delayed water sampling and calibration dips before reaching work region. Second, the salinometer malfunctioned, was not fixable, and we ended up with the spare, less accurate, Port-o-sal for the entire trip. Third, the CTD winch malfunctioned on the last OSNAP validation CTD, at mooring M3. The CTD was completed with difficulty, and we were limited to less than four CTDs for remainder of cruise, so had to ration CTD events. Table 1 and Appendix A show cruise plan for all mooring and CTD operations performed on AR8401.

Table 1. CTD and mooring operation relevant to OSNAP GDWBC 2024.

Date	Day	Day of Week	Summary of OSNAP activities	Details
02 June 2024	1	SUN	Move on board R/V Armstrong, depart. CTD#001	Refuel, move onboard, safety and fire drills. Got connected to internet and onboard email system. Depart. CTD#001 to 175m, test cast
03 June 2024	2	MON	Transit.	Day-to-day timeline review and rework; E-LOG training. Cruise report work.
04 June 2024	3	TUES	Transit. Water sampling meeting.	Transit to deep water / OOI work site. Hashed out sampling plan. Sampling review; sampling plan. OSNAP blog #1 completed and sent. Autosal not functioning.

05 June 2024	4	WED	Transit. Time change from GMT-4hrs to GMT-3hrs.	Transit to deep water / OOI work site. Buffed sampling plan. Got CTD data plotting w/ LTM's diagnostics. Autosal not functioning.
06 June 2024	5	THU	Transit.	More hydrography meetings. Transit to deep water / OOI work site. Looks like we will get clearance to sample water. Pulled PortoSal from science hold.
07 June 2024	6	FRI	Transit; CTD#003, 3 OOI releases.	Transit to deep water / OOI work site. CTD with 3 OOI releases crossing mouth of Lab Sea. Finally got clearance to sample water, so booking it to OOI site to outrun storm. Driving just under 12 knots, got 'special permission' to do this.
08 June 2024	7	SAT	Transit.	Transit to OOI work site, outrunning storm. Continue to work with salinometer – PortoSal is working well, even though numbers have to be handwritten after every sample. Informed Leah/Bob for the next OSNAP cruise. Still driving ~12 knots.
09 June 2024	8	SUN	Transit to SUMO site. Time change from GMT-3hrs to GMT-2hrs. Deploy SUMO.	Transit to OOI work site, going ~12 knots. Deploy SUMO in afternoon to grab weather window before storm hits. Deployment went from setup at 12:00, start at 14:00, finish at 23:00. Long day.
10 June 2022	9	MON	CTD#004, acoustic releases. CTD#005, acoustic releases plus OOI (8) and OSNAP (6) microcats. Met data download from SUMO.	Folks are tired.
11 June 2022	10	TUE	SUMO cast with 3 releases, transit to HYPM site, deploy HYPM, transit to SUMO site, CTD#006 BGC cast@SUMO, SUMO EK80survey.	Better day, except for trying to test an acoustic release that had not been turned on.
12 June 2022	11	WED	Arrive glider box; deploy gliders; recover gliders. CTD#007 CTD@gliders. CTD#008 – OSNAP caldip/releases.	Outrunning a storm. Made cups.
13 June 2022	12	THU	Glider deploy. CTD#009@M4 w releases, remainder microcats.	Transit back to work area through storm. Good solid day. Made more cups.
14 June 2022	13	FRI	Deploy FLMA. CTD#010@FLMA w/ release. Anchor survey. Second CTD#011 to 1000m.	All good, productive day. More cups.
15 June 2022	14	SAT	Deploy FLMB. CTD#012@FLMB w/ release. Anchor survey. Second CTD#013 to 1000m.	All good, productive day.

16 June 2022	15	SUN	SUMO recovery. Glider deployment.	All good, productive day.
17 June 2022	16	MON	CTD#014@M1; CTD#015@M2; CTD#016@M3.	Mooring recovery plans scrapped, crap weather. Validation CTDs. CTD winch bearings bad on last cast – lots of stopping, winch up and down on down cast. Constrained to 30 m/min on upcast and for all future casts.
18 June 2022	17	TUE	Recovered M3, then M2, a blue whale cale to investigate us, then M1.	Clear day, some sun, seas recovering after storm, some confused swell. Good long mooring recovery day. M3 was the most wuzzled out of the set of moorings. All instruments OK. Blue whale day.
19 June 2022	18	WED	Recovered FLMB. CTD#017.	Long cal dip due to winch motor constraints. M1-M3 optodes and 12 microcats.
20 June 2022	19	THU	Deployed M1, M2.	Productive, good, long day. Beautiful sunny day.
21 June 2022	20	FRI	Deploy M3.	Cold wet freezing morning on deck. Calm seas.
22 June 2022	21	SAT	OOI day – anchor survey, data downloads, shipping home kabbitz. Time change from GMT-2hrs to GMT-1hr.	Storm coming in today, quiet day of catching up.
23 June 2022	22	SUN	CTD#018@HYPM, OOI & OSNAP caldip.	Chrome seas, rolling day, winds ~20+ knots.
24 June 2022	23	MON	Hove to.	Hove to; not bad weather. Worked on cruise report; manifests; social media posts. Scavenger hunt. Game night.
25 June 2022	24	TUE	Recover HYPM. Recover FLMA top half.	Good. Folks packing up. Cruise report.
26 June 2022	25	WED	Recover M4. Deploy M4. Anchor survey M4.	Calm seas. Full day.
27 June 2022	26	THU	Recover FLMA bottom half.	Cruise report.
28 June 2022	27	FRI	CTD#019: OOI & OSNAP caldip.	Cruise report. Haiku submissions due.
29 June 2024	28	SAT	Time change GMT-1hr to GMT/Iceland. Transit.	Haiku judging. Packing. Cruise report.
30 June 2024	29	SUN	Transit, wait.	SUMO breakdown. Packing up. Cruise report.
01 July 2024	30	MON	Wait outside harbor.	
02 July 2024	31	TUE	Dock.	

4. GDWBC Mooring Operations

Four OSNAP GDWBC moorings were recovered and deployed. The mooring team was led by Chris Basque of MOE, with John Jordan, working with Adam Houk. Adam Houk was OSNAP instrument lead, with Meg, Ayden and Emma assisting in securing instruments to wire and scrubbing them when they came off the water. OOI team members Dan Bogorff, Mike assisted. H. Furey worked on instrument serial number and position verification, photographing operations, working the clipboard, as well as other deployment tasks. The remaining science party: Jennifer, Rebecca, Dan Bishop, Sheri filled in when needed. A similar configuration of people was used during the OOI mooring operations. Figure 3 provides an overview of the cruise track and operations. 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.

A new consideration for this trip was ice near M1. Photo below shows ice coverage when we left port, when M1 would have been a 'no go' zone, to mid-cruise when we turned the mooring. This is the earliest we have been up to the Irminger Sea, weather was unsettled, rough, and plans were hard to keep.

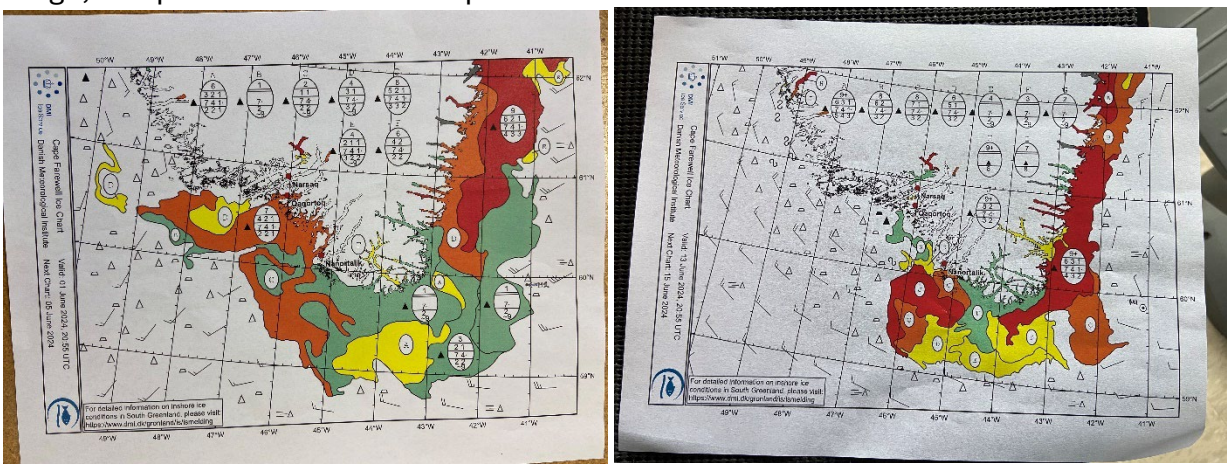


Photo. *Danish Meteorological Institute Cape Farewell Ice Chart for 01 and 03 June 2024. Icebergs and 'bergy bits' were near mooring M1 site.*

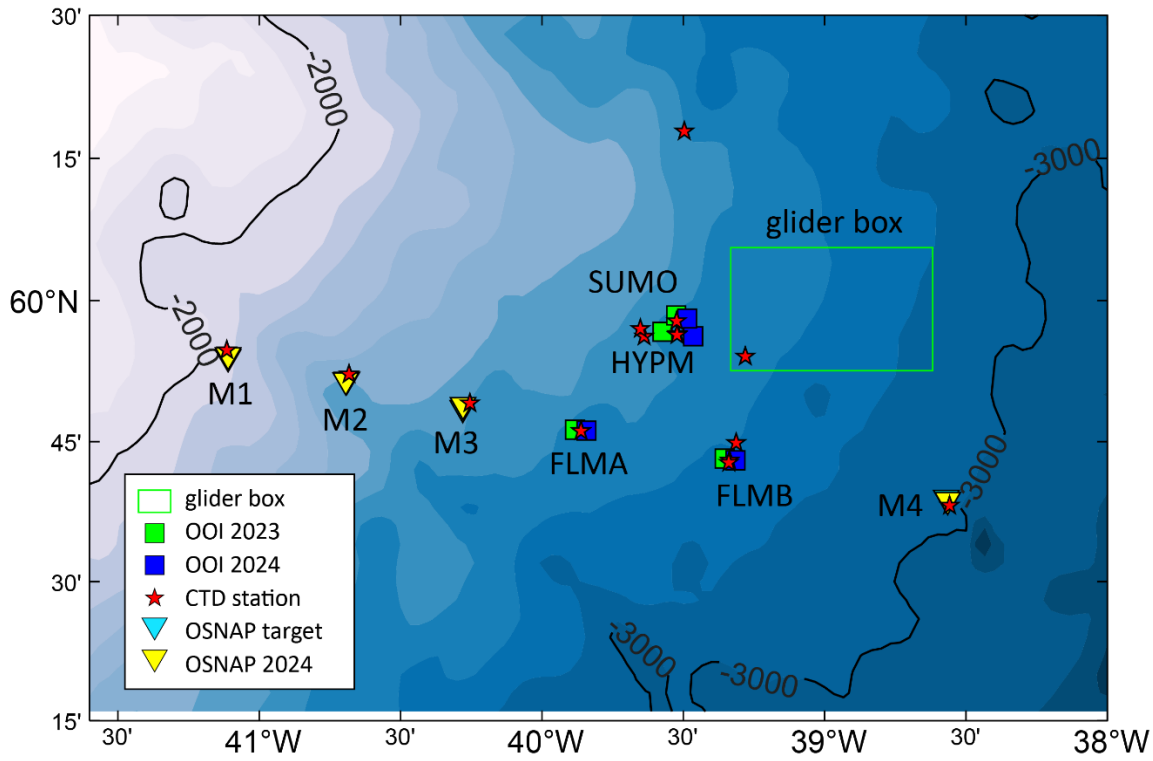


Figure 3. Station locations coded by activity. Bathymetry is shaded every 100 m.

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 was a wuzzle on mooring M3 from 2500m to releases, but everything was recovered safely. Recovery diagrams are included in Appendix B. The total instrument recovery counts were: 8 Edgetech acoustic releases, 19 Aanderaa Aquadopp current meters, and 30 Seabird microcats, and 11 RBR Virtuoso optodes, all successfully recovered. Description of recovered instruments and data return are in 'Section 5: Mooring Instrumentation'.

In chronological order…

M3 Recovery: Early mooring recovery on a day captain Mike wanted to pull M3, M2, and M1 on same day. Day was clear visibility, cloud cover, but horizon visible. Some confused seas and unexpected 12' swell. Winds <=10 knots. Deck setup at 0500; release fired at 0600 local time, balls sighted 9 minutes later, and entire mooring on deck by 0800. The TSE winch was used throughout recovery. The mooring was wuzzled from ~2500m (just above bottom Aquadopp/MicroCAT pair) through the releases. Optode was wrapped up tight in wirerope. Note: the bottom flotation came up while the top flotation was being recovered and was unexpectedly located off aft port quarter of ship. We sped up to avoid entanglement. This led us to hook the top location of mooring M2 in a speedier manner –

well before the bottom floats could come up. Flyby of possible Greenland ice patrol/coast guard/search and rescue 2 times, down low.


M2 Recovery: Deck set up occurred on way to M2. Fired release at 0934, balls surfaced at 0944. Balls hooked at 0951 and mooring on deck by 1105. Bottom floats sighted at 10:36, probably they were up sooner. Bottom floats were this time trailing safely behind ship when sighted due to different manner of hooking top floats. The TSE winch was used throughout recovery. A blue whale visited us in the middle of the recovery – circled the ship – it was stunning. The bottom flotation and releases were wuzzled, care was taken pulling that onboard.

M1 Recovery: Care was taken for this: there were two UFBs seen the mooring prior (Monday June 17th) about 0.5 nm away from mooring anchor. We could not locate the UFBs on a later look yesterday, too foggy. Before release fired, we stopped and looked for UFBs – clear horizon, UFBs not seen. Deemed safe to approach. Because 7 set of ballast attached to bottom, we waited until bottom flotation was on surface (21 minutes) before recovery. Recovery went smoothly, only releases and bottom floatation were wuzzled. The TSE winch was used for some of recovery, then we switched to LEBUS. There was a copious amount of biofouling of instruments – even on the bottom instrument. More than I remember from other years.


M4 Recovery: Calm day, flat seas, visibility to horizon, overcast, 41.5°F, winds 12 knots. We waited until the bottom flotation was at the surface before attempting recovery. Top

flotation was seen 15 minutes after release, bottom flotation seen 18 minutes later. Grabbed top flotation to recover. Release fired at 07:56, chains back up at 10:15.


Table 2. Mooring recovery information June 2024.

Mooring	Recovery Date	2022 Surveyed location	Time Release Fired (local)	Release #	Length of time to recover, from release fire to releases on deck
M1	18 JUNE 2024	59° 54.067'N 41° 06.475'W	13:06	28038	2hr 44min
M2	18 JUNE 2024	59° 51.622'N 40° 41.415'W	09:34	33042	1hr 31min
M3	18 JUNE 2024	59 48.718'N 40 16.747'W	06:00	30864	2hr 00min
M4	26 JUNE 2024	59 38.778'N 38 33.925'W	07:56	31334	2hr 19min

4.b. Mooring Deployments

Moorings were deployed when weather was good. Mooring deployments went smoothly. We did not tape single microcats (those not in cages paired with current meters) to cover screws around the conductivity cell guards as was done in 2020. A. Houk performed all anchor surveys. A. Houk wisdom: Survey distance points should be twice the water depth at the site of the release. Mooring deployment and achor survey information are in Tables

3, 4, and 5. Figures 4 shows a vertical overview of array. 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…

M1 deployment: First real sun in many days. Winds ~15-20 knots. Ocean currents squirrely. Basque ran the deck, and asked for a 150 m fallback, and we started 2.1 miles out. The was a change from previous 3 years 110 m fallback. This is a taller mooring, so less fallback. Deck setup occurred between 0600 and 0800 local time. First flotation was put over side at 08:20 local time, and anchor was dropped 11:35 local time. Time between releases over and anchor drop, or time to finish steaming to anchor drop site, was 17 minutes. XEOS beacon is on sphere, and Basque confirmed messages being received before deployment, H. Furey also received messages (and for all subsequent mooring deployments). Time between ready to deploy and anchor drop was 17 minutes. Distance between surveyed anchor position and target was 115 m.

M2 deployment: Sunny, calm, wind <10 knots. Basque worked with a 3.0-mile (?) distance from anchor drop and a 250-meter fall back estimate. Deck setup occurred between 1300 and 1400 local time, and this was second deployment of the day. First flotation was put over side at 1442 local time, and anchor was dropped 17:43 local time. 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). Total time of deployment, 3hrs 1 minutes. The time between ready to deploy and anchor drop was 45 minutes. Beacon is on top 3-ball radio float, message throughput checked prior to deployment. Distance between surveyed anchor position and target was 201 m.

M3 deployment: Rain, 41F, calm seas. Cold raw deployment. Basque/Mannka settled on a 1.0-mile distance from anchor drop and a 250-meter fall back, down from 350 m in 2022. Mannka sees surface currents inconsistent but due west. Adam observed a sea surface to 1200 m 0.3 m/s southwestward current at this site. Captain Mike reworked setup due to shifting currents, and we ended up with course from SW to anchor drop in the NE, starting 3 nm from target. Kemp states from years past that moorings M2 and M3 are not heavy enough for the sites – this has been a persistent problem. First flotation was put over side at 08:23, and anchor was dropped at 11:11 local time. Time between to finish steaming to anchor drop site was 40 minutes. Total time of deployment, 2hrs 48 minutes. Beacon is on top 3-ball radio float, messages confirmed before deployment. Distance between surveyed anchor position and target was 133 m.

M4 deployment: Basque and Captain Mike settled on a 2.75-mile distance and a 250-m fallback estimate similar to the 2022 deployment. based on previous deployment. First

flotation was put over side at 12:25 local time, and anchor was dropped 15:05 local time. Anchor took 22 minutes to settle on bottom. Beacon message throughput was checked prior to deployment. Smooth deployment, exactly what's best. Distance between surveyed anchor position and target was 96 m.

Table 3. Mooring deployment information June 2024.

Mooring	Distance from target at first buoy over	Fallback estimate used	Mooring deploy duration	Conditions
M1	2.1 nm	150m	3hr 15min	Sunny and clear, could see mountains of Greenland.
M2	3.0 nm	250m	3hr 1 min	Calm. Cold, raining.
M3	3.0 nm	250m	2hr 48min	Calm. Cold, raining.
M4	2.75 nm	250m	2hr 40min	Calm, partly clear, clear horizon.

Table 4. Mooring anchor survey information.

Mooring	Anchor Drop		Surveyed Anchor Position		
	Date	Position	Corrected Depth (m)	Trilaterated position	Distance between anchor and target position (m)
M1	20 June 2024	59° 54.288'N 41° 06.456'W	~2086m	59° 54.204'N 41° 06.594'W	115 m
M2	20 June 2024	59° 51.734'N 40° 41.329'W	~2423m	59° 51.534'N 40° 41.626'W	201 m
M3	21 June 2024	59° 48.966'N 40° 16.372'W	~2557m	59° 48.912'N 40° 16.746'W	133 m
M4	26 June 2024	59° 38.720'N 38° 34.290'W	~2985m	59 38.777'N 38 33.893'W	96 m

Table 5. Distance between surveyed anchor and target locations for all years.

Distance (m)	M1	M2	M3	M4
2018	266	418	289	diff. loc.

2020	160	280	76	49
2022	209	79	312	69
2024	115	201	133	96

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. Five RBR Duets were sent as spare optodes, in case needed. The turnaround of the optodes were a limiting factor on success of the oxygen program, but this was less of a strain than in 2022. In the end, we did not need to use the RBR Duet optodes. The total instrument deployment count was: 8 releases, 19 current meters, 30 microcats, 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. A change was made for this deployment to protect current meter data integrity. where optodes positioned lower than current meters on a wire, optodes were move about 0.5 meters further away from the wide. See photos below. Adam Houk calculated that with a 30° beam angle, the 2-m beam would project 1.7 meters down the wire. For this reason, the optodes were moved to below that distance, so as not to disrupt currents within 1.7 ft of meter. I. La Bras OKed this plan before we deployed in this new manner.

Details on all instrumentation may be found in Appendix E.

Photo: *Chris Basque guides instuments over the transom. Photo shows distance between current meter/microcat and optode, when optode placed lower on wire. This configuration was on all but one instrument sets on moorings M1, M2, and M3.*

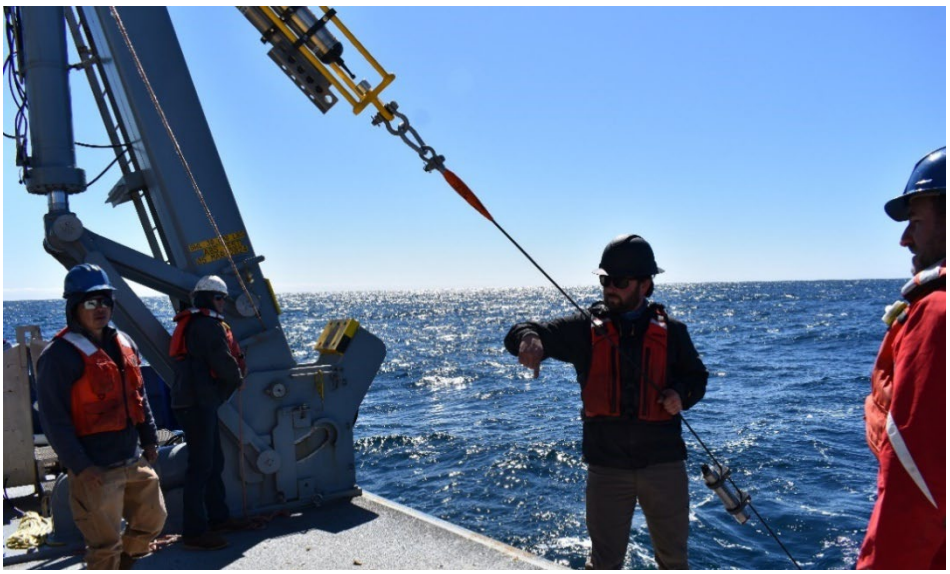


Photo: *Chris Basque guides instuments over the transom. Photo shows distance between current meter/microcat and optode, when optode placed shallower on wire. This configuration was (only) on the bottom instrument set on mooring M1.*

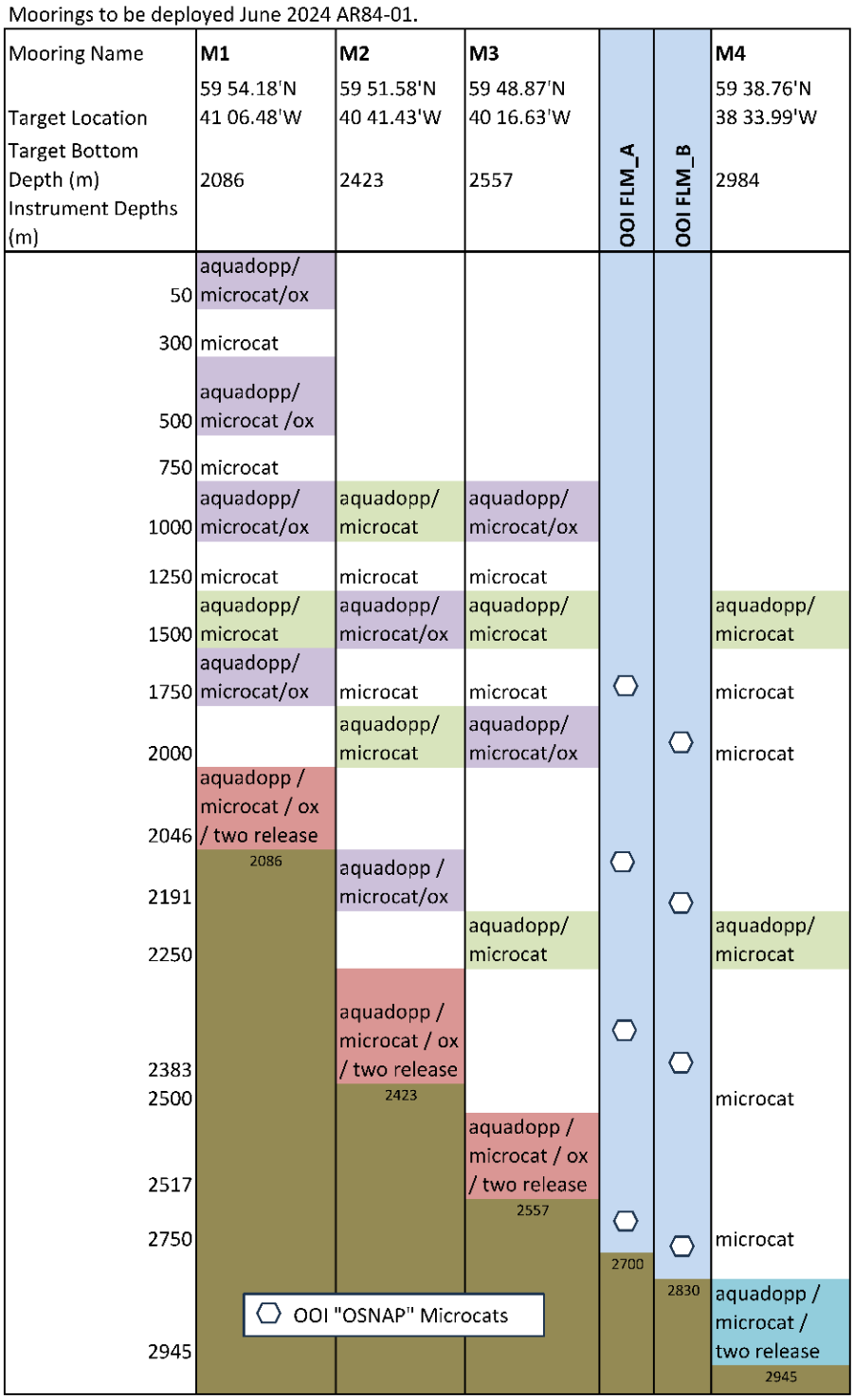
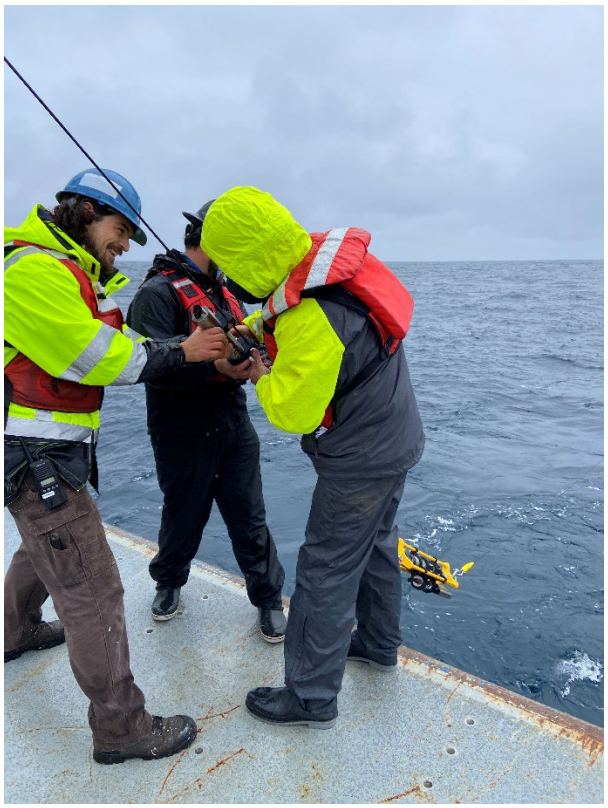


Figure 4. Schematic of the 2024 GDWBC array. Colors indicate different combinations of instruments. Mooring target locations and corrected depths on the schematic are from P. Holliday 2016 cruise report 'OSNAPY3L2report_NOC_CR_40.pdf', Table 6.4.



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 2000m and given 15 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 AR8401 data directory. Overview matrix of instrument calibration and mission configurations, and CTD protocol may be found in Table 6. Instrument serial number assignments for each mooring may be found on the mooring deployment diagrams, Appendix C.

Table 6. Instrument protocol matrix.

OSNAP-GDWBC: AR8401 02 June – 02 July 2024		
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, 2022, 2024: 10-sec rep-rate, 10-min soaks, 5 depths below 1000m.	
Oxygen sensor testing	Freshwater soak before dip; 10-minute soaks, 10-second rep-rate. 4 feature depths, with oxygen water sampling; CAP OFF PRIOR TO DEPLOYMENT. Rinse w/ freshwater. NO SUNLIGHT. KEEP DAMP.	2 water samples taken per depth.
Release testing	3 per frame max, 2500m for deep releases, 15-min soak.	3 on frame max per dip. Basque soaks releases for 15 minutes each to get them to temp before testing. Test [enable, range, release].
Mooring validation CTDs	0.5 nm	How close to site? Depends on watch circle. 1.0 nm is totally safe, 0.5 nm is good.
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
Optode deployment: RBR Concerto / Virtuoso / Duet	**15-minute sample-rate;** start at whole hour interval; UTC; CAP OFF PRIOR TO DEPLOYMENT.	Per Isabela le Bras document.

Optodes

Eleven RBR Concerto optodes secured on moorings M1-M3 were turned around at sea and redeployed for the 2024-2026 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. It was tight (less tight than in 2022), but we did not have to use the spare instruments. One optode-equipped microcat (SBE37- SMP-ODO) was recovered and not redeployed. 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 duplicate sampling.

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#008, and CTD#009. OSNAP microcats s/n14615 failed pre-deploy calibration. Instrument was cleaned, pressure port cleared, and re-calibrated in hopes of being able to deploy. Instead, A. Houk ended up turning around one recovered microcat (#6669), and re-deploying. We would have deployed instruments with drifting conductivity and pressure if we had not performed the caldips and had A. Houk expertise onboard to diagnose.

Post-recovery, all microcats recovered from OSNAP moorings, and the deepest 4 microcats recovered from FLMA and FLMB were strapped to the rosette frame and calibrated by setting to run at 10-second sampling rate and soaked for 10-minutes at 4 depths. Prior to calibrating, the 2-year mission data were downloaded from each instrument. Post-recovery, microcats and optodes were calibrated on casts #017, #018, #019, with 10-minute soaks at 4 depths => 2000m if possible.

2022-2024 instrument data return

Overall, we had 100% data return for instruments on all four moorings combined.

M1: 6 current meters, 9 microcats, 1 microcat with O2, 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: 100% data return.

Microcat, current meter, and optode data were plotted to assess data quality, and to see if looked 'reasonable'. Plots of instrument data records created by A. Houk (current meters and microcats only) may be found in Appendix F.

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 5. 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 sampled four oxygen depths chosen by M. Yoder, to best calibrate the oxygen cast data. In 2022, we sampled at the optode instrument depths, we did not adhere to this in 2024. All oxygen samples were duplicates, a few as triplicates at the start of the cruise to diagnose quality control issues, which turned out to be insufficient shaking immediately after taking samples. On cast #016, the last OSNAP mooring validation cast, the CTD winch broke – water came out of the winch bearing case. We were restricted to 4 casts for the remainder of the cruise, and descending 30m/min on casts.

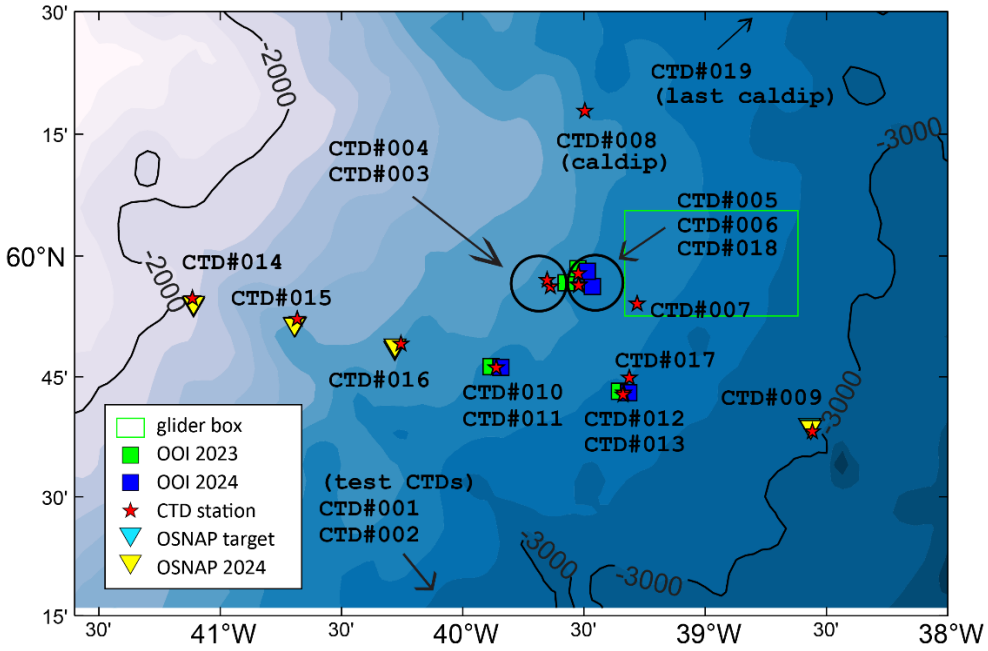
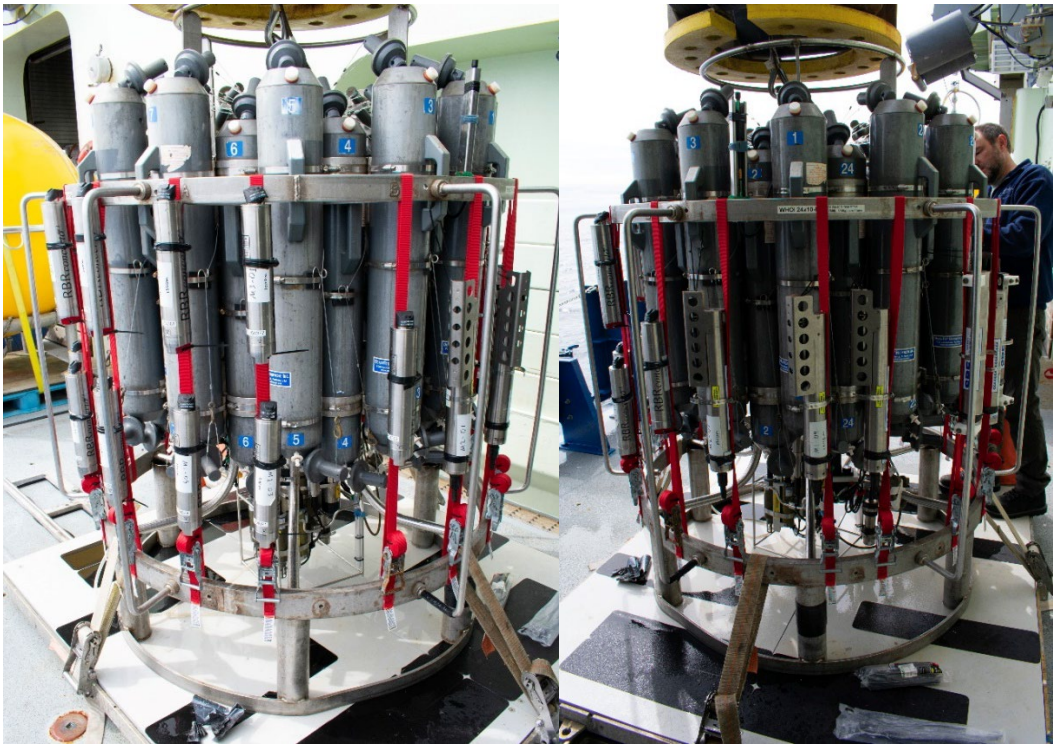


Figure 5. Map showing CTD station numbers relevant to OSNAP line and GDWBC moorings. CTD locations are marked as red stars. Bathymetry is shaded every 100 m.



Photos: caldip set up. We felt having optodes 'upside-down' would not be an issue during the duration of a cast, and this placement allowed more instruments on the frame and not interacting with ratchet straps.

Table 7. CTD casts, release tests, instrument calibrations during AR8401.

Cast #	Date	Time (UTC)	Site (at max depth)	Water Depth	Cast Depth	Water Samples, Instruments
001	2024-06-02	23:01-23:29	41 39.786' N 69 09.376' W	174 m	166 m	Gulf of Maine; Test altimeter. Test CTD acquisition system. Practice sampling.
002	2024-06-07	11:28-13:38	51.561 N 47.890 W	3580 m	2000 m	Test 3 OOI acoustic releases.
003	2024-06-09	10:51-13:00	59.937 N 39.639 W	2652 m	2483 m	Test 3 OOI acoustic releases.
004	2024-06-10	14:13-16:51	59.950 N 39.652 W	2637 m	2493 m	Cal-dip with six OSNAP mcats. Salts at 4 stops. Microcat SBE37 s/ns 16805; 16783; 16768; **14615 (bad pressure)**; 14616; 14610. Eight (8) additional OOI FLMA/FLMB mcats, 3 OOI acoustic releases. Salinometer failure, move to Port-o-sal.
005	2024-06-11	09:01-12:27	59.941 N 39.521 W	2680 m	2496 m	Test 1 OOI acoustic release, 2 OSNAP releases [54678, 33040]. One OSNAP release [33040] not turned on before putting on frame – need to retest.
006	2024-06-11	18:00-19:18	59.939 N 39.522 W	2677 m	1150 m	BGC cast.
007	2024-06-12	08:38-09:48	59.901 N 39.281W	2763 m	1000 m	Glider cast.

Cast #	Date	Time (UTC)	Site (at max depth)	Water Depth	Cast Depth	Water Samples, Instruments
008	2024-06-12	14:19-16:57	60.297 N 39.496 W	2671 m	2654 m	OSNAP releases [33040, 31336, 65431]. OSNAP microcats s/n **14615 (repeat, still bad pressure);** 14600; 14620; 14605; 14602; 14619; 14611; 16792; 14614; 14595; 14609; 11524; 11522; 11526; 11523; 11525; 14630; 14535. Optodes: 21800; 21801; 210802; 210803; 210804.
009	2024-06-13	15:48-19:01	59.636 N 38.558 W	2989 m	2970 m	M4 validation, 3 OSNAP releases [31267, 55470, 65425]; 7 OSNAP microcats [14554, 16798, 14551, 14553, 14552, 14607, 14613].
010	2024-06-14	16:19-18:49	59.769 N 39.862 W	2697 m	2685 m	FLMA site center, OSNAP release 65424.
011	2024-06-14	21:07-22:17	59.769 N 39.862 W	2696 m	1150 m	FLMA site center, BGC cast.
012	2024-06-15	15:48-18:13	59.717 N 39.336 W	2825 m	2795 m	FLMB site; all the things.
013	2024-06-15	21:05-22:18	59.713 N 39.339 W	2826 m	1150 m	FLMB, BGC cast
014	2024-06-17	10:01-11:59	59.912 N 41.115 W	2072 m	2055 m	M1 validation cast.
015	2024-06-17	14:28-16:32	59.868 N 40.669 W	2402 m	2382 m	M2 validation cast.

Cast #	Date	Time (UTC)	Site (at max depth)	Water Depth	Cast Depth	Water Samples, Instruments
016	2024-06-17	18:24-22:12	59.818 N 40.255 W	2563 m	2547 m	M3 validation cast. Stopped winch at 2220 m and again at 2332 m on downcast to diagnose the "clanking-and-a-clunking" of winch. Went up to 2186(?) then back down. Serious winch problems, couldn't help what happened to CTD data quality – lots of stops and us and downs on the downcast. Might lose winch for rest of cruise – bearing issues is problem. Chief Engineer Piotr will try to get us 4 more casts.
017	2024-06-17	14:53-19:03	59.747 N 39.313W	2816 m	2803 m	FLMB site, OSNAP post-recovery caldip: 11 optodes [204362; 204371; 204368; 204382; 204380; 204381;204369; 204378; 204377; 204373; 204379], 12 microcats [5921 6056 6669 7585 7588 7590 7596 7597 7601 7602 7607 14599].
018	2024-06-23	10:16-14:37	59.964N 39.524W	2669 m	2655 m	HYPM site, OOI & OSNAP post-recovery caldip. OSNAP mcat w/ optode [37-23986], 11 microcats [5917 6655 6660 6668 7581 7586 7589 7593 14612 14634 14635].
019	2024-06-28	09:21-13:49	61.601N 33.758W	2959 m	2952 m	Caldip: remainder 4 OOI (from FLMA) & 7 OSNAP microcats [7587 11527 7580 6664 8417 13215 7592].

7. Notes for next cruise, lessons learned, and supply list for 2026.

The OSNAP portion cruise went well with instrumentation specialist Adam Houk and an experienced hydrographer/water sampler, Meg Yoder. Also helping were two students from Boston College, Emma Brown and Ayden Schirmacher. The water sampling and care of rosette CTD sensors continued to be of better quality than 2020. A. Houk allowed us to use caldip information during the cruise to place microcats on the to-be-deployed moorings, and to eliminate 'bad' microcats. M. Yoder brought care and an exacting method to the oxygen sampling which was a great help.

ELOG definitions, a la OOI:

- Mooring deployment: chains off, splash
- Mooring recovery: release fires, chains up
- Anchor Survey: first position, last position
- CTD: deploy = ctd off deck, bottom=max depth, recover - ctd touches deck

Additional items to bring on/actions to take for next cruise, 2024 version:

1. Get new set of mooring diagrams made with updated year. Can mooring M4 be redesigned without the join in reels at ~1800- and ~2400-m?
2. Drill out bushings on current meter/microcat frames: had to do this during a deployment – bushings could be checked prior to going to sea – or on transit. Watch for this next time.
3. Bring a camera from graphics. Tried this year without success – try harder next time.
4. Spare microcats. Some fail cal-dipping – would be nice to have at least one extra.
5. More plugs for microcats – would be helpful to have a complete set of extras, so can plug ports of recovered instruments before deploying anything. Maybe 10 is a good number?
6. Purchase this jacket for next cruise: https://www.westmarine.com/west-marine-women-s-third-reef-jacket-P019573153.html
7. Get photo card reader: suggest SATECHI SATECHI USB-C ST-UCSMA3M.

Lessons learned in 2024:

1. Releases w/ turn-on switches: put one down to test and it was off. This happened in 2022 also.
2. We used 1000-m and 1500-m (for M4) distances for anchor survey, but let bridge pick locations – this worked very well.

3. Drill out bushings on Aquadopp/Microcat frames – the last of fit held up a mooring deployment.

Items now brought, summary from 2020 & 2022:

1. Hand carry tote (carryall) for tools.
2. Fish totes in which to put instruments coming off of or going onto mooring lines.
3. Scrubbing squares for cleaning instruments and Simple Green.
4. All tools and hardware needed to access instruments and put on/remove from moorings.
5. Matlab/Adobe - check that software can run offline well before leaving dock, 2++ weeks prior.
6. Rain overalls. Big baggy fit-over-pants-and-long-johns things.
7. Triton X, syringe.
8. Anchor survey software! I forgot it. Bring both Weller's and Newhall's.
1. Rite-in-Rain paper and pen.
2. GPS handheld device.
3. Camera from Graphics for documentation.
4. More clipboards.
5. Charting software and knowledge of how to use it (did not get this – relied on Sheri for charting).

Lessons learned prior to 2024:

6. **Clarity.** Be clearer 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 caldips, I am assuming chief sci knows 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.

7. **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.

8. **Acoustic release testing:** make sure that if the power-off type, power on prior to release testing.

9. **Validation CTDs (pre-recover CTDs):** can happen days before recovery, do not need to wait until recovery day.

10. **Fallback** is not the same as distance between target and surveyed anchor position.

11. List method of **calibration CTDs** on waypoints to Chief Sci – 0.5 nm from mooring site.

12. **Anchor survey:** OOI method: 750 m 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 at start of cruise; 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.

13. Remember to ask and record **ship's course and adjusted distance** before deployment begins.

An aside 2024: *The pandemic seemed 'over' – we did no testing prior to or during cruise. We were asked to 'use caution' for 7 days prior to departure. No masks were worn. Also, the bandwidth on the boat is now significantly better – it made a big difference in workflow and ease. Cruise marked by water sampling events: last minute request by Danish/Greenlandic government to get license for genetic testing – water samples falls under this umbrella now. Auto-sal malfunctioned, had to use PortoSal from hold (less accurate, had to hand-transcribe results onto log sheets). CTD winch broke down and had to limit number of CTD casts. Breaking down the SUMO mooring in Prince Christian Sound was not possible: too much ice. At start of cruise icebergs thick around mooring M1 – a function of an early season cruise.*

Scavenger hunt and haiku contest were a good distraction – it felt like a long cruise with a lot of down time, exacerbated by all gray and 41F and raw. Seeing a blue whale up close was an amazing highlight. Life goals.

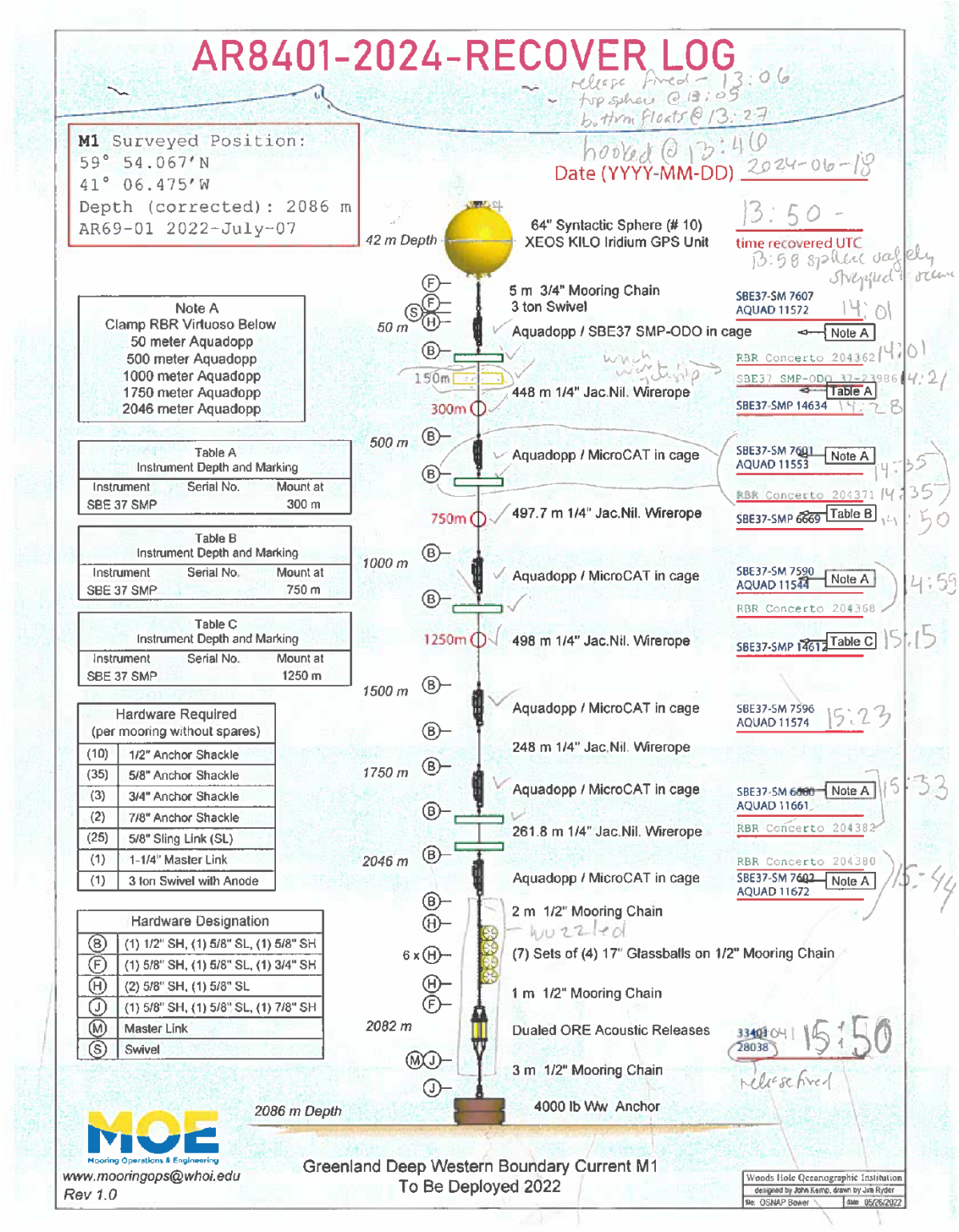
Appendix A: Work performed for both OOI and OSNAP.

Days-at-Sea at start of operation	Hour of day at start of operation **LOCAL TIME**	Operation	Date
1	0930	Ship docked at WHOI, board boat.	02 JUN, Sunday
1	1000	Science meeting w/ SSSGs and Chief Mate.	
1	1202	Lines cast.	
1	1500-1600	Fire and safety drills.	
1	1900	**CTD#001:** on shelf in US waters CTD to test altimeter, acquisition system, sampling.	
2		Transit	03 JUN, Monday
3		Transit	04 JUN, Tuesday
4		Time change from GMT-4hrs to GMT-3hrs.	05 JUN, Wednesday
4		Transit	
5		Transit	06 JUN, Thursday
6		Steam to SUMO site.	07 JUN, Friday
6	0930	**CTD#002**, 2000m, 3 OOI releases	
6	1200	**Water sampling license granted.**	
7		Transit	08 JUN, Saturday
8	0000	Time change from GMT-3hrs to GMT-2hrs.	09 JUN, Sunday
8	0000	Transit to SUMO site.	
8	1253	**Deploy SUMO**	
9	0751	**CTD#003**, 3 OOI acoustic releases.	10 JUN, Monday
9	1112	**CTD#004**, 3 OOI acoustic releases, 8 OOI CTDMOs, 6 OSNAP microcats.	
10	0701	**CTD#005**, SUMO cast, 1 OOI release, 2 OSNAP releases. One OSNAP release not enabled prior to launch.	11 JUN, Tuesday

10	1305	**Deploy HYPM**	
10	1600	**CTD#006**, BGC cast@SUMO	
11	0802	Deploy two gliders.	12 JUN, Wednesday
	0838	**CTD #007**, glider cast	
11	1023, 1058	Recover two gliders (one that was just deployed, and one that had been in water a year)	
11		*Run from weather to north*	
11	1419	**CTD #008**, OSNAP calibration cast: 3 releases, 5 optodes, 18 microcats	
12		*Hove to due to weather*	13 JUN, Thursday
12	1348	**CTD #009**@M4, 3 OSNAP releases, 7 microcats	
13	0809	**Deploy FLMA**	14 JUN, Friday
13	1419	**CTD#010**@FLMA w/ 1 OSNAP releases	
13	1650	Anchor survey FLMA	
13	1907	**CTD#011**@FLMA for BGC	
14	0756	**Deploy FLMB**	15 JUN, Saturday
14	1348	**CTD#012**@FLMB	
14	1620	Anchor survey FLMB	
15	0804	**Recover SUMO**	16 JUN, Sunday
15	1813	Glider deploy	
16	0801	**CTD#014**@M1 validation	17 JUN, Monday
16	1228	**CTD#015**@M2 validation	
16	1624	**CTD#016**@M3 validation, CTD winch broke during cast	
17	0600	**Recover M3**	18 JUN, Tuesday
17	0935	**Recover M2**	
17	1306	**Recover M1**	
18	0804	**Recover FLMB**	19 JUN, Wednesday
18	1229	**CTD#017**@FLMA, OSNAP caldip cast	
18	1229	Rebuild M1 Sphere	
19	0816	**Deploy M1**	20 JUN, Thursday
19	1151	Anchor survey M1	
19	1441	**Deploy M2**	
19	1803	Anchor survey M2	
20	0808	**Deploy M3**	21 JUN, Friday
20	1125	Anchor survey M3	
21	0805	Anchor survey SUMO	22 JUN, Saturday

21		Waited out storm w/ OOI data downloads	
22	0800	Anchor survey HYPM	
22	0915	**CTD#018**@FLMA, OSNAP caldip	23 JUN, Sunday
23	0828	Hove to. Nothing to do since cannot do mooring ops and cannot spare CTD casts.	24 JUN, Monday
24	0806	**Recover HYPM**	25 JUN, Tuesday
	1254	**Recover top of FLMA**	
25	0756	**Recover M4**	26 JUN, Wednesday
	1225	**Deploy M4**	
	1518	Anchor survey M4	
26	0806	**Recover bottom of FLMA**	27 JUN, Thursday
27		**CTD#019**, OOI & OSNAP caldip	28 JUN, Friday
		Transit	
28		Transit	29 JUN, Saturday
29		Transit	30 JUN, Sunday
30			01 JUL, Monday
31			02 JUL, Tuesday

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



AR8401-2024-RECOVER LOG

fired 33042 @ 09:34
surfaced @ 09:44
hooked @ 09:51
bottom floats @ never saw them !! 10:36

M2 Surveyed Position:
59° 51.622′ N
40° 41.415′ W
Depth (corrected): 2423 m
AR69-01 2022-July-11

Date (YYYY-MM-DD) 2024-06-18

second mooring of day

got hits ✓

950 m Depth — 3 Ball Radio Float with Xeos Apollo — 09:57 time recovered UTC

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

5 x (A) — (6) Sets of (4) 17" Glassballs on 3/8" Mooring Chain

(A)

20 m 3/16" Jac.Nil. Wirerope

1000 m (B) (B) — Aquadopp / MicroCAT in cage — SBE37-SM 5921, AQUAD 11555 — 10:06

1250m — 497.4 m 3/16" Jac.Nil. Wirerope — SBE37-SMP 14635 — Table A — 10:15

1500 m (B) (B) — Aquadopp / MicroCAT in cage — SBE37-SM 6056, AQUAD 11647 — Note A — 10:21

1750m — 497.4 m 3/16" Jac.Nil. Wirerope — RBR Concerto 204381 — Table B — SBE37-SMP 14599 — 10:31

2000 m (B) (B) — Aquadopp / MicroCAT in cage — SBE37-SM 7585, AQUAD 11575 — 10:38

189.1 m 3/16" Jac.Nil. Wirerope

2191 m (B) (B) — Aquadopp / MicroCAT in cage — SBE37-SM 7588, AQUAD 11660 — Note A — 10:48 — RBR Concerto 204369 — 12:18

190 m 3/16" Jac.Nil. Wirerope — whales!! by BLUEWHALE!

2383 m (B) (B) — Aquadopp / MicroCAT in cage — SBE37-SM 7597, AQUAD 11642 — Note A — RBR Concerto 204378 — 10:56

16.7 m 3/16" Jac.Nil. Wirerope

(A) — nuzzled

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

(A) (C) — 5 m 3/8" Mooring Chain

2417 m — Dualed ORE Acoustic Releases — 33042, 33412 — 11:05 — release this one

(M) (J) — 5 m 3/8" Mooring Chain

(J) — 2333 lb Ww Anchor

2423m Depth

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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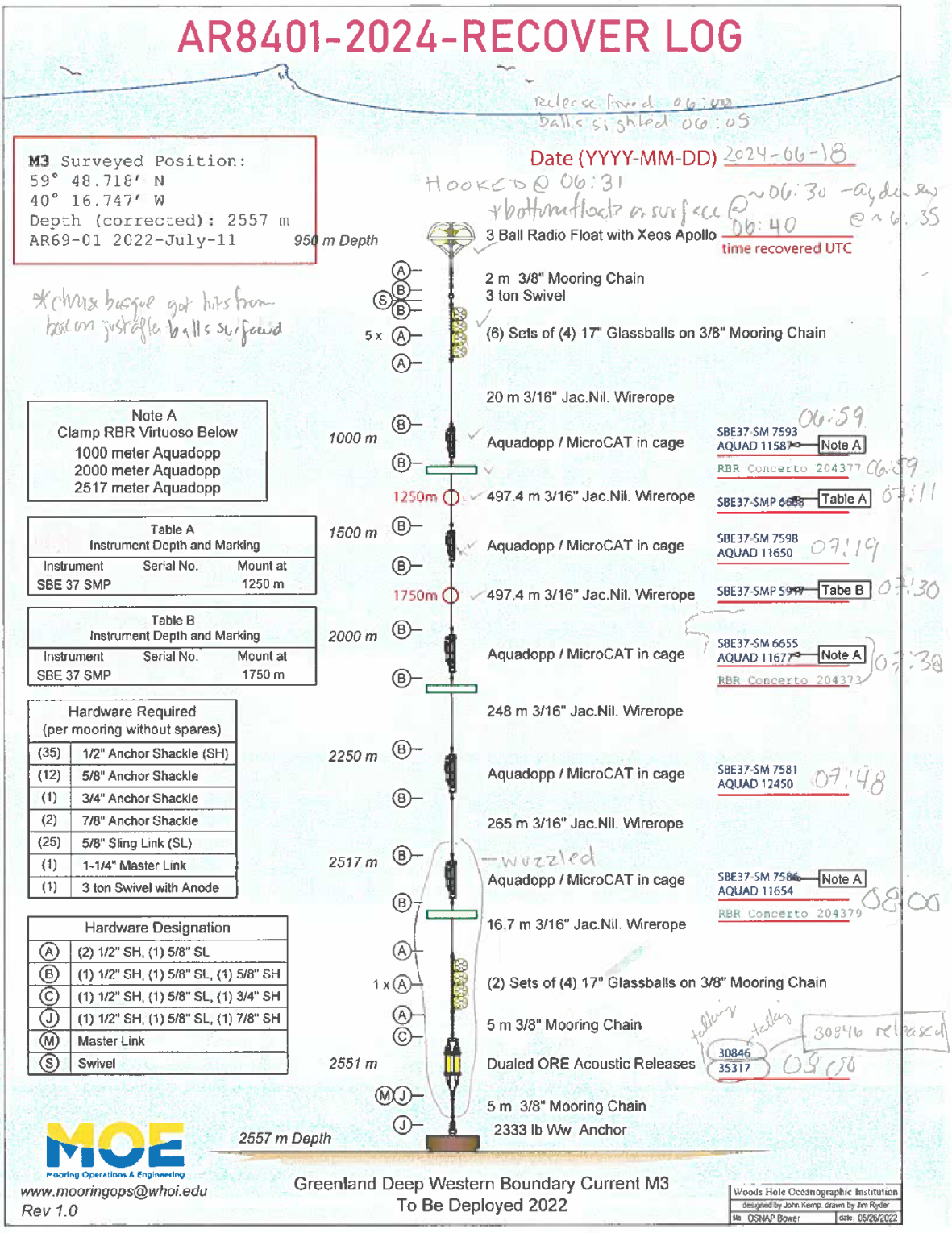
Greenland Deep Western Boundary Current M2
To Be Deployed 2022

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

AR8401-2024-RECOVER LOG



*chris bosque got hits from beacon just after balls surfaced

AR8401-2024-RECOVER LOG

14 min for surf ack
in 2022

release freed: 0756 715' ΔT
top floats: 0809
bottom floats: 0827] 18' ΔT

M4 Surveyed Position:
59° 38.778′ N
38° 33.925′ W
Depth (corrected): 2984 m
AR69-01 2022-July-04

1455 m Depth

wurzle

Date (YYYY-MM-DD) wednesday 2024-06-26

got a hit after recovery.

3 Ball Radio Float with Xeos Apollo — 08:40 time recovered UTC

2 m 3/8" Mooring Chain
3 ton Swivel

0840

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

20 m 3/16" Jac.Nil. Wirerope

1500 m — Aquadopp / MicroCAT in cage — SBE37-SM 7587 AQUAD 11560 08:50

Good feed transfer

1750m — 346.7 m 3/16" Jac.Nil. Wirerope — 09:14 SBE37-SMP 11527 ← Table A

2000m — 400 m 3/16" Jac.Nil. Wirerope — 09:27 SBE37-SMP 7580 ← Table B

2250 m — Aquadopp / MicroCAT in cage — SBE37-SM 6664 AQUAD 11645 09:35

191.9 m 3/16" Jac.Nil. Wirerope

2500m — 09:55 SBE37-SMP 8417

2750m — 500 m 3/16" Jac.Nil. Wirerope — 10:03 SBE37-SMP 13215 ← Table C

2945 m — Aquadopp / MicroCAT in cage — SBE37-SM 7592 AQUAD 11551 10:10

16.8 m 3/16" Jac.Nil. Wirerope

wurzle

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

5 m 3/8" Mooring Chain

2979 m — Dualed ORE Acoustic Releases 32479 31335 10:15

popped 09:56 local

5 m 3/8" Mooring Chain

2333 lb Ww Anchor

2985 m Depth

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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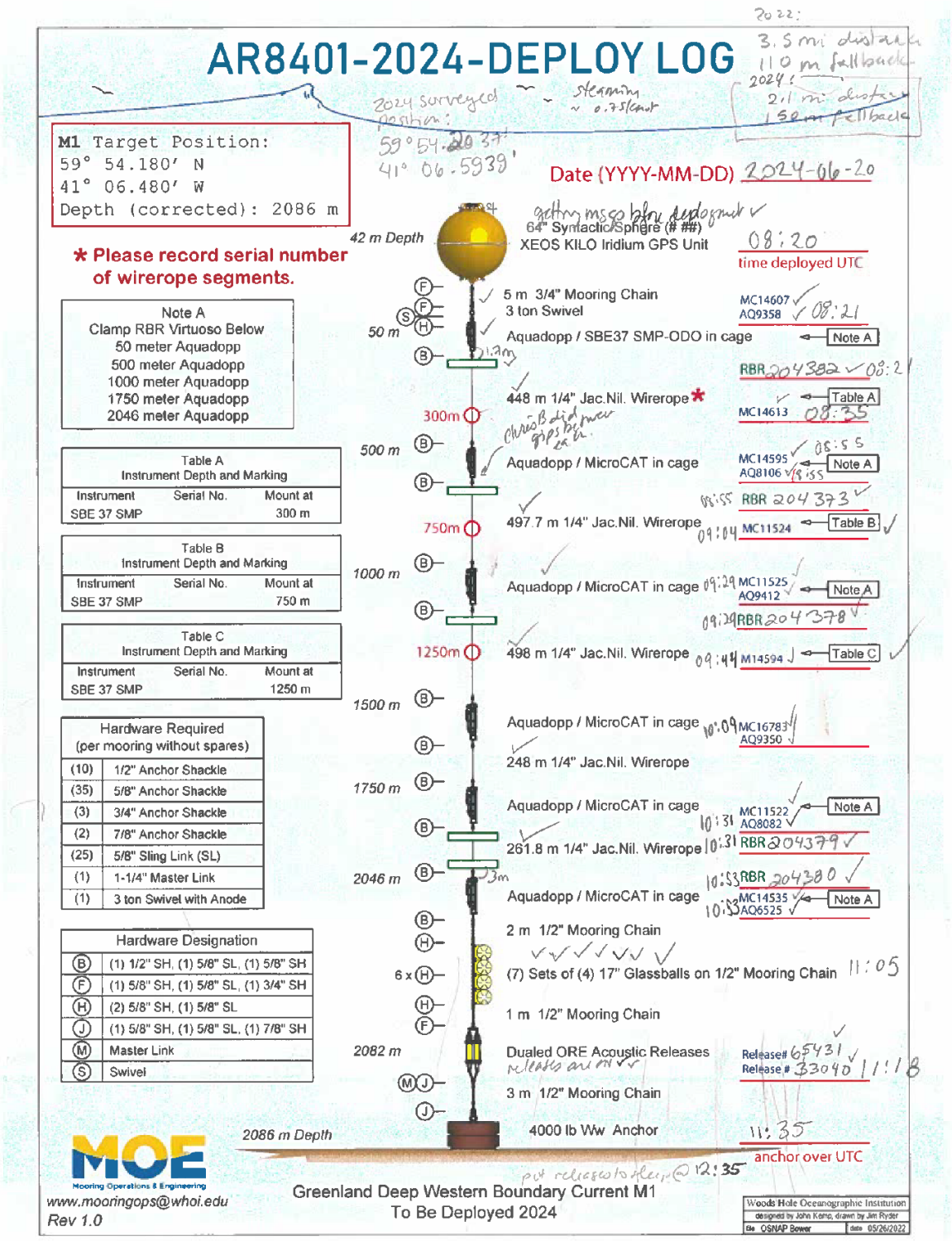
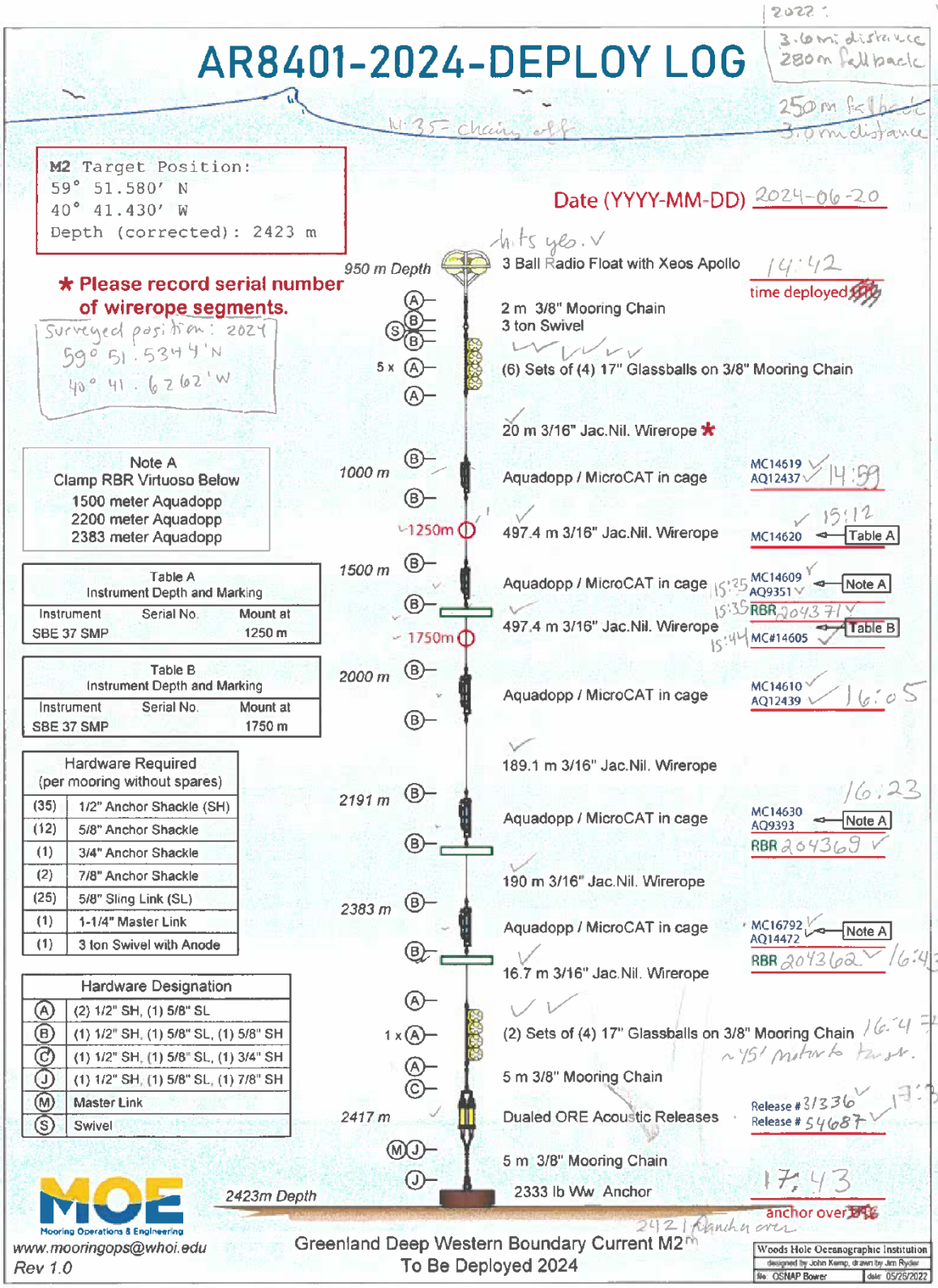
Greenland Deep Western Boundary Current M4
To Be Deployed 2022

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

Appendix C: Mooring deployment diagrams for moorings M1-M4. Chris Basque/MOE has the IMEI/SN information for the XEOS beacons.




AR8401-2024-DEPLOY LOG
2022:
3.6mi distance
280m fallback
250m fallback
3.0mi distance
W: 35 = chain off
M2 Target Position:
59° 51.580' N
40° 41.430' W
Depth (corrected): 2423 m
Date (YYYY-MM-DD) 2024-06-20
hits yes.
* Please record serial number of wirerope segments.
Surveyed position: 2024
59° 51.5344'N
40° 41.6262'W
950 m Depth
3 Ball Radio Float with Xeos Apollo
14:42
time deployed
2 m 3/8" Mooring Chain
3 ton Swivel
5 x
(6) Sets of (4) 17" Glassballs on 3/8" Mooring Chain
20 m 3/16" Jac.Nil. Wirerope *
Note A
Clamp RBR Virtuoso Below
1500 meter Aquadopp
2200 meter Aquadopp
2383 meter Aquadopp
1000 m
Aquadopp / MicroCAT in cage
MC14619
AQ12437
14:59
1250m
497.4 m 3/16" Jac.Nil. Wirerope
15:12
MC14620
Table A
1500 m
Aquadopp / MicroCAT in cage
15:25
MC14609
AQ9351
Note A
15:35
RBR 204371
497.4 m 3/16" Jac.Nil. Wirerope
15:44
MC#14605
Table B
1750m
2000 m
Aquadopp / MicroCAT in cage
MC14610
AQ12439
16:05
189.1 m 3/16" Jac.Nil. Wirerope
2191 m
Aquadopp / MicroCAT in cage
16:23
MC14630
AQ9393
Note A
RBR 204369
190 m 3/16" Jac.Nil. Wirerope
2383 m
Aquadopp / MicroCAT in cage
MC16792
AQ14472
Note A
RBR 204362
16:43
16.7 m 3/16" Jac.Nil. Wirerope
1 x
(2) Sets of (4) 17" Glassballs on 3/8" Mooring Chain
16:47
~45' Motor to tow.
5 m 3/8" Mooring Chain
2417 m
Dualed ORE Acoustic Releases
17:35
Release # 31336
Release # 54687
5 m 3/8" Mooring Chain
2333 lb Ww Anchor
17:43
anchor over
2423m Depth
2421 Anchor over
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 2024
Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder
file: OSNAP Bower
date: 05/26/2022

AR8401-2024-DEPLOY LOG

M3 Target Position:
59° 48.870′ N
40° 16.630′ W
Depth (corrected): 2557 m

Date (YYYY-MM-DD) 2024-06-21

2024 surveyed location:
59° 48.912′
40° 16.746′

950 m Depth

3 Ball Radio Float with Xeos Apollo — 08:23 time deployed local

2 m 3/8" Mooring Chain
3 ton Swivel
(6) Sets of (4) 17" Glassballs on 3/8" Mooring Chain — 08:28
20 m 3/16" Jac.Nil. Wirerope

1000 m — Aquadopp / MicroCAT in cage — MC14611, AQ12481, RBR 204377 — Note A
497.4 m 3/16" Jac.Nil. Wirerope
1250m — MC11526 — Table A

1500 m — Aquadopp / MicroCAT in cage — MC14600, AQ9401
497.4 m 3/16" Jac.Nil. Wirerope
1750m — MC14614 — Tabe B

2000 m — Aquadopp / MicroCAT in cage — MC16768, AQ14476, RBR204368 — Note A
248 m 3/16" Jac.Nil. Wirerope

2250 m — Aquadopp / MicroCAT in cage — MC16805, AQ9330
265 m 3/16" Jac.Nil. Wirerope

2517 m — Aquadopp / MicroCAT in cage — MC16798, AQ9369, RBR 204381 — Note A
16.7 m 3/16" Jac.Nil. Wirerope

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

2551 m — Dualed ORE Acoustic Releases — Release 6542, Release 5549
[2.3 m/sec descent rate]
5 m 3/8" Mooring Chain
2333 lb Ww Anchor — 11:11:30 anchor over local — 11:20 on bottom

2557 m Depth

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

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Greenland Deep Western Boundary Current M3
To Be Deployed 2024

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

AR8401-2024-DEPLOY LOG

2020 fallback: 240m
2022 fallback: 250m
3.5m distance

TIME "SUNK COST FALLACY"

2022: 2hr 45min deploy

2.75 miles
250 m fallback

M4 Target Position:
59° 38.760′ N
38° 33.990′ W
Depth (corrected): 2984 m

Date (YYYY-MM-DD) 2024-06-

"Wing rail weights"

1455 m Depth

got hits - confirmed

3 Ball Radio Float with Xeos Apollo 12:25
time deployed local

2 m 3/8" Mooring Chain
3 ton Swivel

12:32

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

20 m 3/16" Jac.Nil. Wirerope

+ pre-drilled bushings prior to start

2024 surveyed location:
59° 38.777′
38° 33.893′

1500 m Aquadopp / MicroCAT in cage
MC14551
AQ8039 12:37

346.7 m 3/16" Jac.Nil. Wirerope

1750m MC14552 12:52 Table A

why?

2000m 400 m 3/16" Jac.Nil. Wirerope
MC14602 13:10 Table B

2250 m Aquadopp / MicroCAT in cage
MC6669 - refurbished at sea
AQ9362 13:30

191.9 m 3/16" Jac.Nil. Wirerope

why?

2500m
MC11523 13:49

2750m 500 m 3/16" Jac.Nil. Wirerope
MC14616 13:56 Table C

2945 m Aquadopp / MicroCAT in cage
MC14553
AQ6730 14:16 14:18

16.8 m 3/16" Jac.Nil. Wirerope

14:23

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

5 m 3/8" Mooring Chain

2979 m Dualed ORE Acoustic Releases
Release 31267
Release 65424 14:52

5 m 3/8" Mooring Chain

2985 m Depth 2333 lb Ww Anchor

15:05 → 15:27 on bottom
anchor over local depth: 2985 ΔT = 22min

2979m depth over target in 2024

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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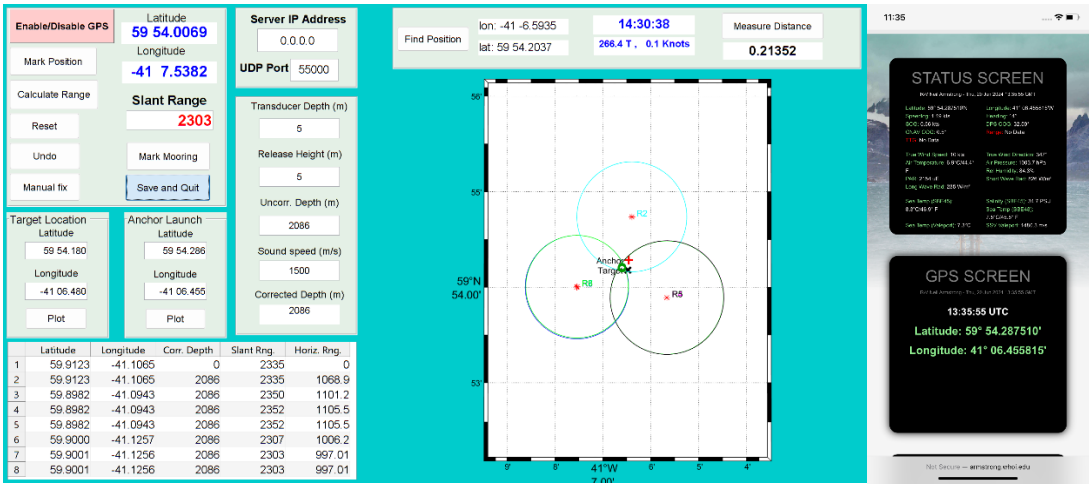
Greenland Deep Western Boundary Current M4
To Be Deployed 2024
1485

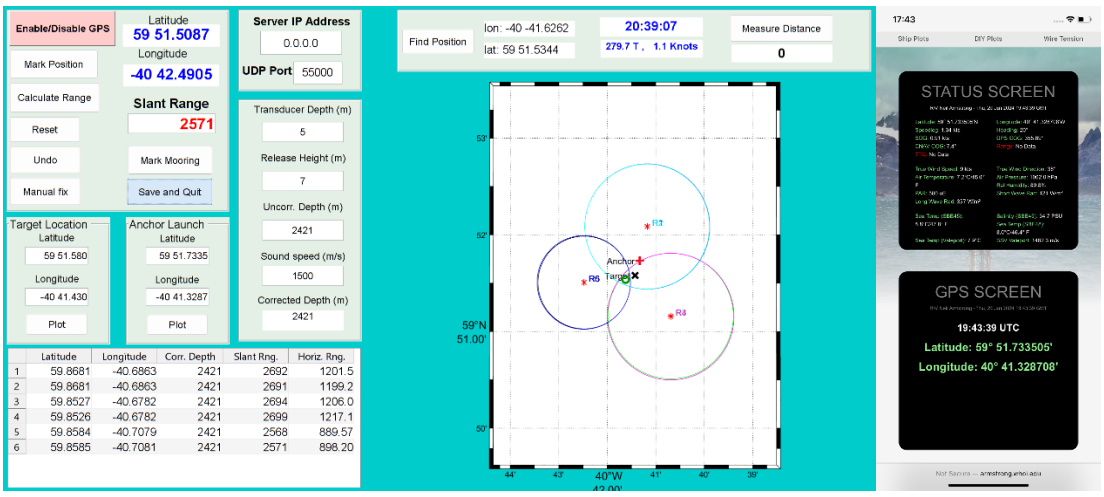
Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder
file OSNAP Bower date 05/26/2022

Appendix D. Mooring Anchor Survey Information. Adam does not use *in situ* sound speed (except in M4 example where sound speed of 1485 was entered into deck box *a priori*), but locates center of triangle created by three range circles. Ranges were found 1000-m from anchor drop for M1- M3, and 1500-m for M4, as water depth was deeper at that site. Survey results were given to bridge after calculation. Input data for Houk method are saved with cruise data.

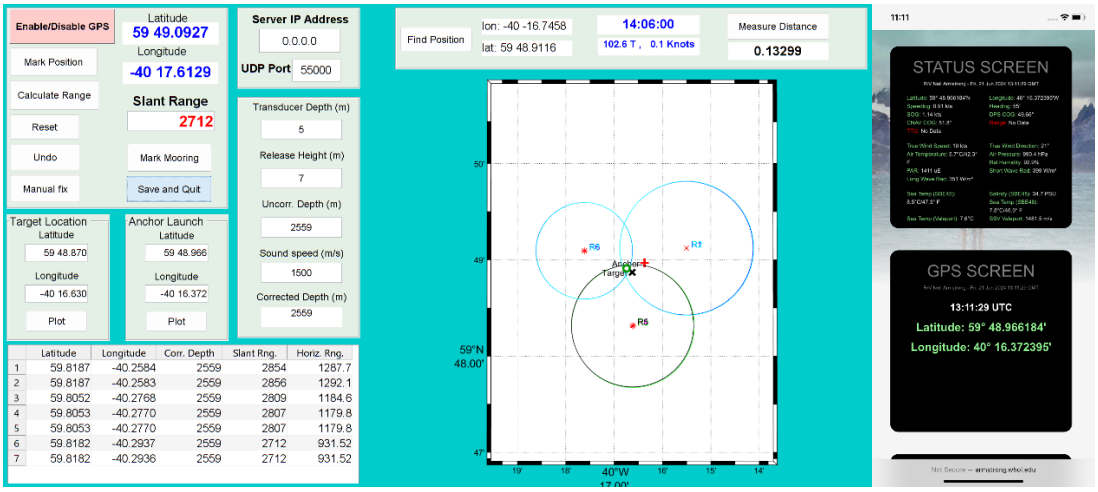
M1:



M2:

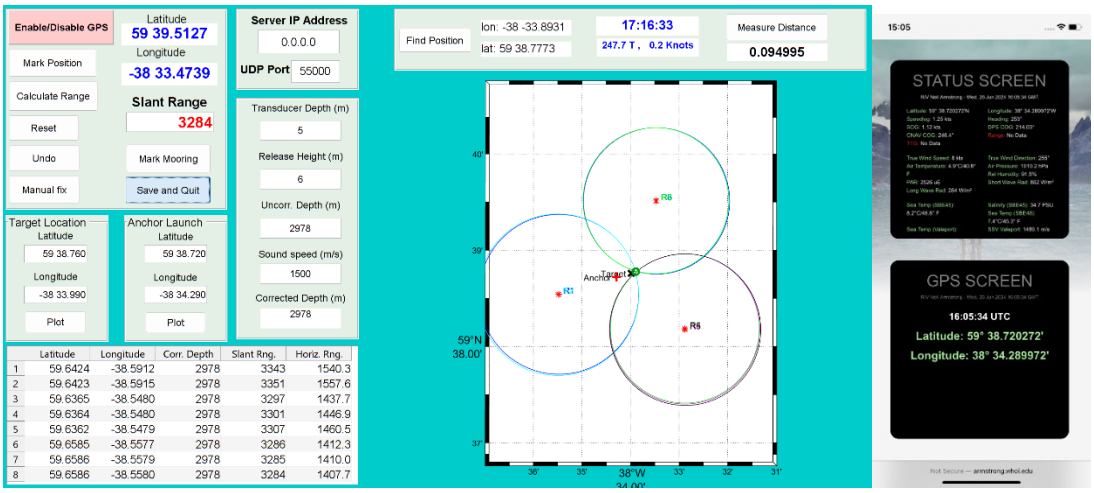


M3:



	Latitude	Longitude	Corr. Depth	Slant Rng.	Horiz. Rng.
1	59.8187	-40.2584	2559	2854	1287.7
2	59.8187	-40.2583	2559	2856	1292.1
3	59.8052	-40.2768	2559	2809	1184.6
4	59.8053	-40.2770	2559	2807	1179.8
5	59.8053	-40.2770	2559	2807	1179.8
6	59.8182	-40.2937	2559	2712	931.52
7	59.8182	-40.2936	2559	2712	931.52

M4:



	Latitude	Longitude	Corr. Depth	Slant Rng.	Horiz. Rng.
1	59.6424	-38.5912	2978	3343	1540.3
2	59.6423	-38.5915	2978	3351	1557.6
3	59.6365	-38.5480	2978	3297	1437.7
4	59.6364	-38.5480	2978	3301	1446.9
5	59.6362	-38.5479	2978	3307	1460.5
6	59.6585	-38.5577	2978	3286	1412.3
7	59.6586	-38.5579	2978	3285	1410.0
8	59.6586	-38.5580	2978	3284	1407.7

Appendix E: Recovered instrument summary.

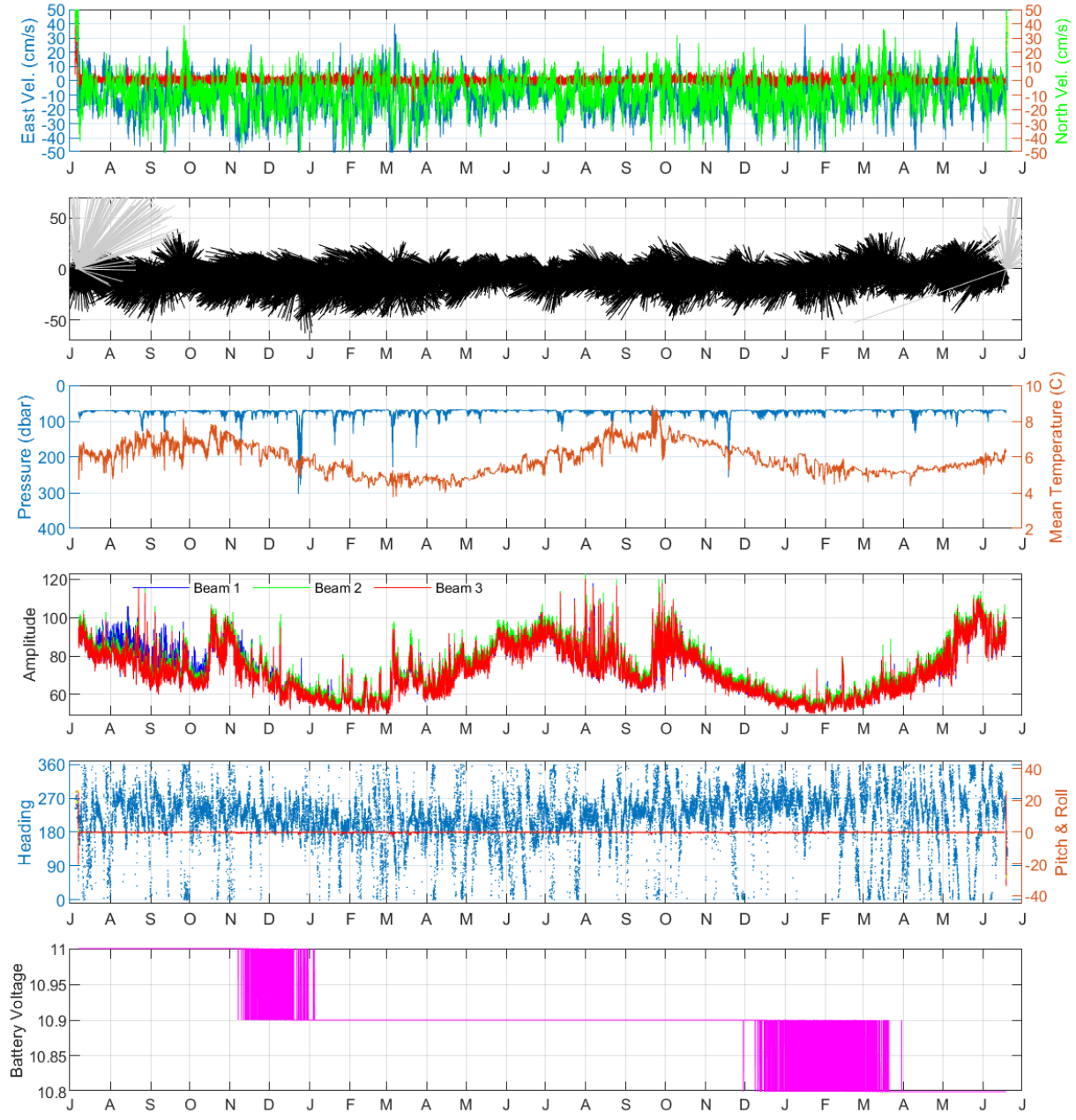
All instrument worked as designed and reported full data sets. On some plots, data is reported as 99% good; A. Houk states this should be considered essentially 100% good. Table below reflects this. Apparent depth is estimated from plots in Appendix F. Plots of each microcat and current meter instrument output 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	75	AQD11572	100%	100%	Not applicable (n/a)	
		500	525	AQD11553	100%	100%	n/a	
		1000	1025	AQD11544	100	100	n/a	
		1500	1550	AQD11574	100	100	n/a	Battery voltage dropped at end of record
		1750	1810	AQD11661	100	100	n/a	
		2055	2085	AQD11672	100	100	n/a	
	Seabird SBE37-SM or SBE37-SMP	50	80	7607	100	100	yes	
		150	175	23986	100	100	yes	Le Bras SMP-ODO
		300	330	14634	100	100	yes	
		500	530	7601	100	100	yes	
		750	780	6669	100	100	yes	turned
		1000	1045	7590	100	100	yes	
		1250	1305	14612	100	100	yes	
		1500	1550	7596	100	100	Yes	
		1750	1805	6660	100	100	yes	
		2046	2078	7602	100	100	yes	
	RBR Concerto or SMP-ODO	50	n/a	204362	100	100	yes	redeployed
		150	175	23986	100		yes	not redeployed
		500	n/a	204371	100	100	yes	redeployed
		1000	n/a	204368	100	100	yes	redeployed
		1750	n/a	204382	100	100	yes	redeployed
		2046	n/a	204380	100	100	yes	redeployed
	Edgetech ARs	Releases 33401 and 28038 recovered.						
M2	Aquadopp Current Meter	1000	1020	AQD11555	100	100	n/a	
		1500	1525	AQD11647	100	100	n/a	Battery voltage dropped at end of record

		2000	2030	AQD11575	100	100	n/a	
		2191	2230	AQD11660	100	100	n/a	
		2383	2425	AQD11642	100	100	n/a	
	Seabird SBE37-SM or SBE37-SMP	1000	1020	5921	100	100	yes	
		1250	1270	14635	100	100	yes	
		1500	1535	6056	100	100	yes	
		1750	1780	14599	100	100	yes	
		2000	2030	7585	100	100	yes	
		2191	2230	7588	100	100	yes	
		2383	2425	7597	100	100	yes	
	RBR Concerto	1500	n/a	204381	100	100	yes	redeployed
		2191	n/a	204369	100	100	yes	redeployed
		2383	n/a	204378	100	100	yes	redeployed
	Edgetech ARs	Releases 33042 and 33412 recovered.						
M3	Aquadopp Current Meter	1000	1005	11587	100	100	n/a	
		1500	1530	11650	100	100	n/a	
		2000	2030	11677	100	100	n/a	
		2250	2273	12450	100	100	n/a	
		2517	2566	11654	100	100	n/a	
	Seabird SBE37-SM or SBE37-SMP	1000	1010	7593	100	100	yes	
		1250	1270	6668	100	100	yes	
		1500	1525	7589	100	100	yes	
		1750	1780	5917	100	100	yes	
		2000	2035	6655	100	100	yes	
		2250	2290	7581	100	100	yes	
		2517	2565	7586	100	100	yes	
	RBR Concerto	1500	n/a	204377	100	100	yes	redeployed
		2191	n/a	204373	100	100	yes	redeployed
		2383	n/a	204379	100	100	yes	redeployed
	Edgetech ARs	Releases 30846 and 35317 recovered.						
M4	Aquadopp Current Meter	1500	1520	11560	100	100	n/a	
		2250	2290	11645	100	100	n/a	
		2945	2995	11551	100	100	n/a	
	Seabird SBE37-SM or SBE37-SMP	1500	1520	7587	100	100	Yes	
		1750	1775	11527	100	100	Yes	
		2000	2030	7580	100	100	Yes	
		2250	2285	6664	100	100	Yes	
		2500	2542	8417	100	100	yes	
		2750	2800	13215	100	100	yes	
		2945	3002	7592	100	100	Yes	
	RBR Concerto	No optodes on M4.						
	Edgetech ARs	Releases 32479 and 31335 recovered.						
FLMA-10 (2023-2024)	Seabird SBE37-SMP (IMs)	1000m from bottom	n/a	37-10265	100	100	Yes	
		700m “”	n/a	37-12220	100	100	Yes	
		400m “”	n/a	37-12226	100	100	Yes	
		100m “”	n/a	37-12395	100	100	Yes	

FLMB-10 (2023-2024)	Seabird SBE37-SMP (IMs)	1000m “”	n/a	37-12387	100	100	Yes	
		700m “”	n/a	37-13632	100	100	Yes	
		400m “”	n/a	37-13448	100	100	Yes	
		100m “”	n/a	37-11597	100	100	Yes	

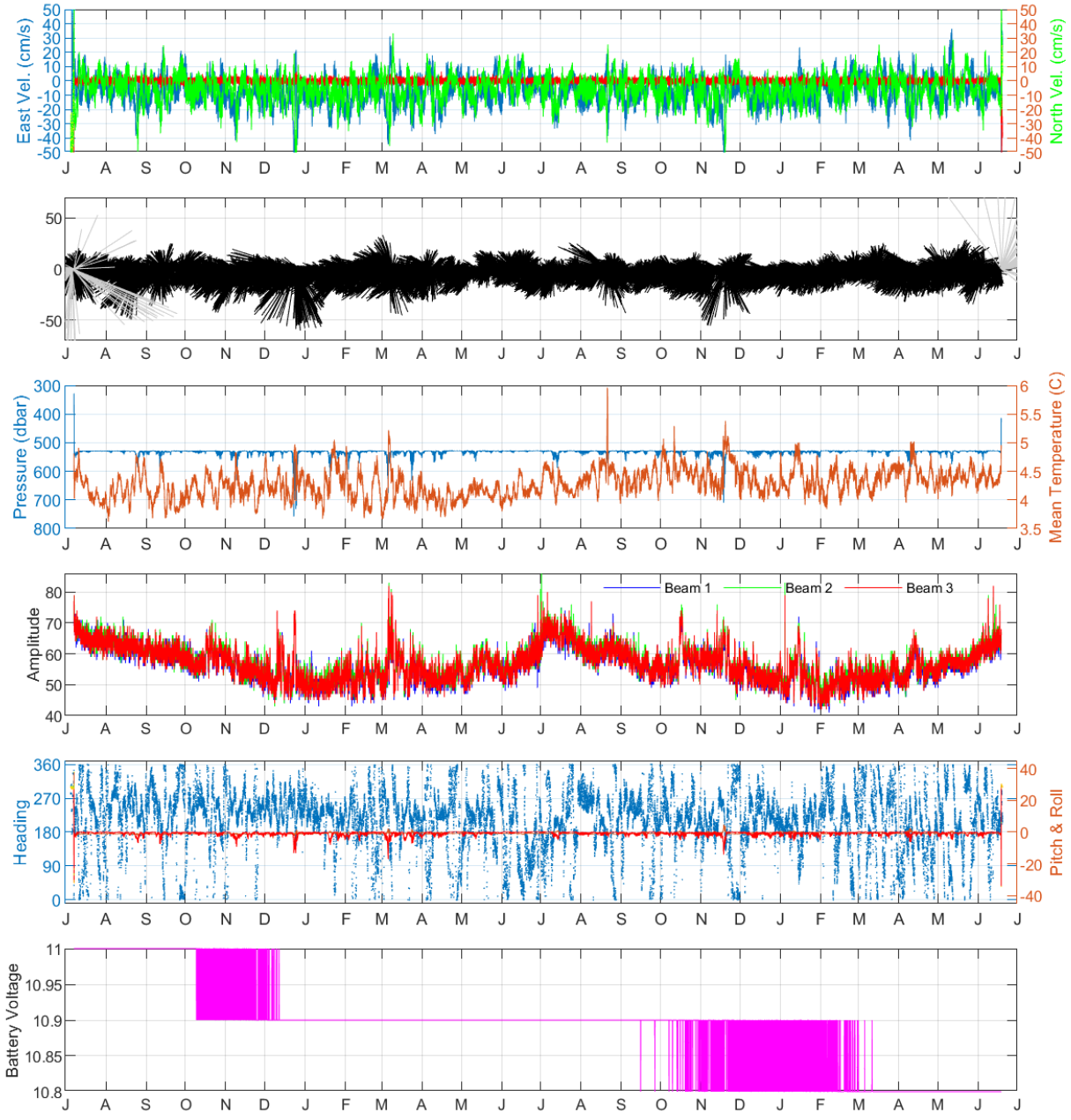
Appendix F: Recovered Instrument Data Records. All figures are of uncalibrated data. Instrument data record plots organized by mooring, with plots showing current meter, then microcat, records, with each instrument type organized by depth. Optode data are not plotted. However, the SMP-ODO s/n23986 (owned by Isabela Le Bras) CTD data are plotted and included with the other microcats, plot '1a'.



M1-01

Percentage good data: 99%

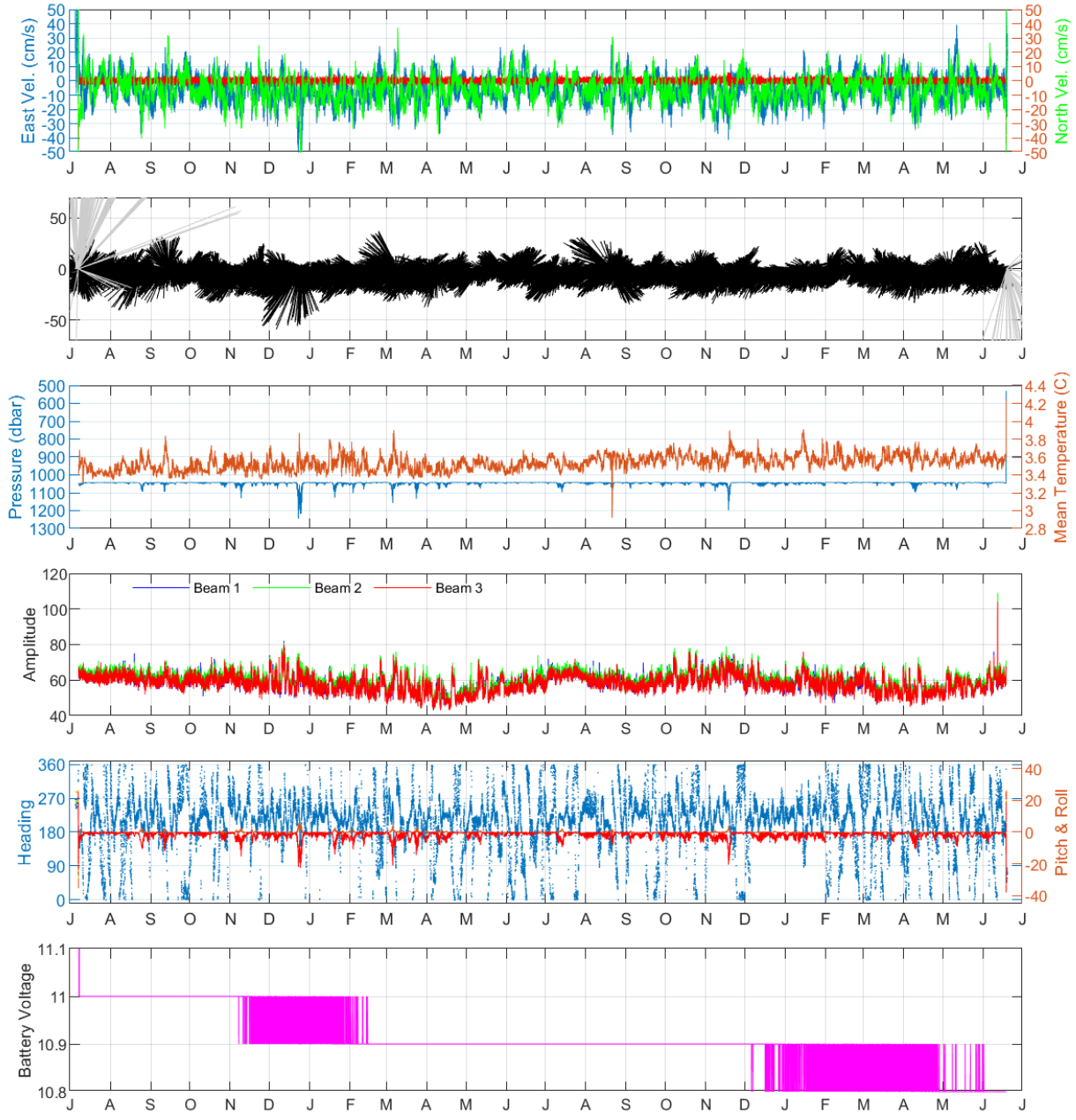
Number of measurements	34353	Serial number	AQD11572
Time of first measurement	7/5/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 16:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M1-03

Percentage good data: 100%

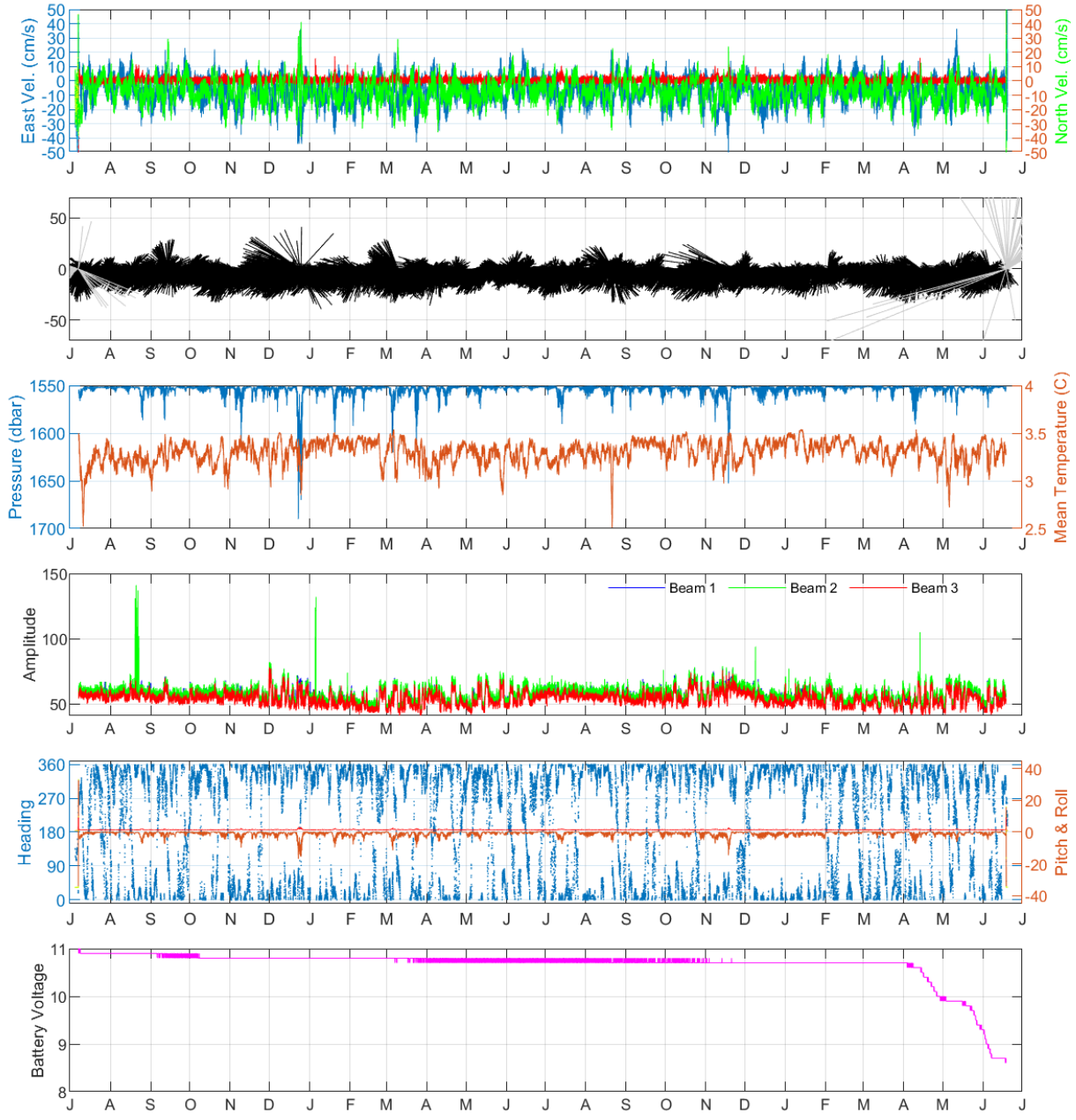
Number of measurements	34353	Serial number	AQD11553
Time of first measurement	7/5/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 16:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M1-05

Percentage good data: 100%

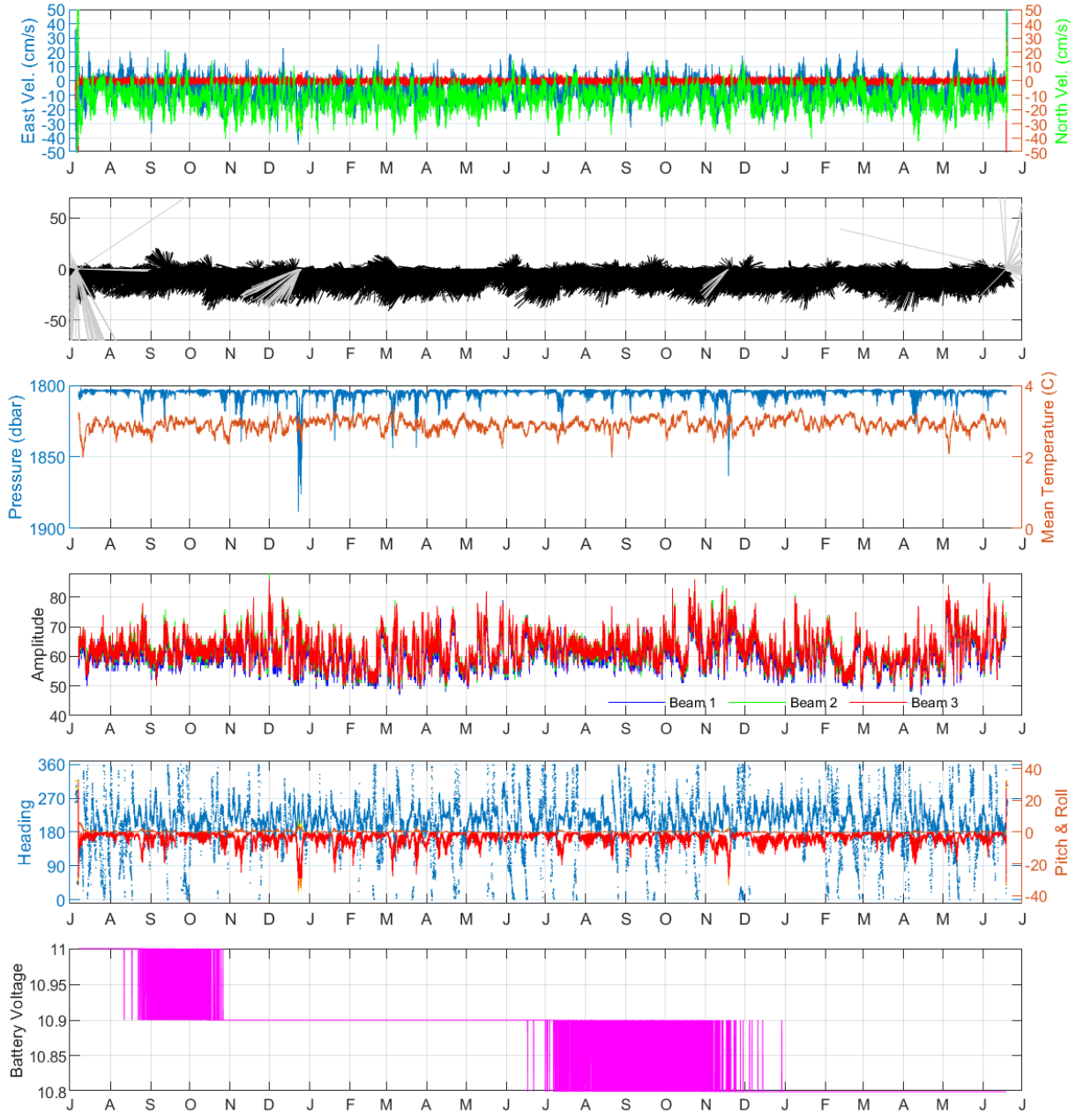
Number of measurements	34351	Serial number	AQD11544
Time of first measurement	7/5/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 15:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M1-07

Percentage good data: 99%

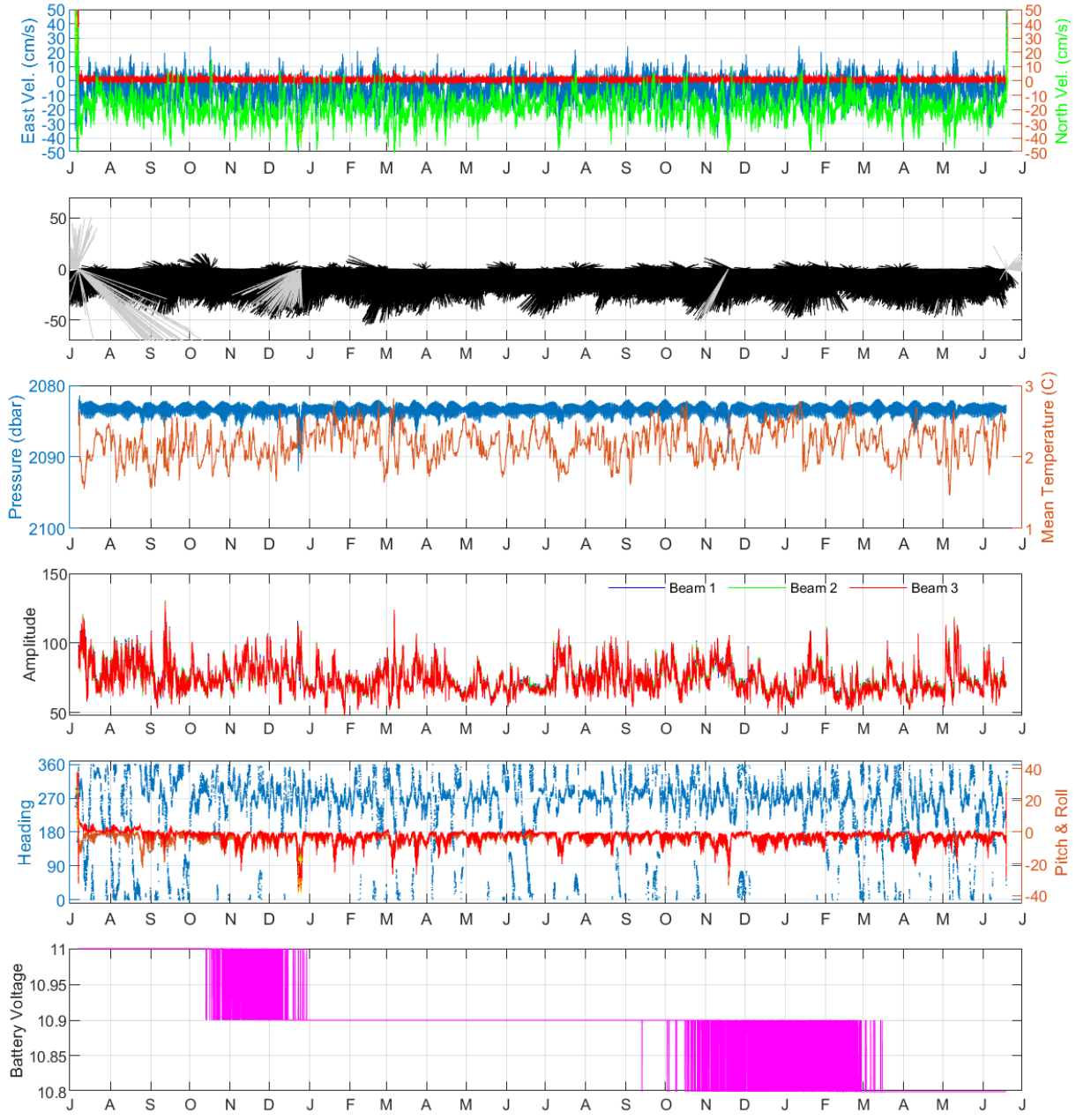
Number of measurements	34353	Serial number	AQD11574
Time of first measurement	7/5/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 16:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M1-08

Percentage good data: 99%

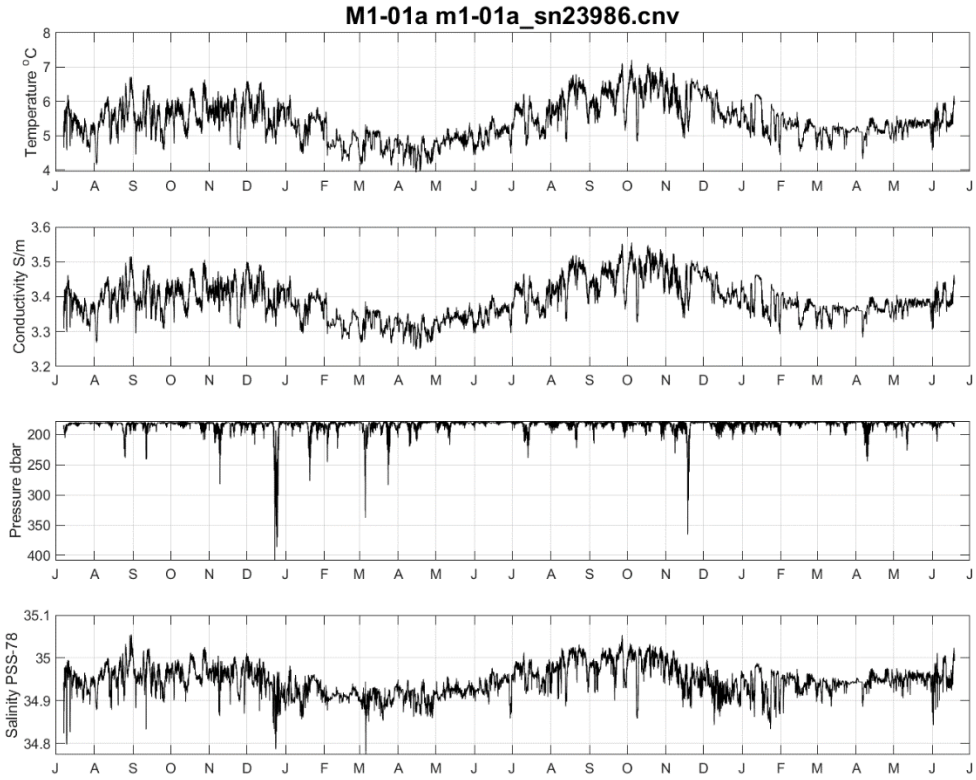
Number of measurements	34353	Serial number	AQD11661
Time of first measurement	7/5/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 16:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

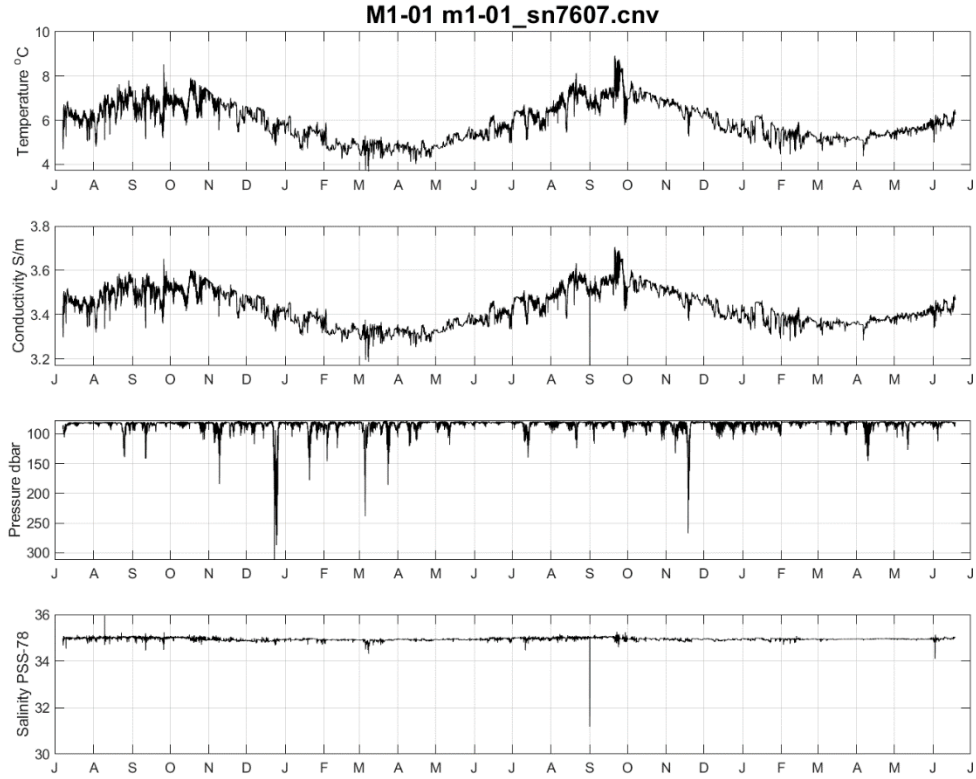


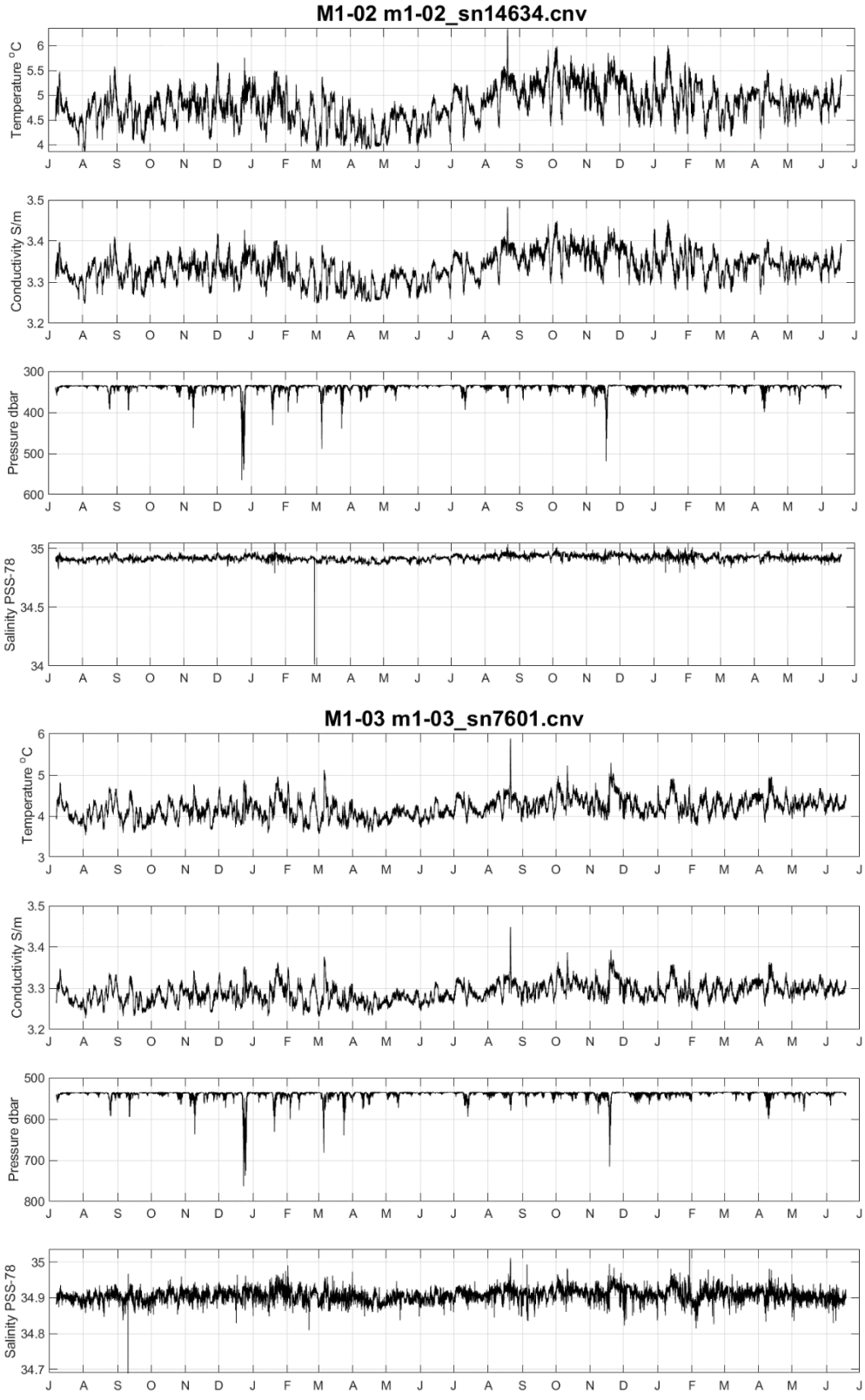
M1-09

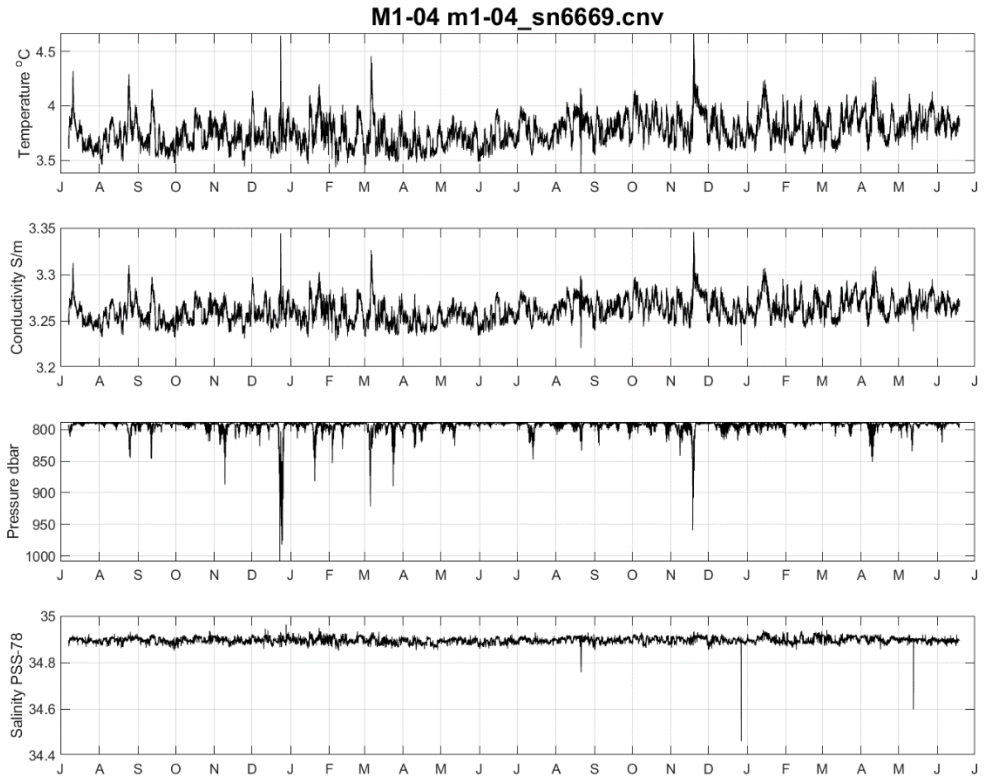
Percentage good data: 99%

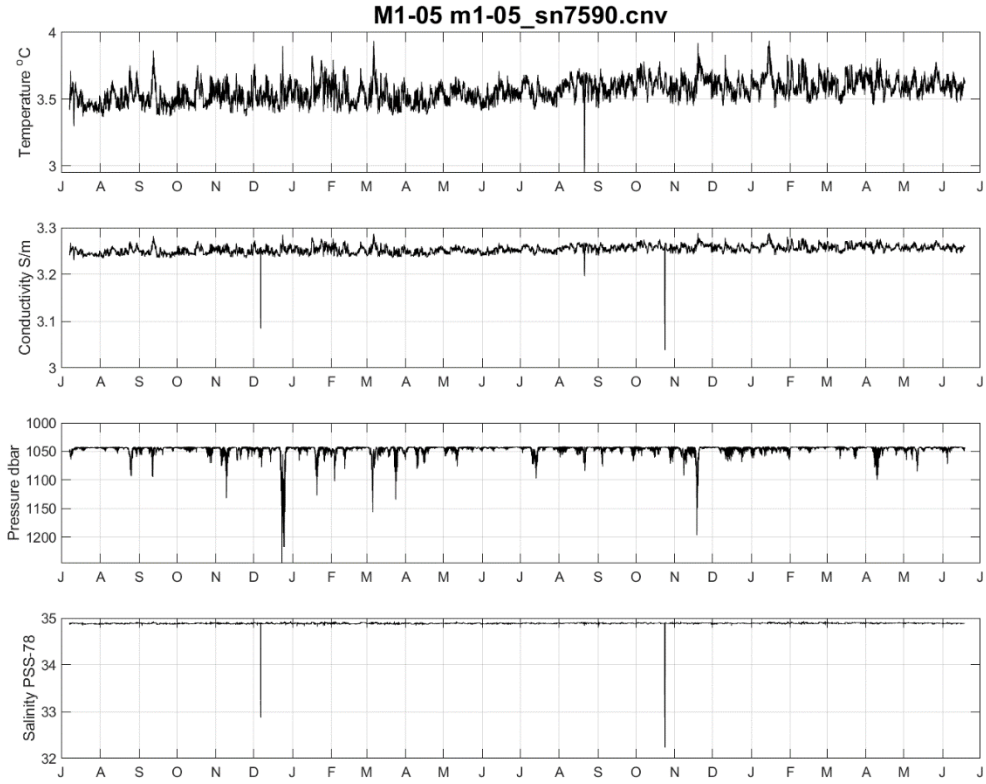
Number of measurements	34351	Serial number	AQD11672
Time of first measurement	7/5/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 15:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

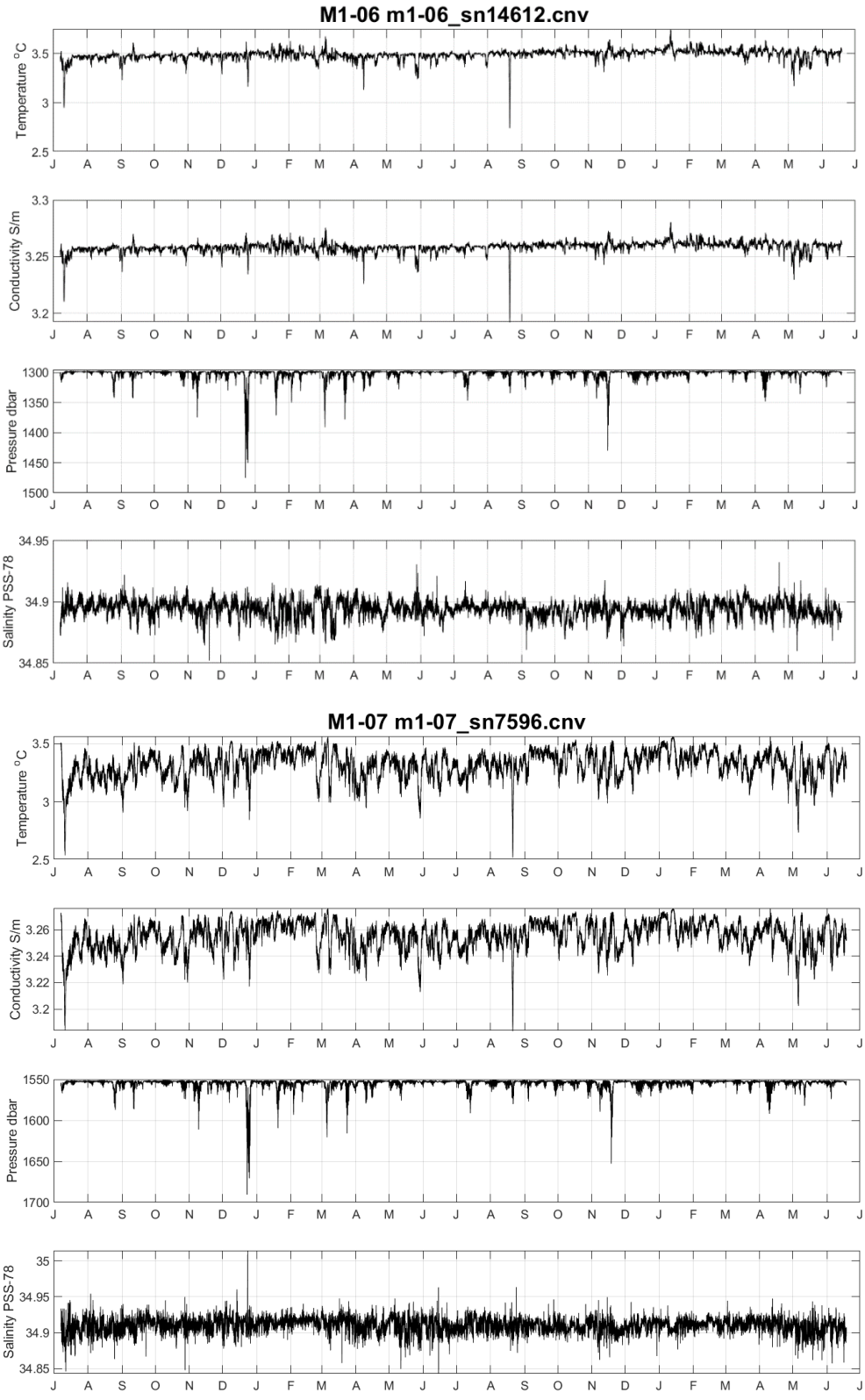

M1-01a m1-01a_sn23986.cnv
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
J A S O N D J F M A M J J A S O N D J F M A M J J

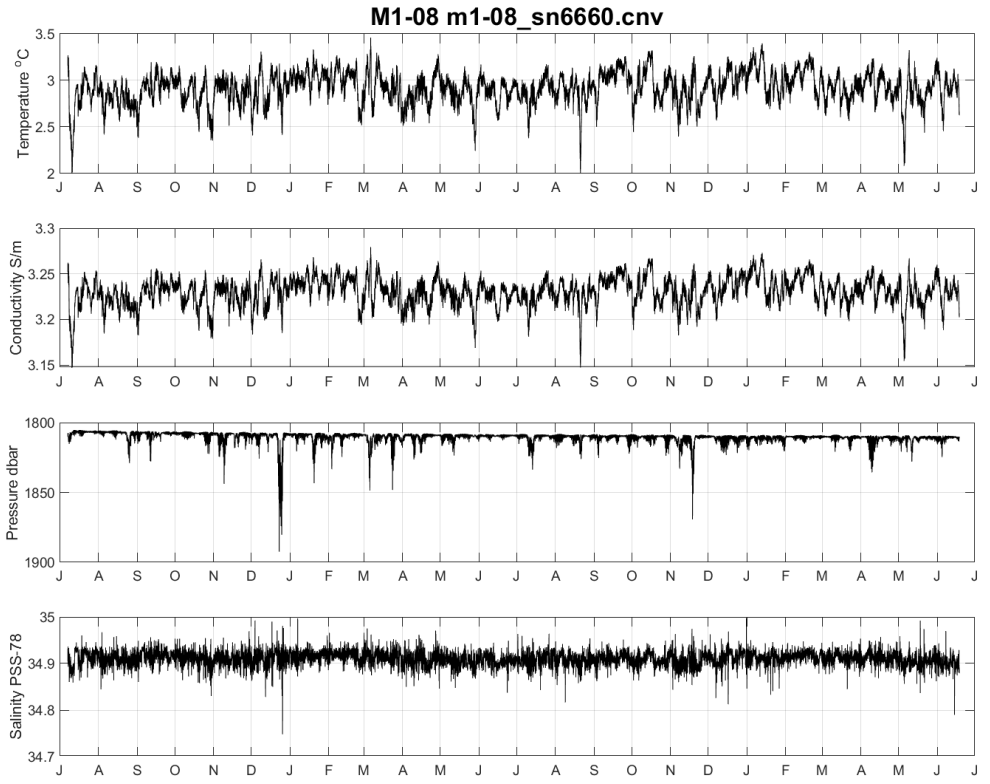

M1-01 m1-01_sn7607.cnv
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
J A S O N D J F M A M J J A S O N D J F M A M J J

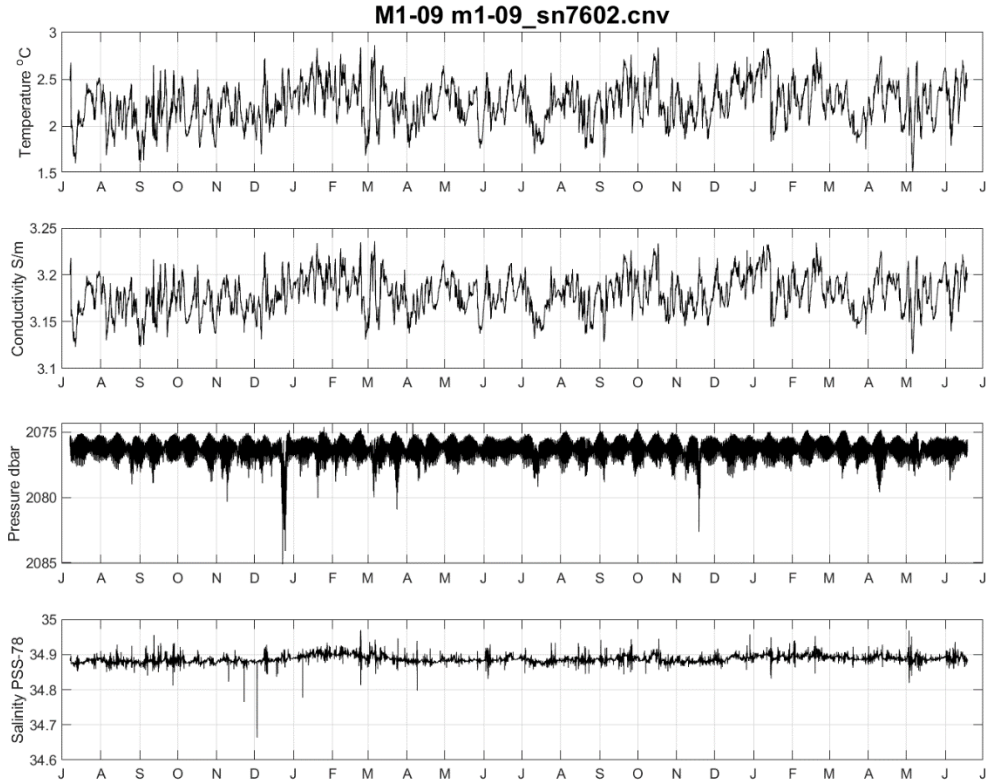

M1-02 m1-02_sn14634.cnv
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
M1-03 m1-03_sn7601.cnv
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
J A S O N D J F M A M J J A S O N D J F M A M J

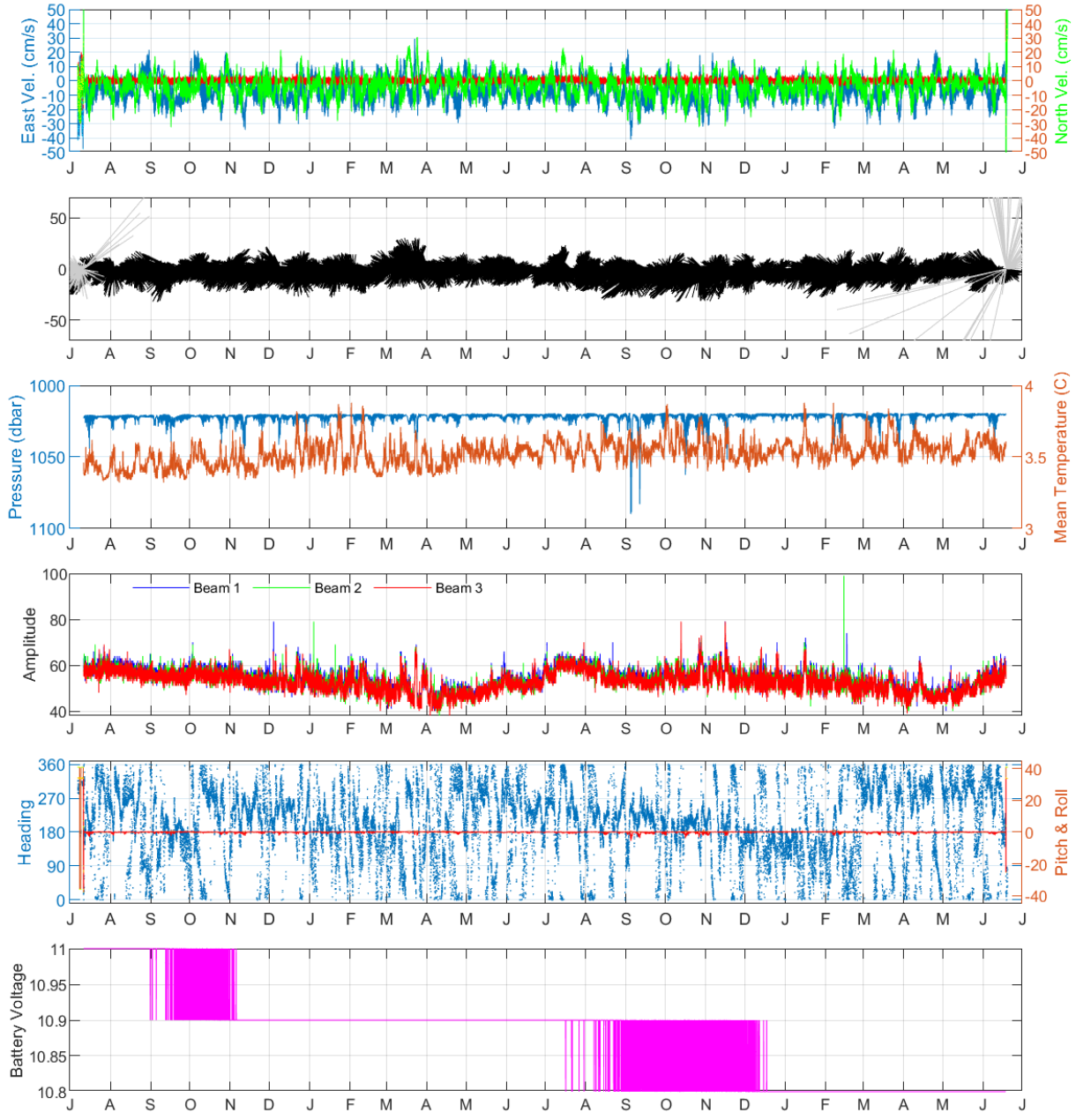

M1-04 m1-04_sn6669.cnv
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
J A S O N D J F M A M J J A S O N D J F M A M J J


M1-05 m1-05_sn7590.cnv
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
J A S O N D J F M A M J J A S O N D J F M A M J J


M1-06 m1-06_sn14612.cnv
Temperature °C
3.5
3
2.5
Conductivity S/m
3.3
3.25
3.2
Pressure dbar
1300
1350
1400
1450
1500
Salinity PSS-78
34.95
34.9
34.85
J A S O N D J F M A M J J A S O N D J F M A M J J
M1-07 m1-07_sn7596.cnv
Temperature °C
3.5
3
2.5
Conductivity S/m
3.26
3.24
3.22
3.2
Pressure dbar
1550
1600
1650
1700
Salinity PSS-78
35
34.95
34.9
34.85
J A S O N D J F M A M J J A S O N D J F M A M J J


M1-08 m1-08_sn6660.cnv
Temperature °C
3.5
3
2.5
2
Conductivity S/m
3.3
3.25
3.2
3.15
Pressure dbar
1800
1850
1900
Salinity PSS-78
35
34.9
34.8
34.7
J A S O N D J F M A M J J A S O N D J F M A M J J

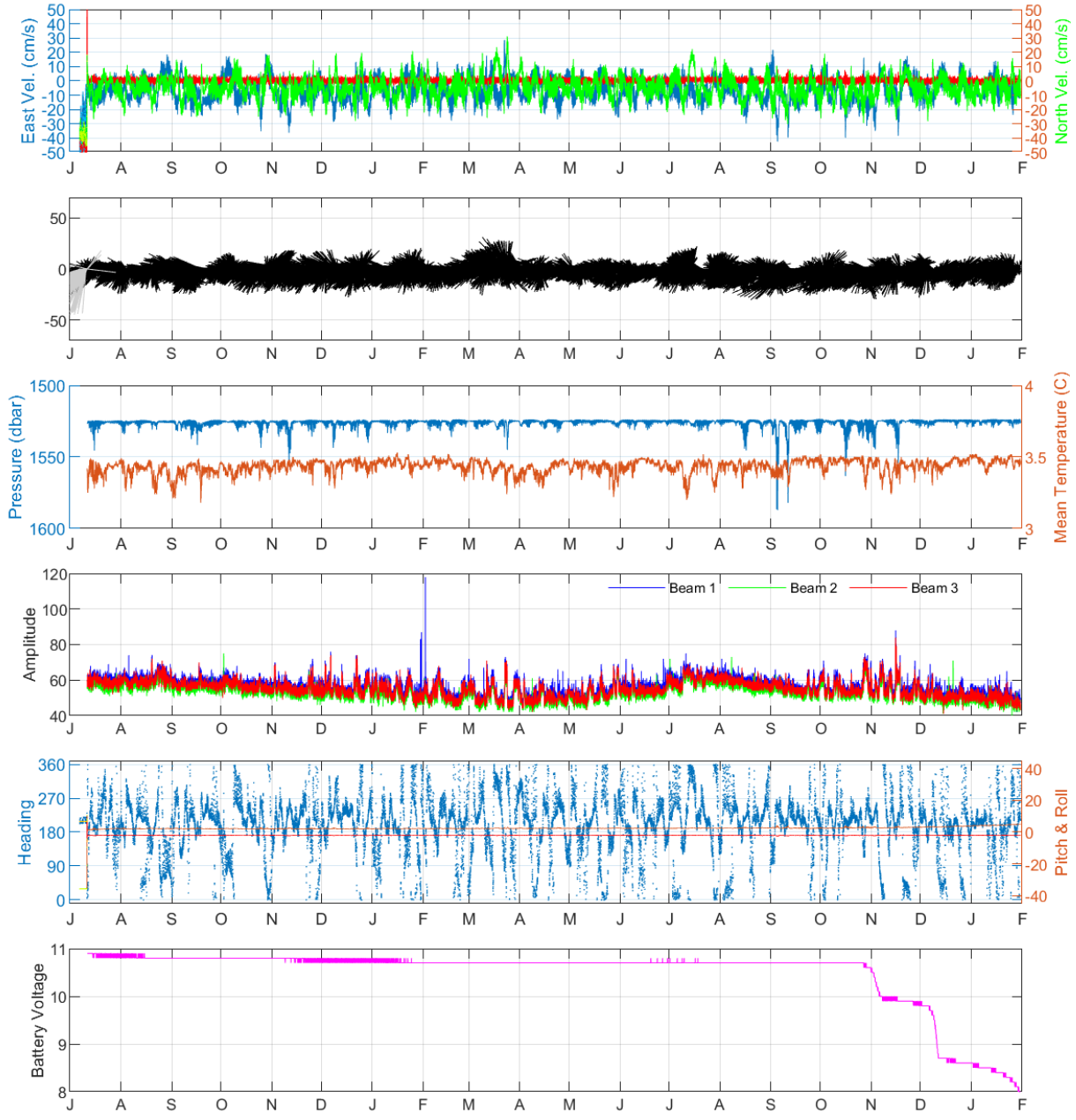

M1-09 m1-09_sn7602.cnv
Temperature °C
3
2.5
2
1.5
Conductivity S/m
3.25
3.2
3.15
3.1
Pressure dbar
2075
2080
2085
Salinity PSS-78
35
34.9
34.8
34.7
34.6
J A S O N D J F M A M J J A S O N D J F M A M J J



M2-01

Percentage good data: 99%

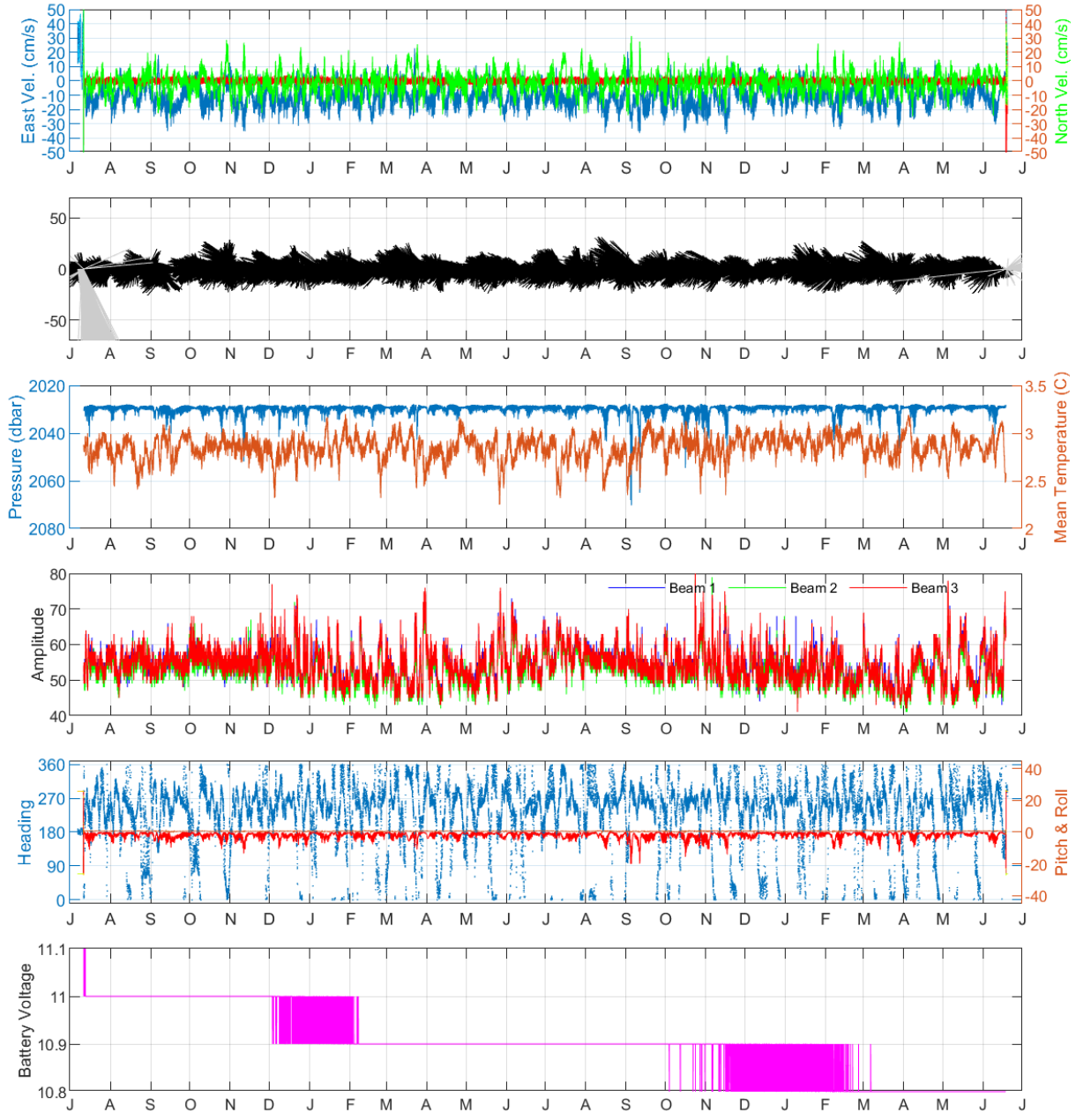
Number of measurements	34256	Serial number	AQD11555
Time of first measurement	7/7/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 15:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M2-03

Percentage good data: 99%

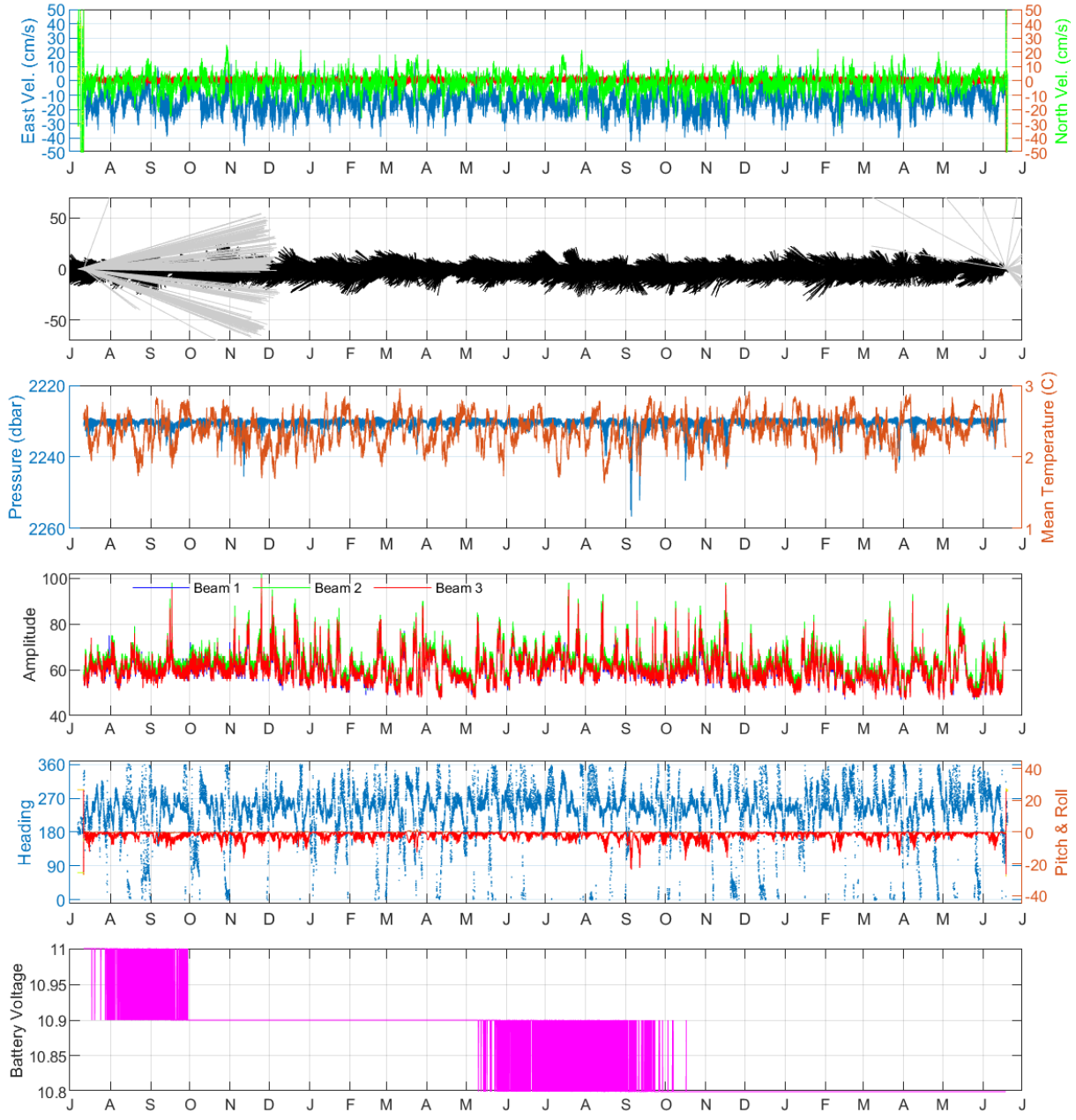
Number of measurements	27505	Serial number	AQD11647
Time of first measurement	7/7/2022	Transmit pulse length	0.75 m
Time of last measurement	1/31/2024 00:01:13	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M2-05

Percentage good data: 99%

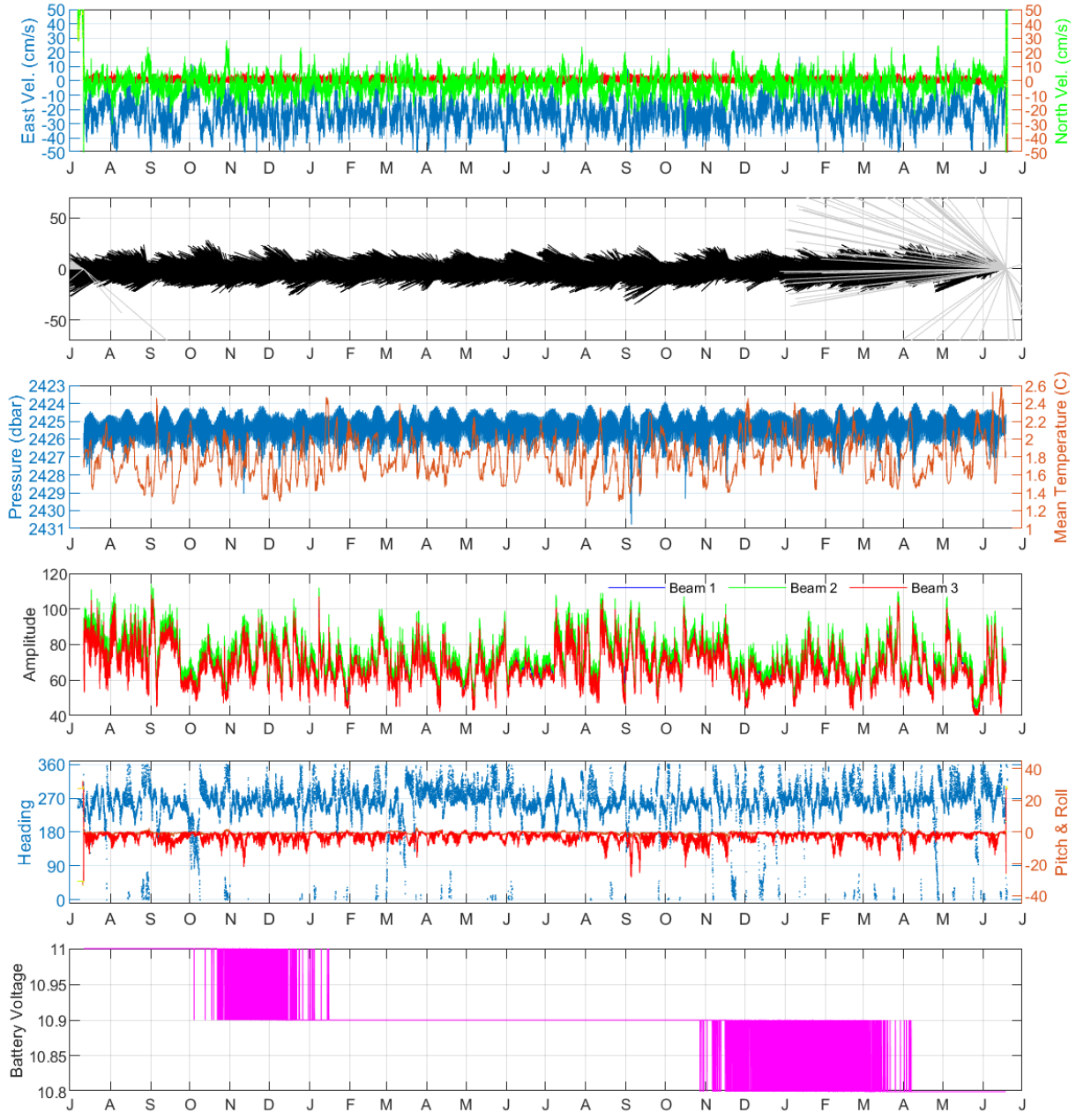
Number of measurements	34256	Serial number	AQD11575
Time of first measurement	7/7/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 15:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M2-06

Percentage good data: 99%

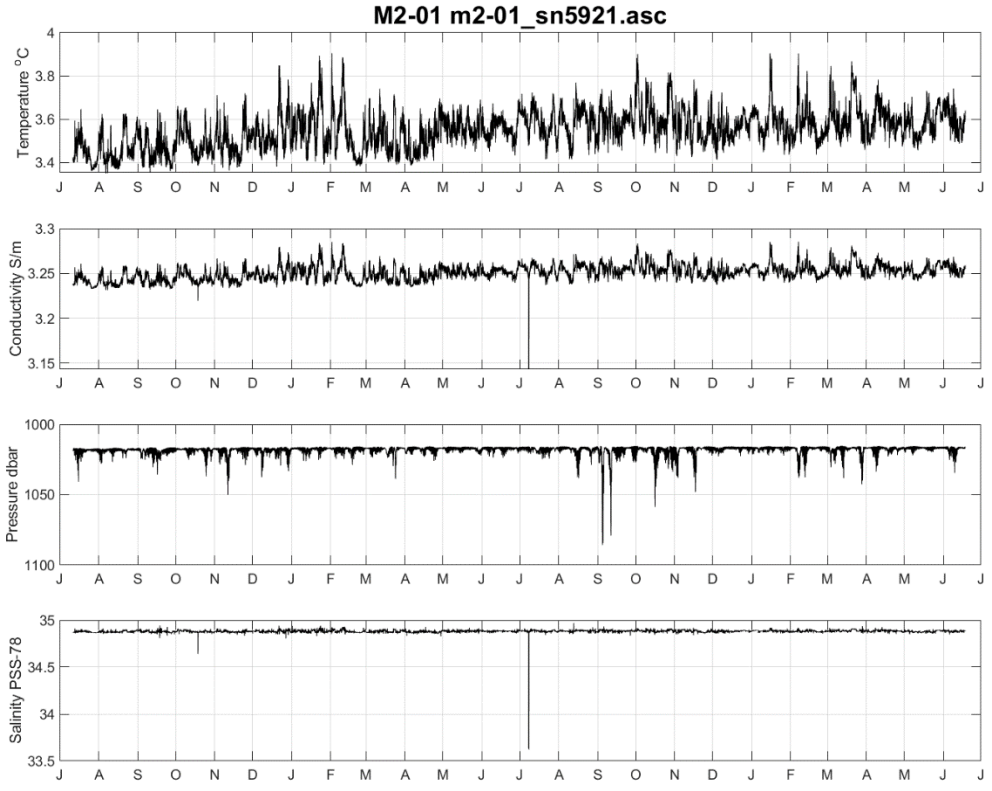
Number of measurements	34257	Serial number	AQD11660
Time of first measurement	7/7/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 16:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

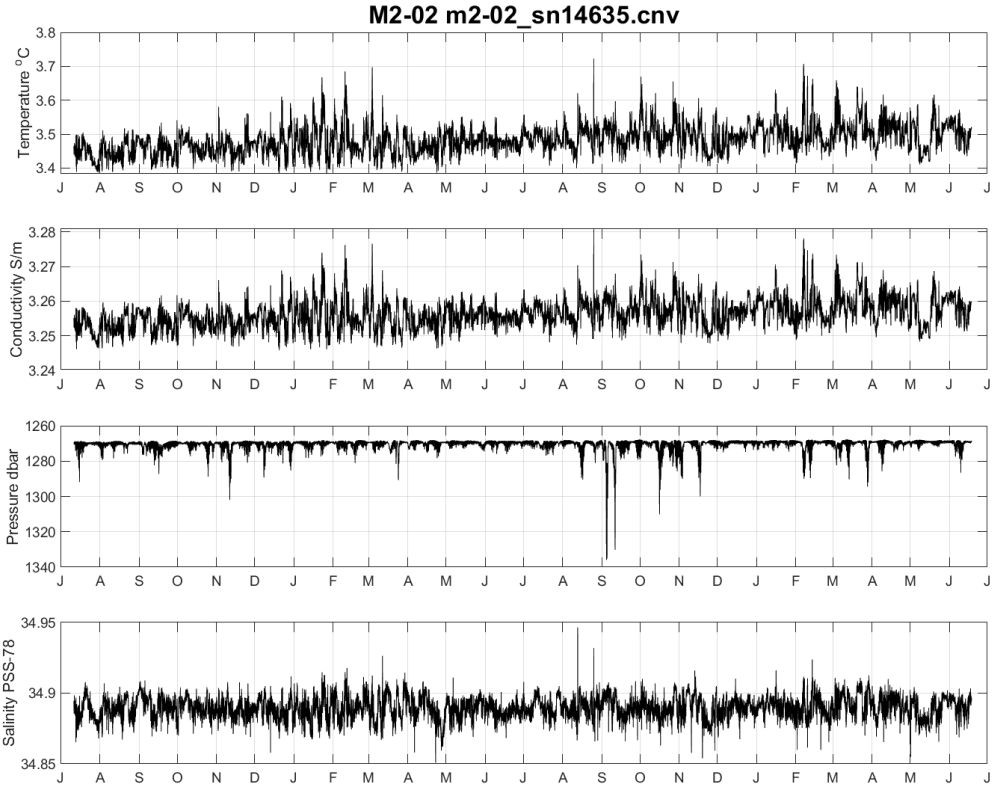


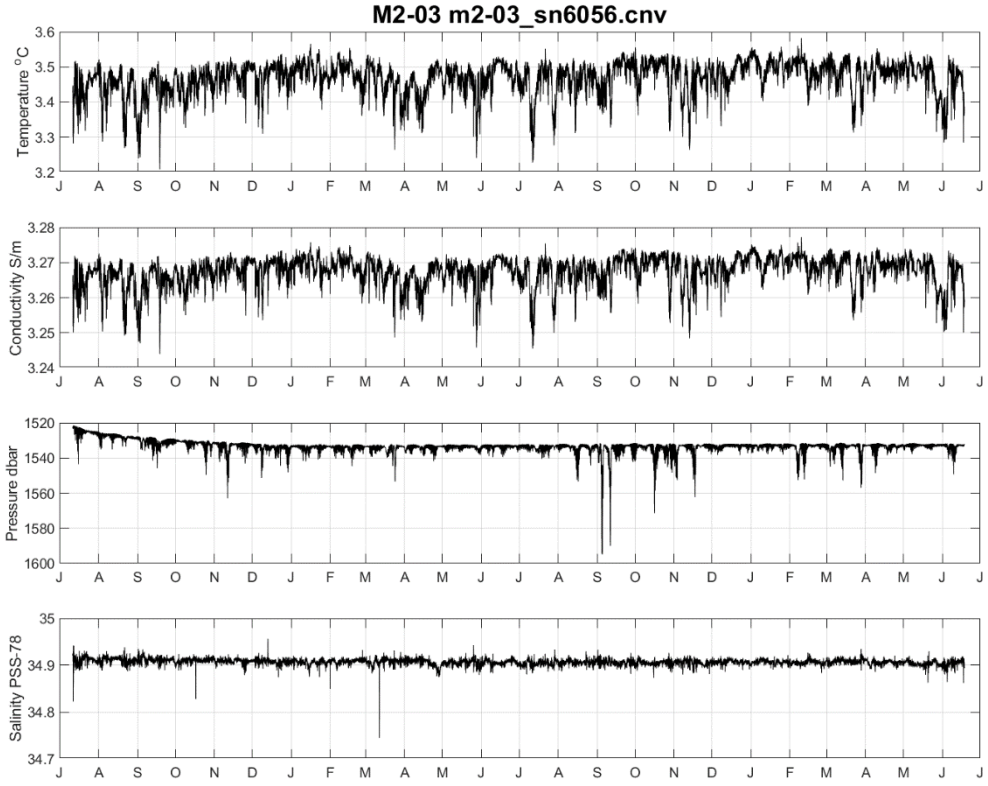
M2-07

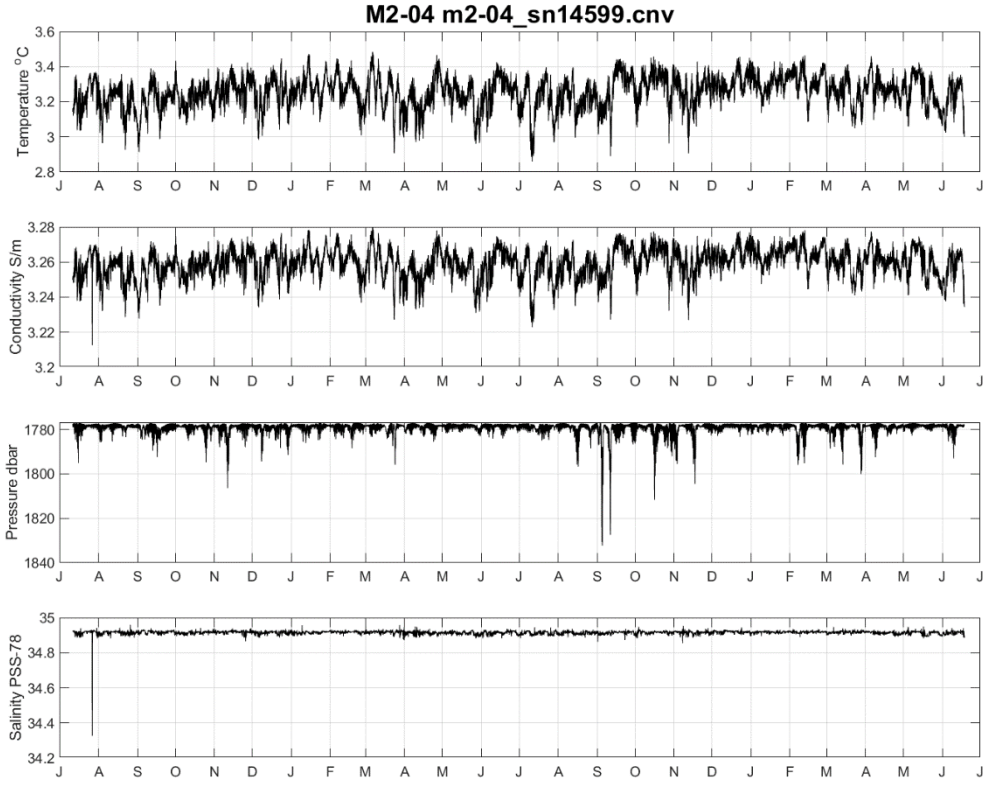
Percentage good data: 99%

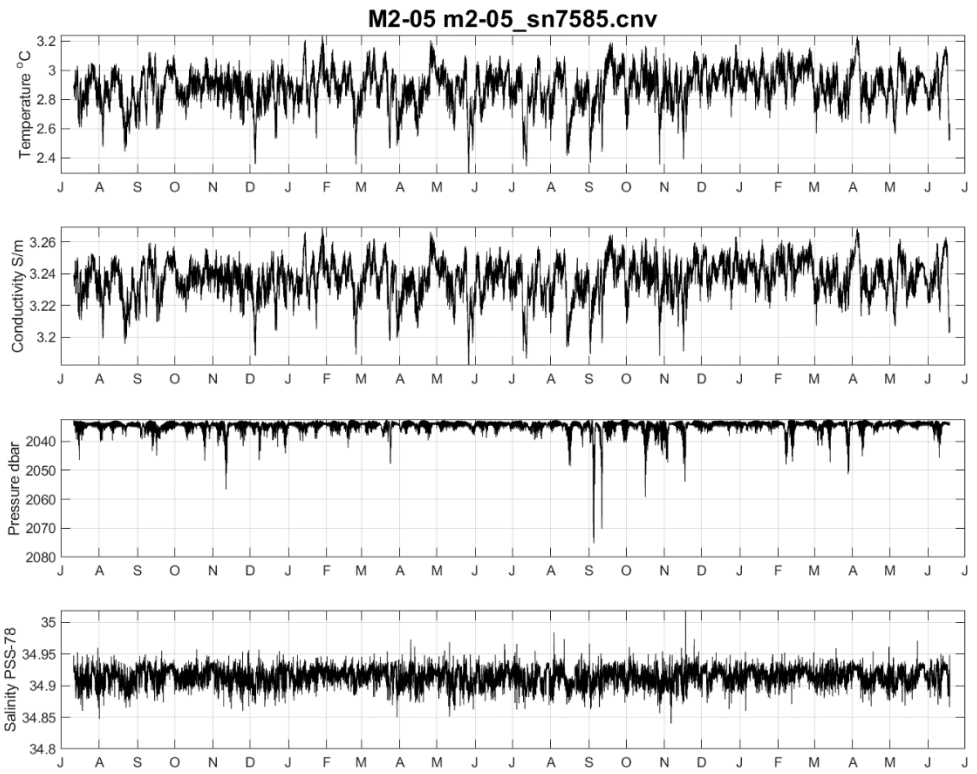
Number of measurements	34256	Serial number	AQD11642
Time of first measurement	7/7/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 15:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

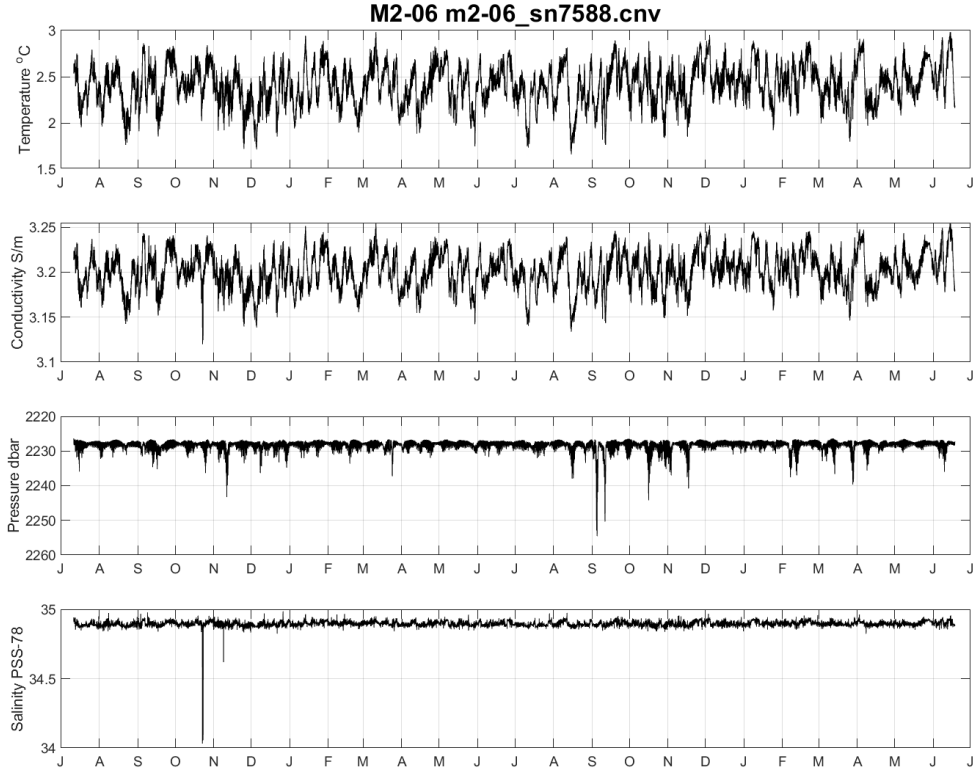

M2-01 m2-01_sn5921.asc
Temperature °C
4
3.8
3.6
3.4
Conductivity S/m
3.3
3.25
3.2
3.15
Pressure dbar
1000
1050
1100
Salinity PSS-78
35
34.5
34
33.5
J A S O N D J F M A M J J A S O N D J F M A M J J

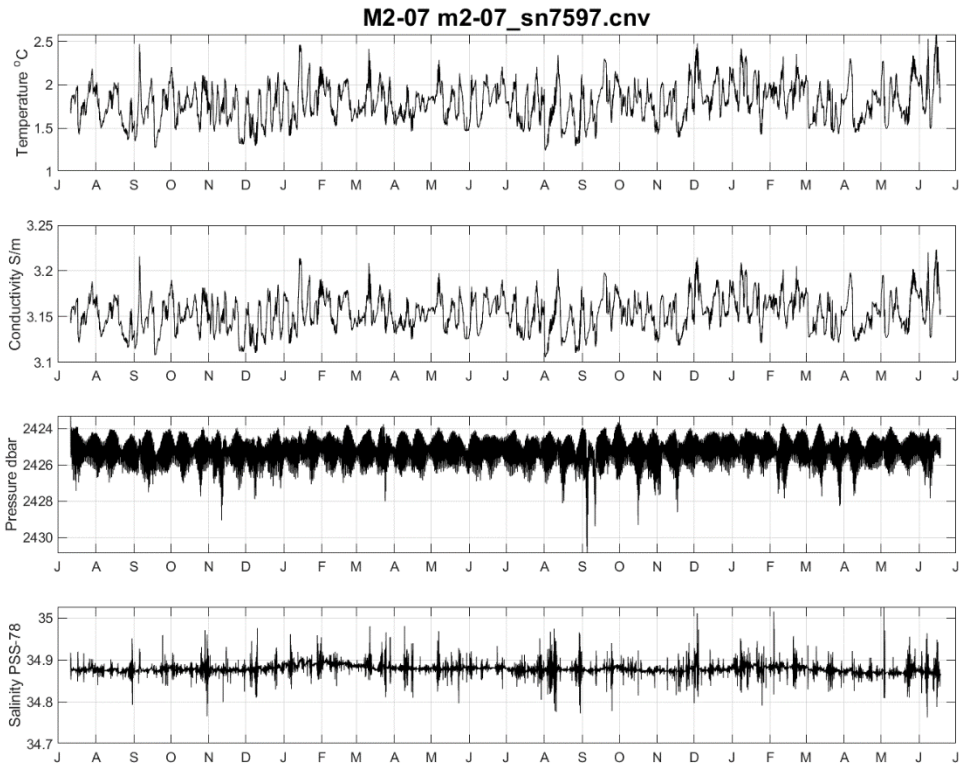

M2-02 m2-02_sn14635.cnv
Temperature °C
3.8
3.7
3.6
3.5
3.4
Conductivity S/m
3.28
3.27
3.26
3.25
3.24
Pressure dbar
1260
1280
1300
1320
1340
Salinity PSS-78
34.95
34.9
34.85
J A S O N D J F M A M J J A S O N D J F M A M J J

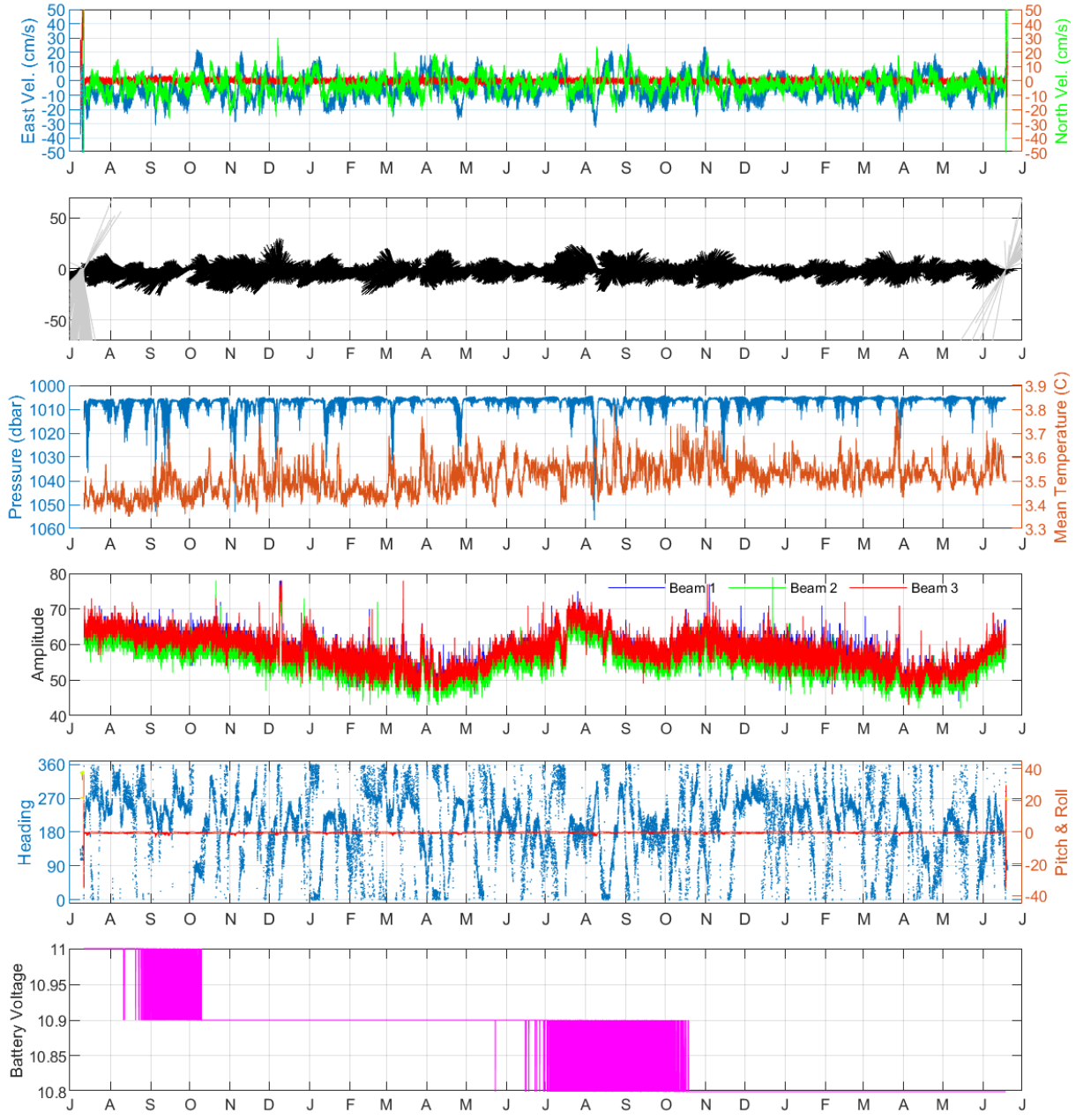

M2-03 m2-03_sn6056.cnv
Temperature °C
3.6
3.5
3.4
3.3
3.2
Conductivity S/m
3.28
3.27
3.26
3.25
3.24
Pressure dbar
1520
1540
1560
1580
1600
Salinity PSS-78
35
34.9
34.8
34.7
J A S O N D J F M A M J J A S O N D J F M A M J J


M2-04 m2-04_sn14599.cnv
Temperature °C
3.6
3.4
3.2
3
2.8
Conductivity S/m
3.28
3.26
3.24
3.22
3.2
Pressure dbar
1780
1800
1820
1840
Salinity PSS-78
35
34.8
34.6
34.4
34.2
J A S O N D J F M A M J J A S O N D J F M A M J J


M2-05 m2-05_sn7585.cnv
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
J A S O N D J F M A M J J A S O N D J F M A M J J


M2-06 m2-06_sn7588.cnv
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
J A S O N D J F M A M J J A S O N D J F M A M J J

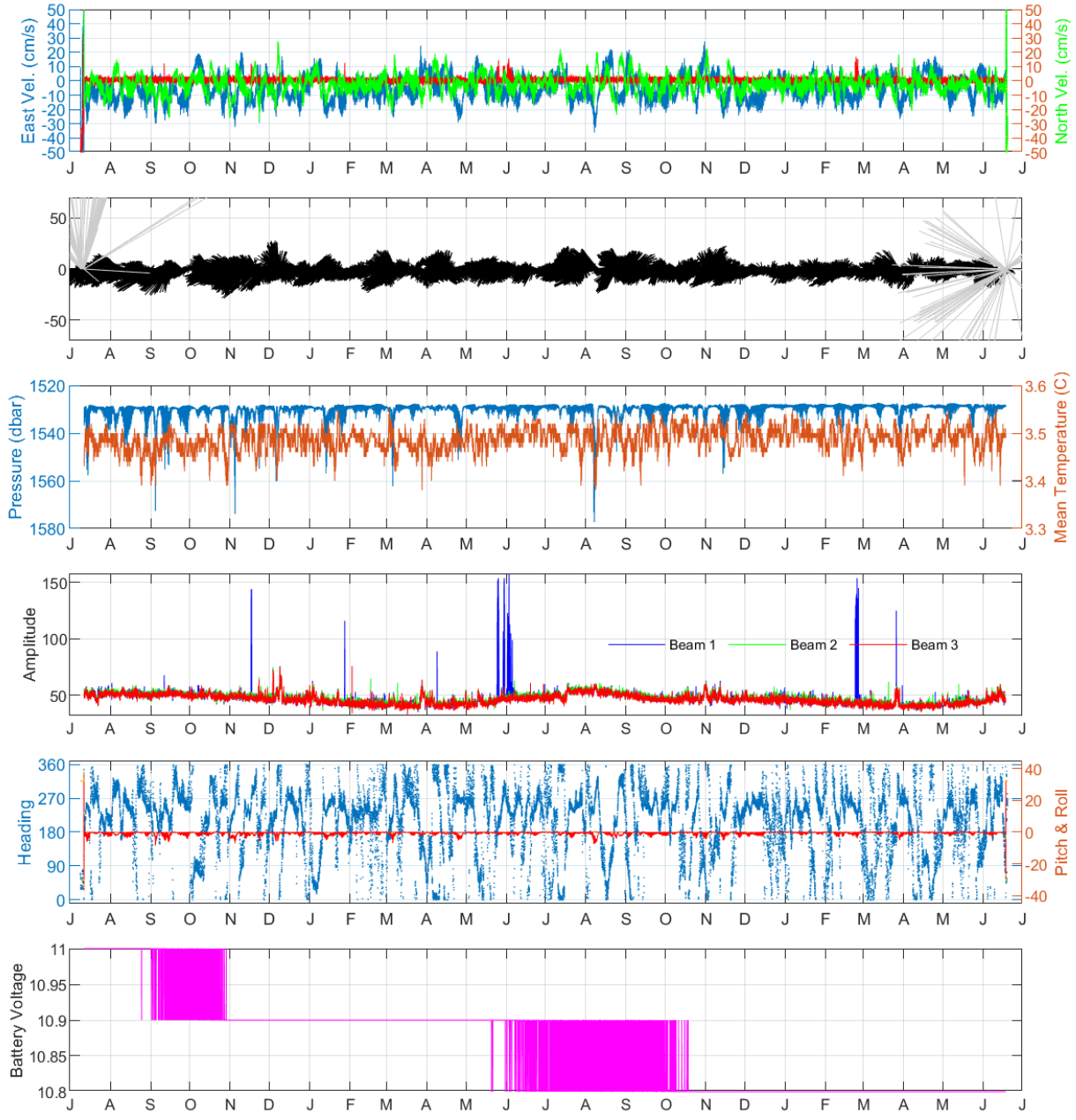

M2-07 m2-07_sn7597.cnv
Temperature °C
2.5
2
1.5
1
Conductivity S/m
3.25
3.2
3.15
3.1
Pressure dbar
2424
2426
2428
2430
Salinity PSS-78
35
34.9
34.8
34.7
J A S O N D J F M A M J J A S O N D J F M A M J J



M3-01

Percentage good data: 99%

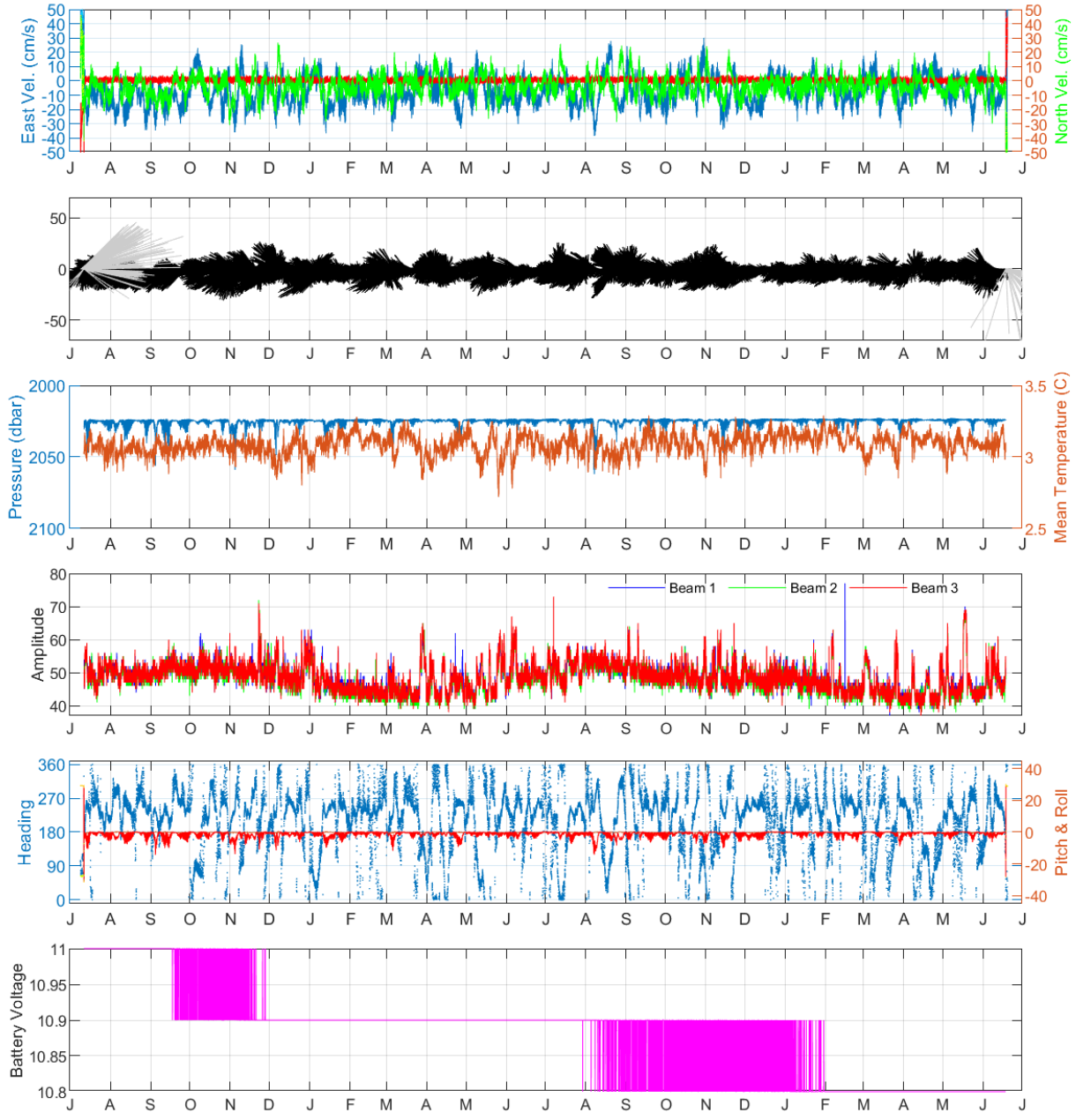
Number of measurements	34162	Serial number	AQD11587
Time of first measurement	7/9/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 16:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M3-03

Percentage good data: 99%

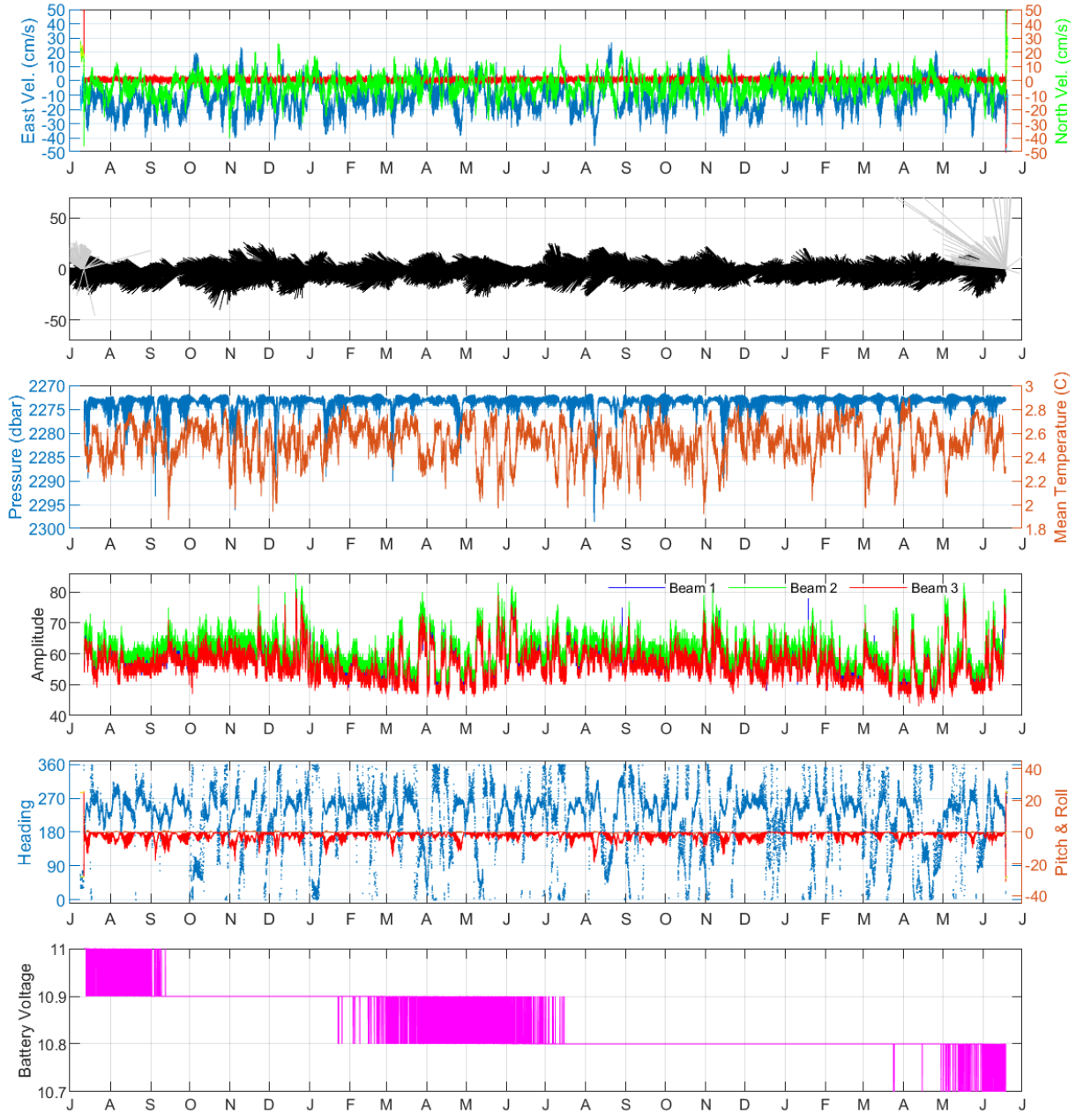
Number of measurements	34162	Serial number	AQD11650
Time of first measurement	7/9/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 16:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M3-05

Percentage good data: 99%

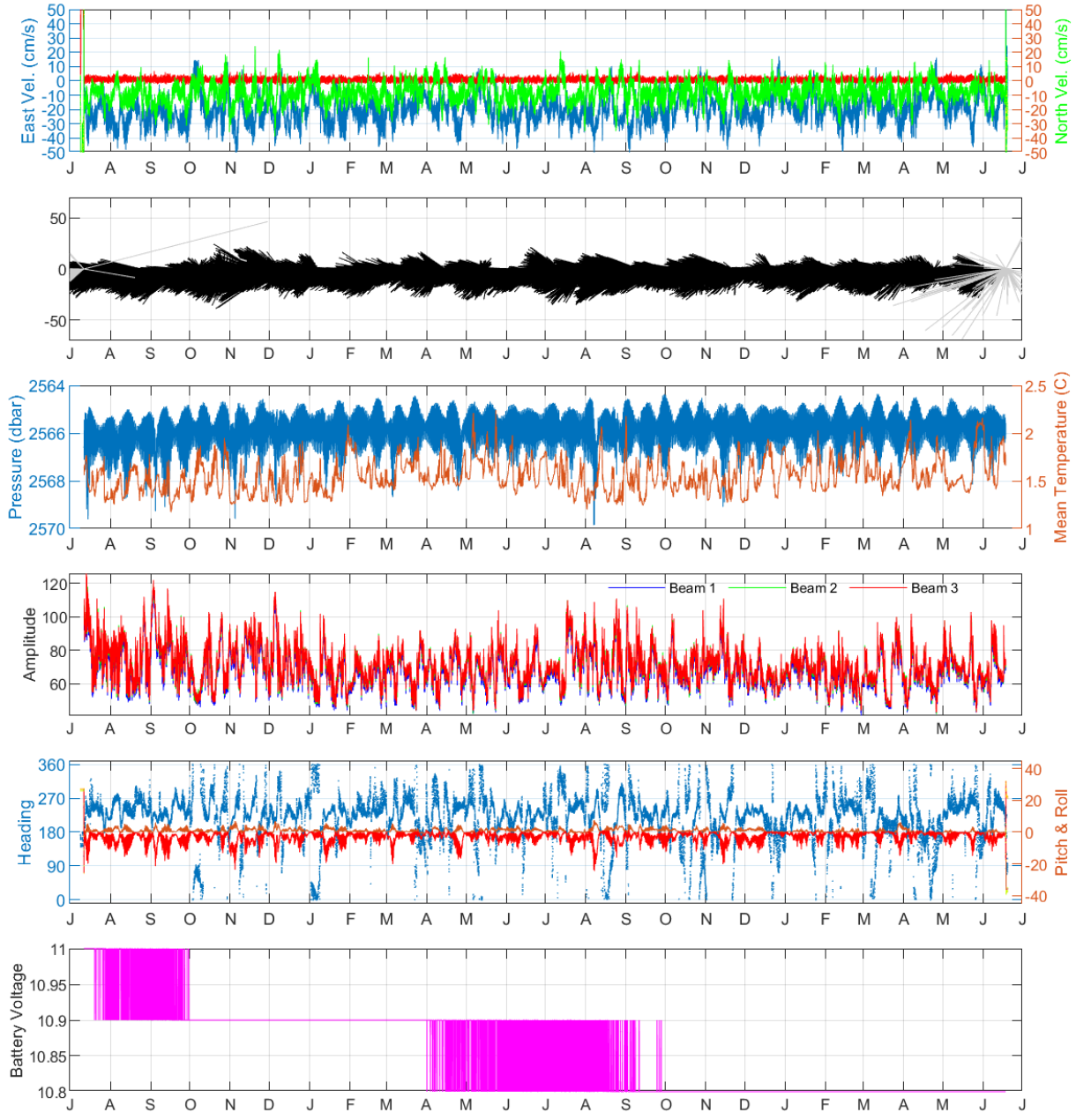
Number of measurements	34160	Serial number	AQD11677
Time of first measurement	7/9/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 15:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M3-06

Percentage good data: 99%

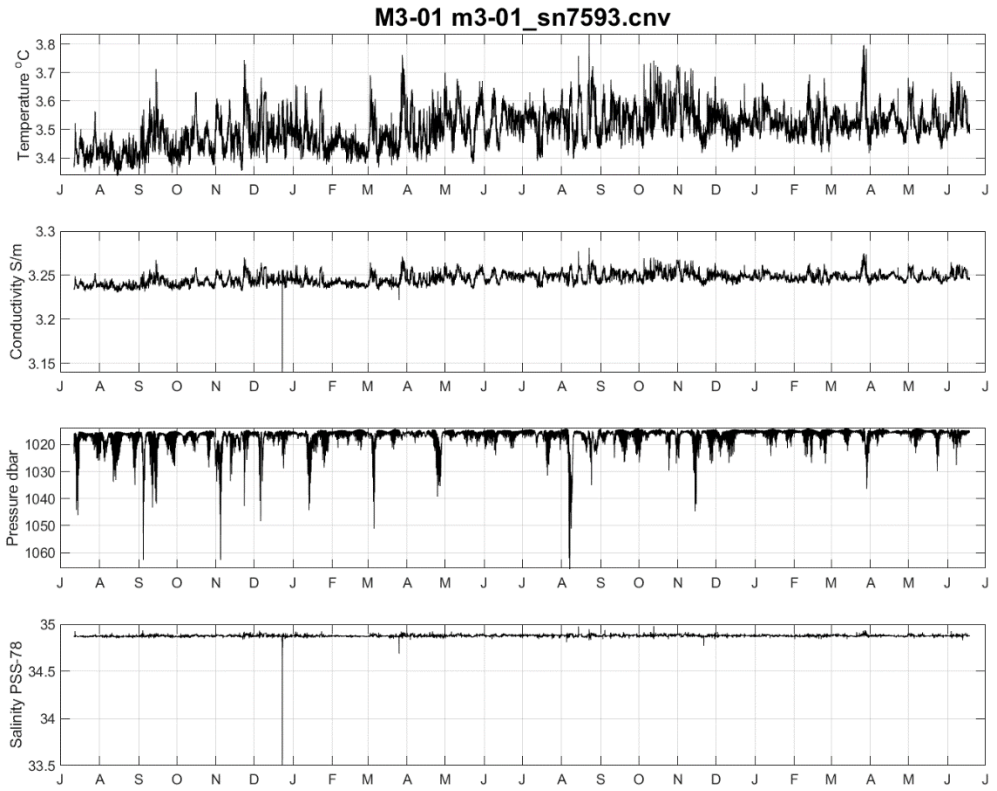
Number of measurements	34161	Serial number	AQD12450
Time of first measurement	7/9/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 16:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

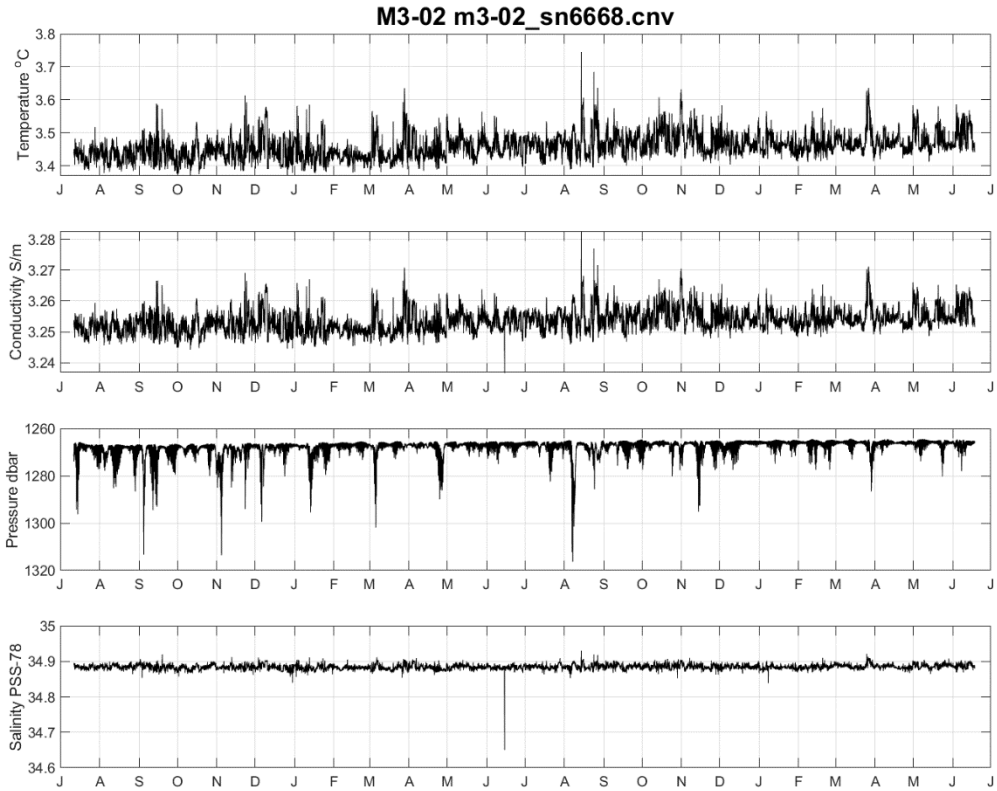


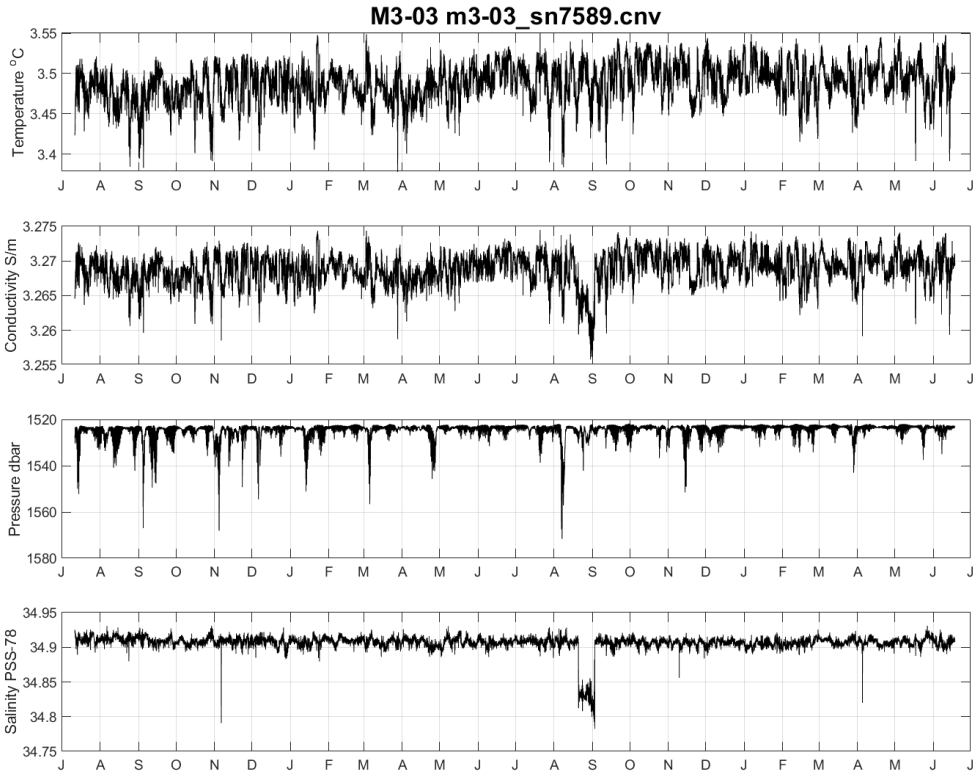
M3-07

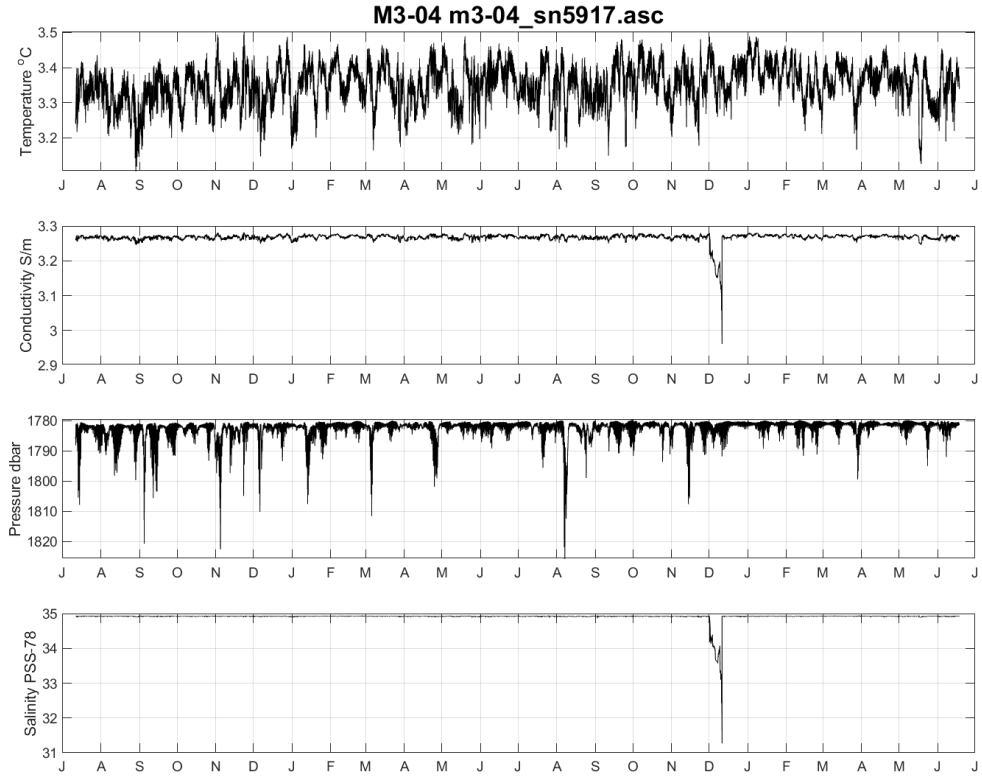
Percentage good data: 99%

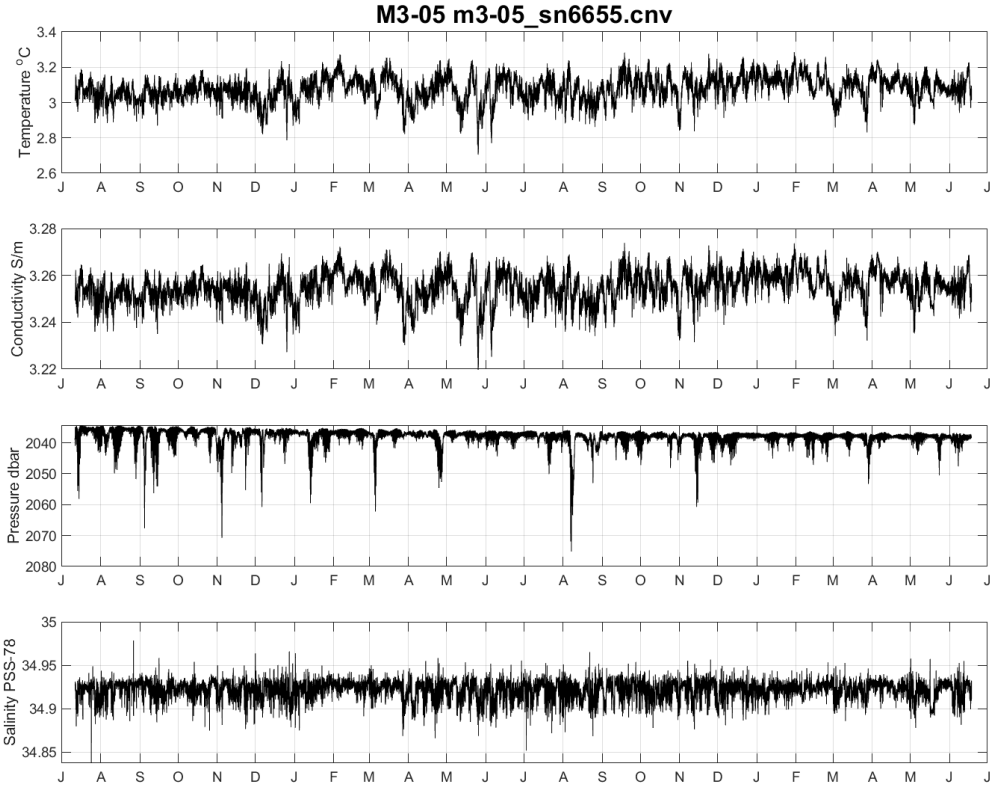
Number of measurements	34162	Serial number	AQD11654
Time of first measurement	7/9/2022	Transmit pulse length	0.75 m
Time of last measurement	6/19/2024 16:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec

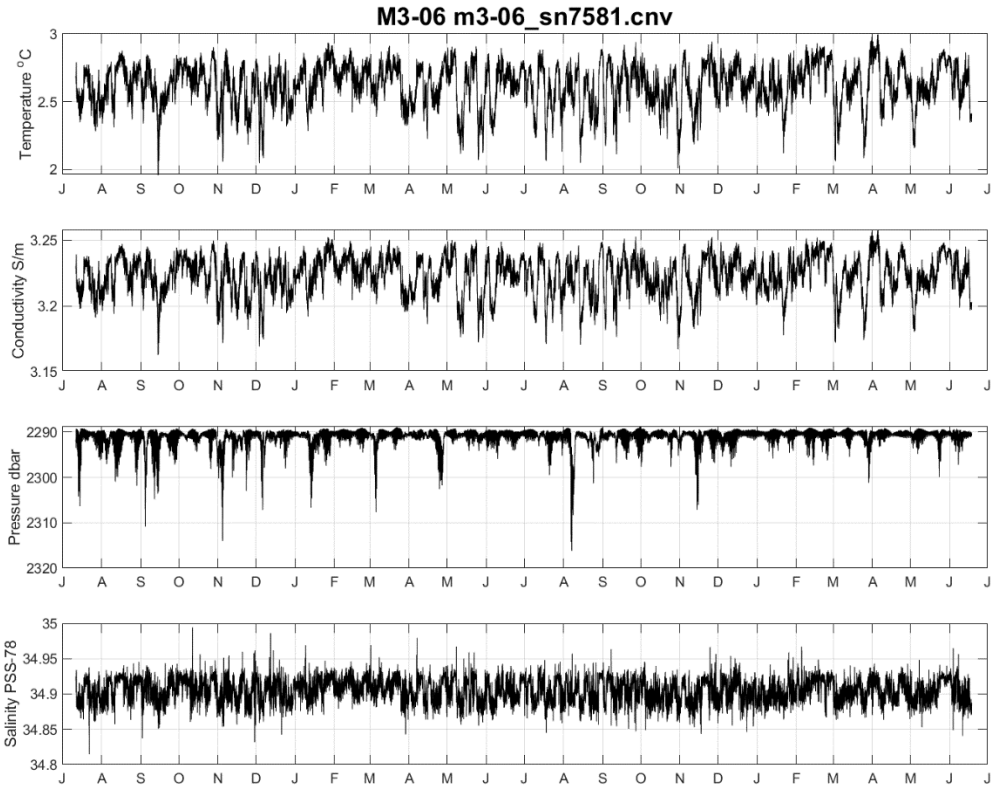

M3-01 m3-01_sn7593.cnv
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
J A S O N D J F M A M J J A S O N D J F M A M J

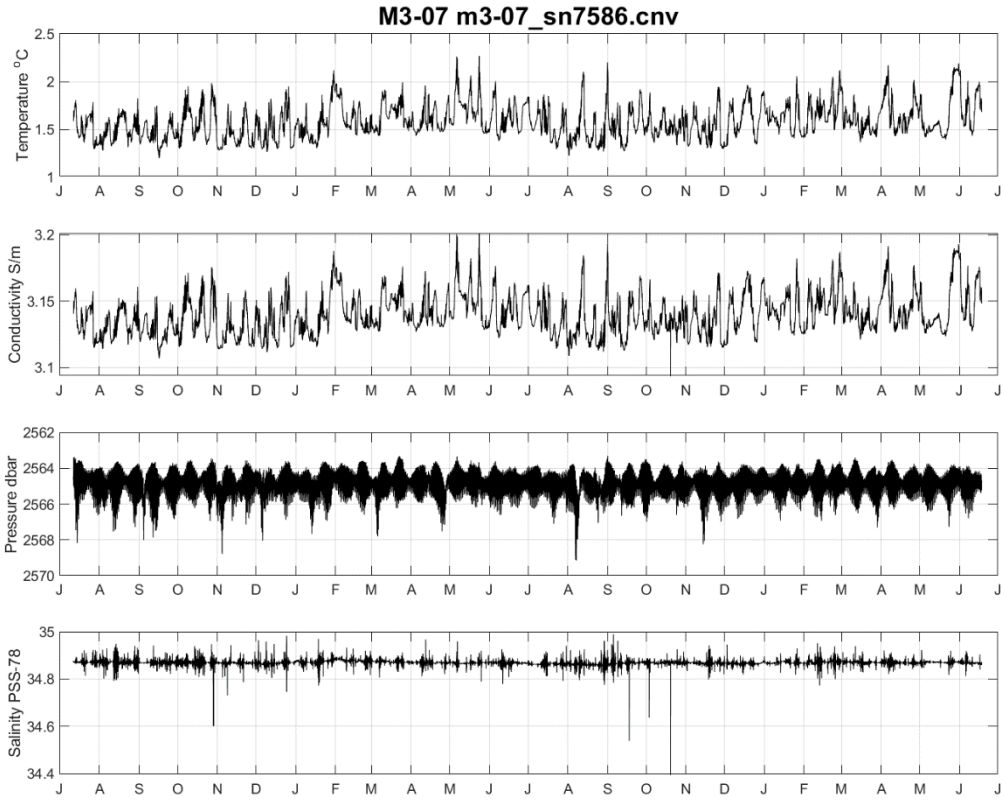

M3-02 m3-02_sn6668.cnv
Temperature °C
Conductivity S/m
Pressure dbar
Salinity PSS-78
J A S O N D J F M A M J J A S O N D J F M A M J

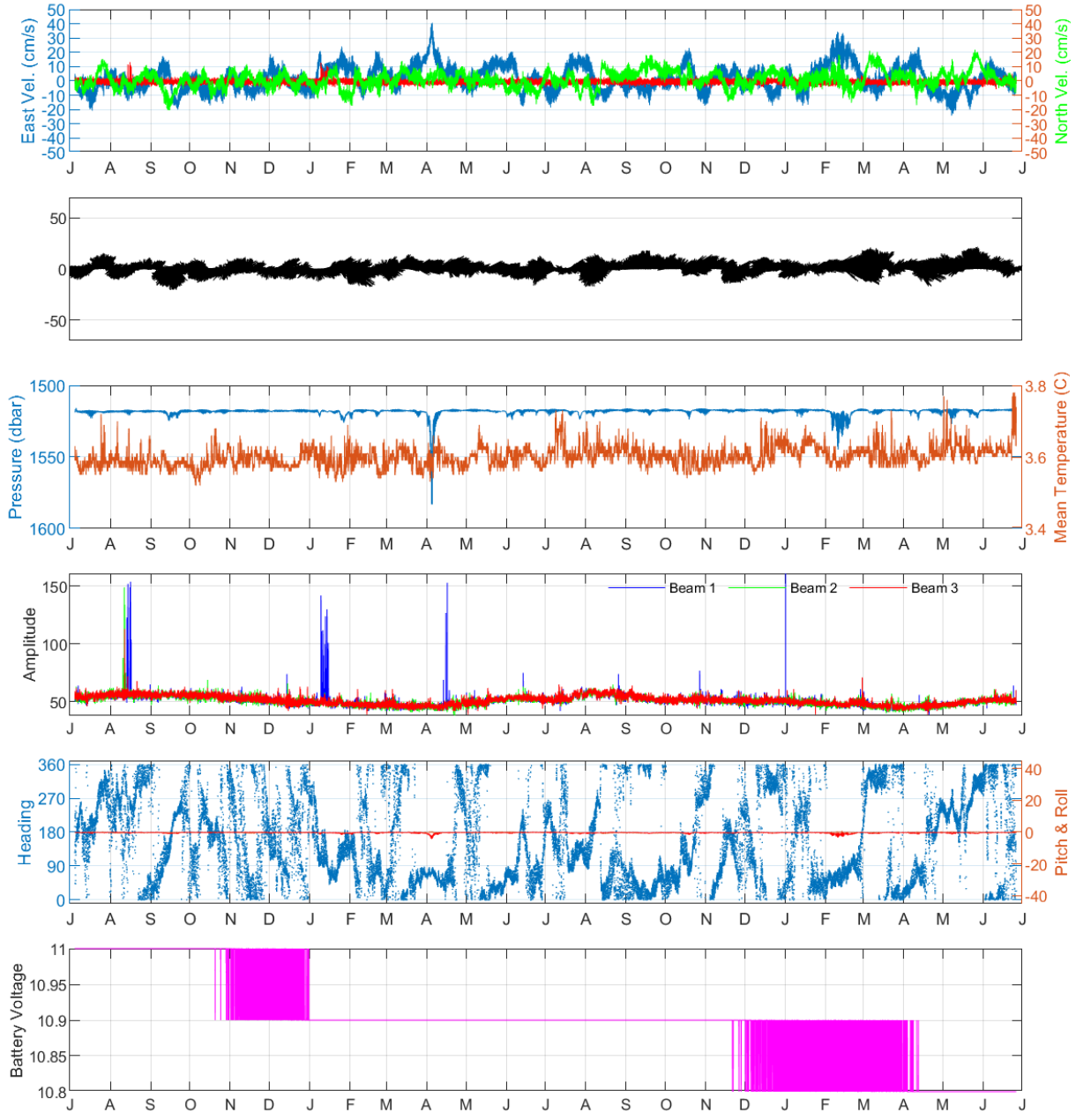

M3-03 m3-03_sn7589.cnv
Temperature °C
3.55
3.5
3.45
3.4
Conductivity S/m
3.275
3.27
3.265
3.26
3.255
Pressure dbar
1520
1540
1560
1580
Salinity PSS-78
34.95
34.9
34.85
34.8
34.75
J A S O N D J F M A M J J A S O N D J F M A M J J


M3-04 m3-04_sn5917.asc
Temperature °C
3.5
3.4
3.3
3.2
Conductivity S/m
3.3
3.2
3.1
3
2.9
Pressure dbar
1780
1790
1800
1810
1820
Salinity PSS-78
35
34
33
32
31
J A S O N D J F M A M J J A S O N D J F M A M J J


M3-05 m3-05_sn6655.cnv
Temperature °C
3.4
3.2
3
2.8
2.6
Conductivity S/m
3.28
3.26
3.24
3.22
Pressure dbar
2040
2050
2060
2070
2080
Salinity PSS-78
35
34.95
34.9
34.85
J A S O N D J F M A M J J A S O N D J F M A M J


M3-06 m3-06_sn7581.cnv
Temperature °C
3
2.5
2
Conductivity S/m
3.25
3.2
3.15
Pressure dbar
2290
2300
2310
2320
Salinity PSS-78
35
34.95
34.9
34.85
34.8
J A S O N D J F M A M J J A S O N D J F M A M J

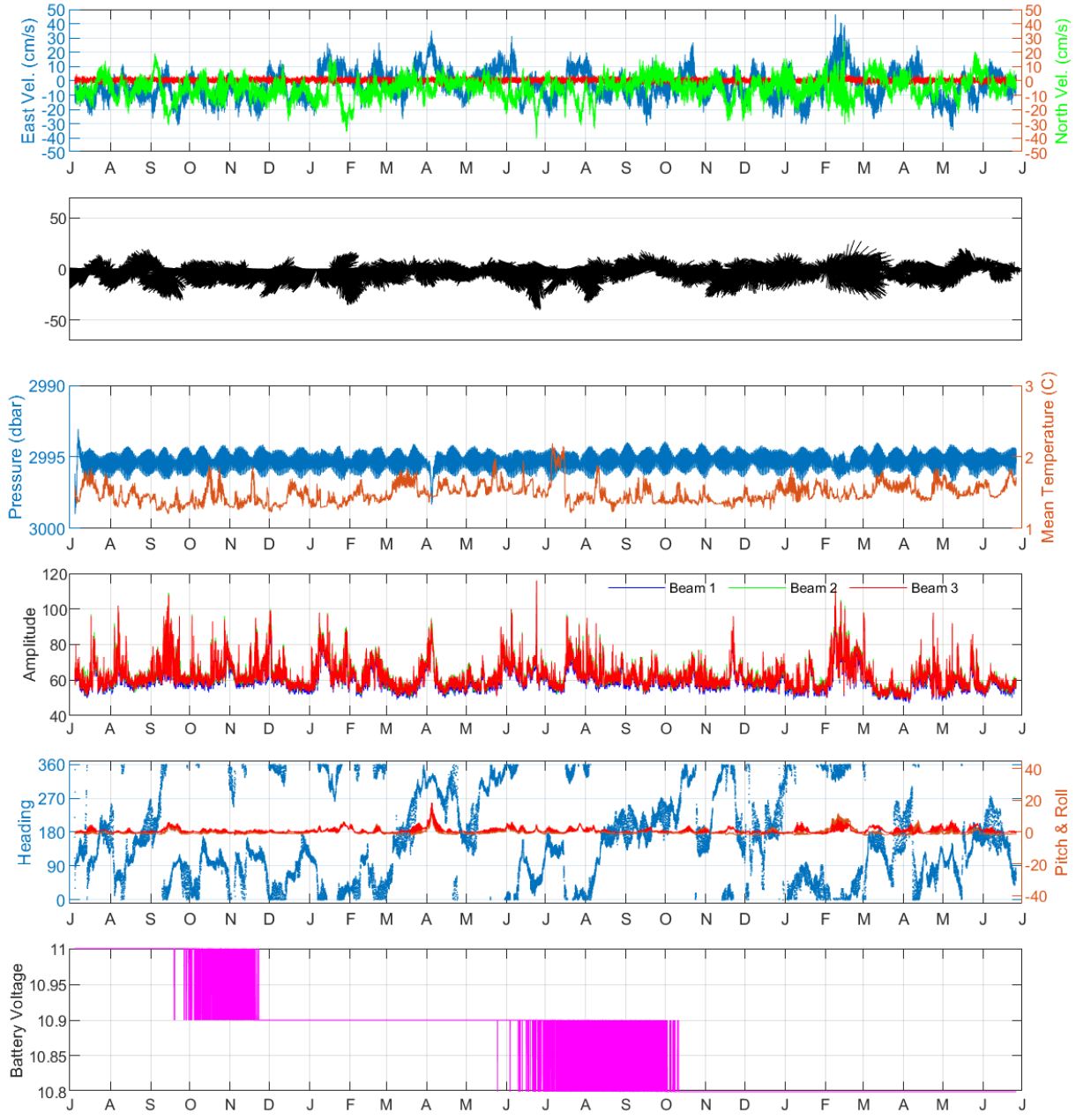

M3-07 m3-07_sn7586.cnv
Temperature °C
2.5
2
1.5
1
Conductivity S/m
3.2
3.15
3.1
Pressure dbar
2562
2564
2566
2568
2570
Salinity PSS-78
35
34.8
34.6
34.4
J A S O N D J F M A M J J A S O N D J F M A M J J



M4-01

Percentage good data: 100%

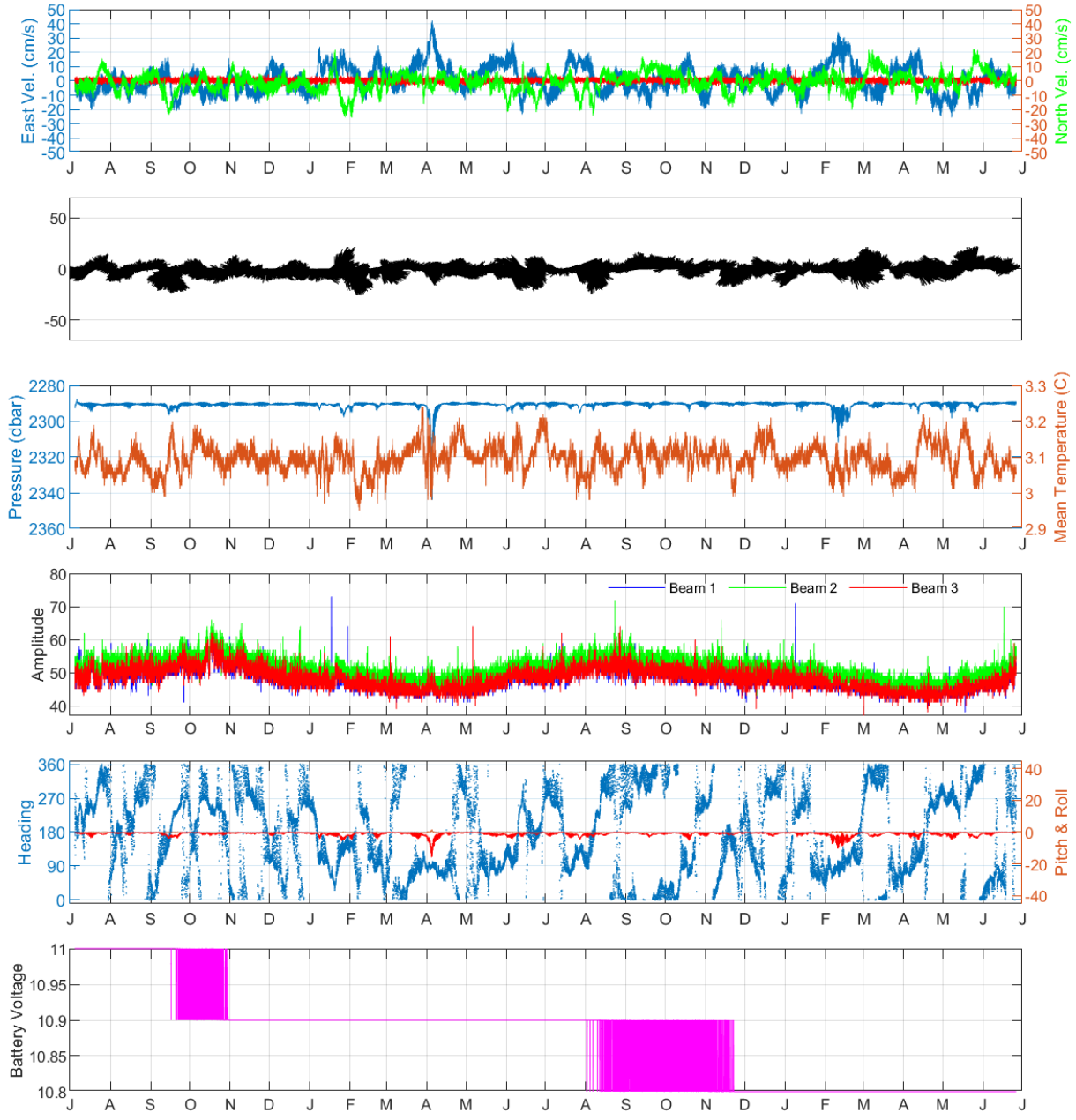
Number of measurements	34836	Serial number	AQD11560
Time of first measurement	7/2/2022	Transmit pulse length	0.75 m
Time of last measurement	6/26/2024 17:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M4-07

Percentage good data: 100%

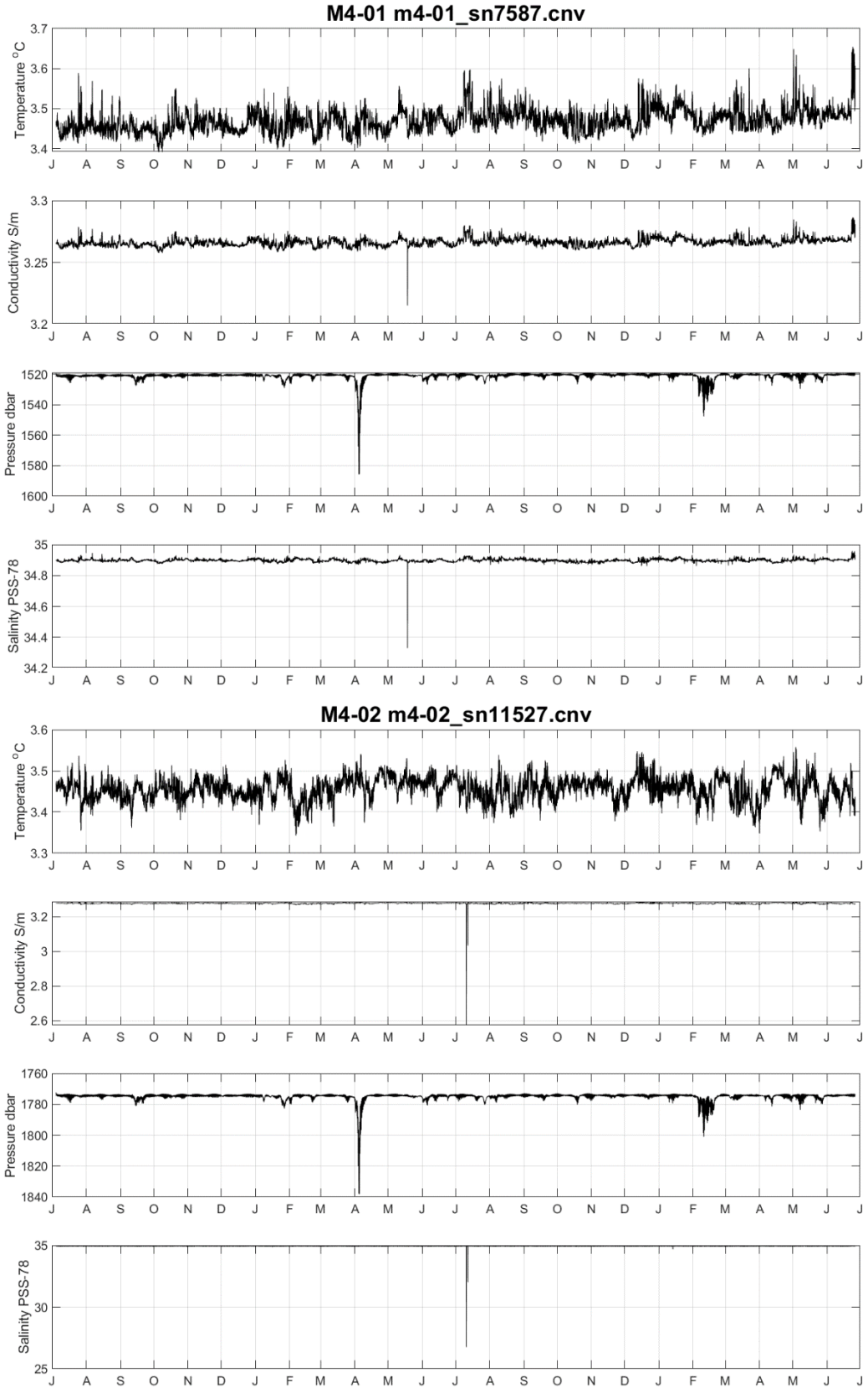
Number of measurements	34836	Serial number	AQD11551
Time of first measurement	7/2/2022	Transmit pulse length	0.75 m
Time of last measurement	6/26/2024 17:30:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec



M4-04

Percentage good data: 100%

Number of measurements	34835	Serial number	AQD11645
Time of first measurement	7/2/2022	Transmit pulse length	0.75 m
Time of last measurement	6/26/2024 17:00:00	Blanking distance	0.50 m
Compass update rate	1 sec	Measurement interval	1800 sec
Transmit pulse length	0.75 m	Average interval	60 sec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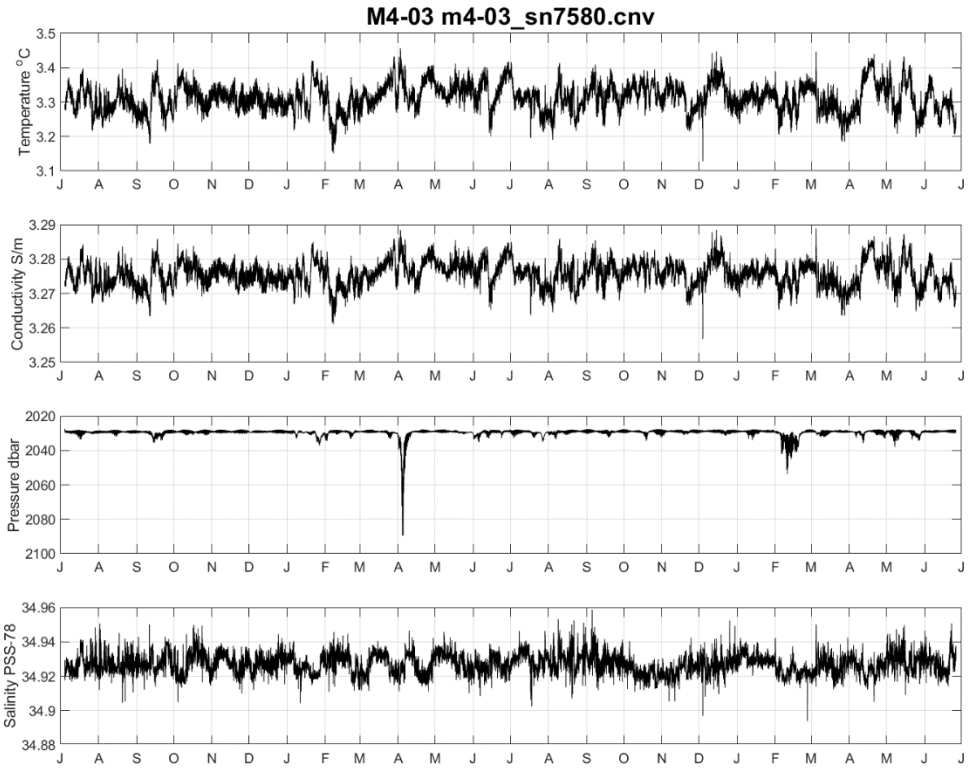
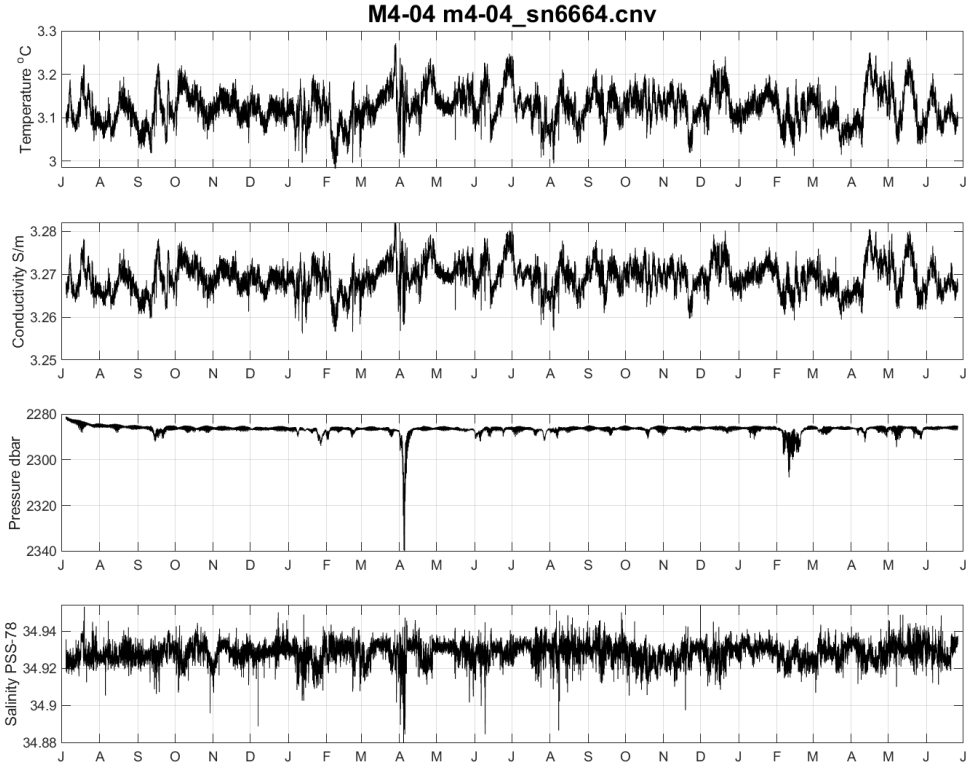
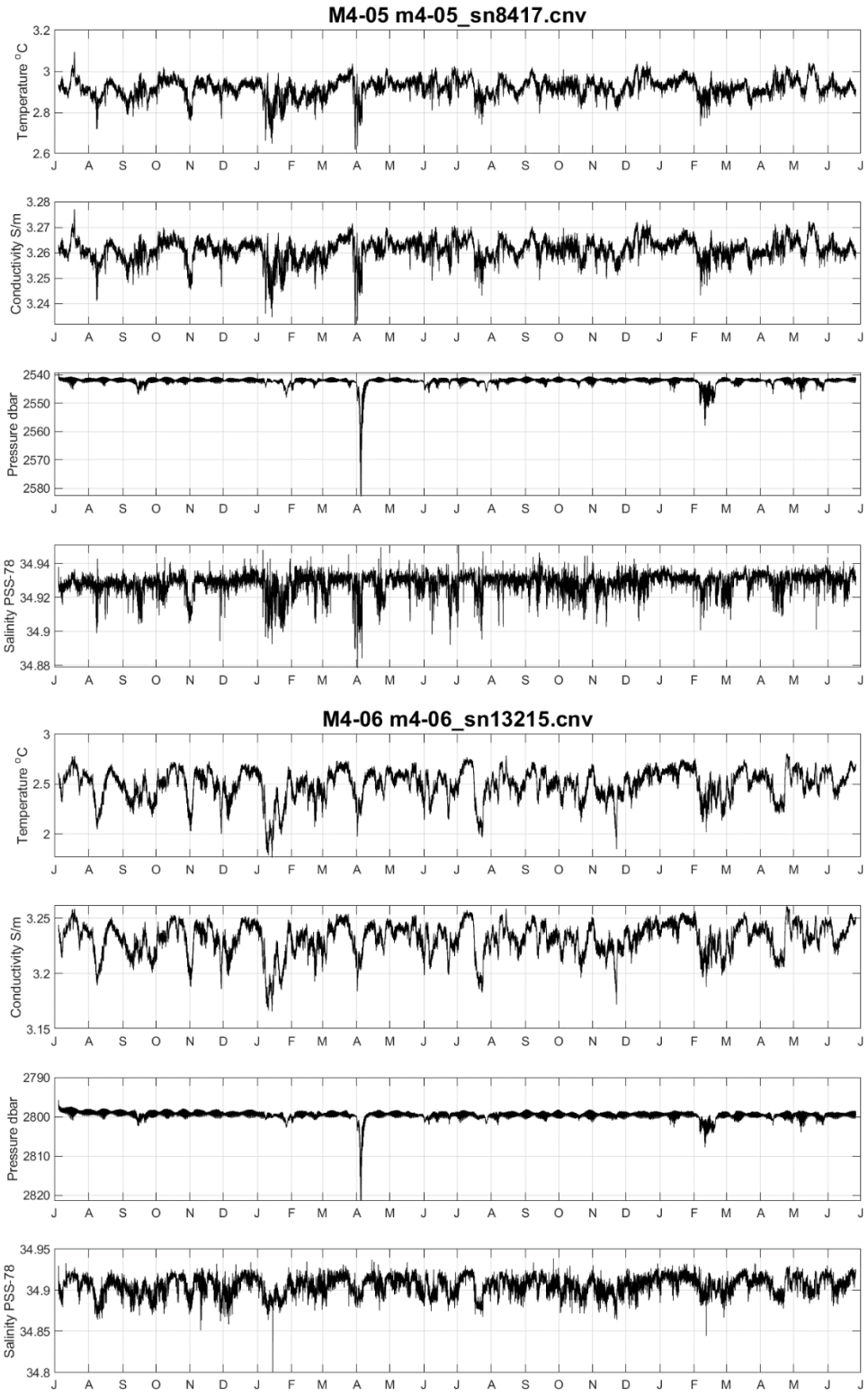
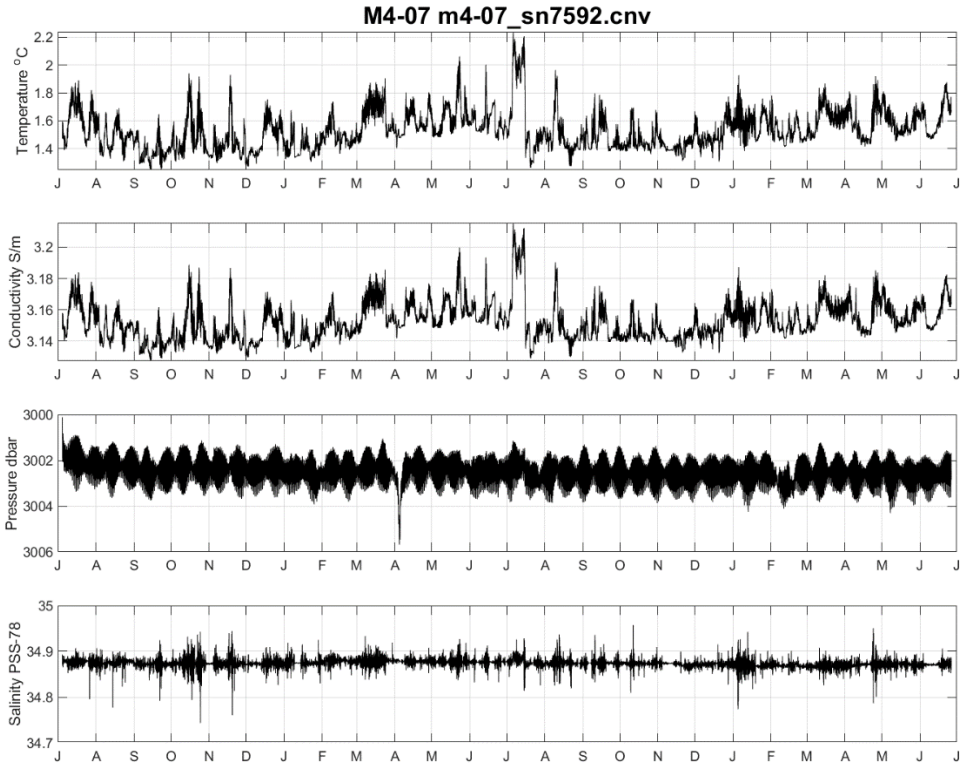
Temperature °C
3.7
3.6
3.5
3.4
Conductivity S/m
3.3
3.25
3.2
Pressure dbar
1520
1540
1560
1580
1600
Salinity PSS-78
35
34.8
34.6
34.4
34.2
J A S O N D J F M A M J J A S O N D J F M A M J J
M4-02 m4-02_sn11527.cnv
Temperature °C
3.6
3.5
3.4
3.3
Conductivity S/m
3.2
3
2.8
2.6
Pressure dbar
1760
1780
1800
1820
1840
Salinity PSS-78
35
30
25
J A S O N D J F M A M J J A S O N D J F M A M J J


M4-03 m4-03_sn7580.cnv
Temperature °C
3.5
3.4
3.3
3.2
3.1
Conductivity S/m
3.29
3.28
3.27
3.26
3.25
Pressure dbar
2020
2040
2060
2080
2100
Salinity PSS-78
34.96
34.94
34.92
34.9
34.88
J A S O N D J F M A M J J A S O N D J F M A M J J


M4-04 m4-04_sn6664.cnv
Temperature °C
3.3
3.2
3.1
3
Conductivity S/m
3.28
3.27
3.26
3.25
Pressure dbar
2280
2300
2320
2340
Salinity PSS-78
34.94
34.92
34.9
34.88
J A S O N D J F M A M J J A S O N D J F M A M J J


M4-05 m4-05_sn8417.cnv
Temperature °C
3.2
3
2.8
2.6
Conductivity S/m
3.28
3.27
3.26
3.25
3.24
Pressure dbar
2540
2550
2560
2570
2580
Salinity PSS-78
34.94
34.92
34.9
34.88
J A S O N D J F M A M J J A S O N D J F M A M J J
M4-06 m4-06_sn13215.cnv
Temperature °C
3
2.5
2
Conductivity S/m
3.25
3.2
3.15
Pressure dbar
2790
2800
2810
2820
Salinity PSS-78
34.95
34.9
34.85
34.8
J A S O N D J F M A M J J A S O N D J F M A M J J


M4-07 m4-07_sn7592.cnv
Temperature °C
2.2
2
1.8
1.6
1.4
Conductivity S/m
3.2
3.18
3.16
3.14
Pressure dbar
3000
3002
3004
3006
Salinity PSS-78
35
34.9
34.8
34.7
J A S O N D J F M A M J J A S O N D J F M A M J J

Appendix G: Hydrography report.

Overview

Over the course of the cruise, 19 CTD casts were completed. CTD casts were executed for one or more of the following reasons:

1. Mooring sensor validation
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 19 of the 19 stations. Water samples were analyzed on-board for salts and dissolved oxygen for both OSNAP and OOI CTD casts. OOI water samples collected for dissolved inorganic carbon (DIC), total alkalinity (TA), pH, nutrients, and chlorophylls will be analyzed on-land after the cruise. The Palevsky group also collected DIC and POC/DOC, where POC/DOC were filtered onboard, and all analyzed post-cruise. Sample logs are saved in the cruise directory.

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, all sensors and the rosette were hosed down.

Other Notes

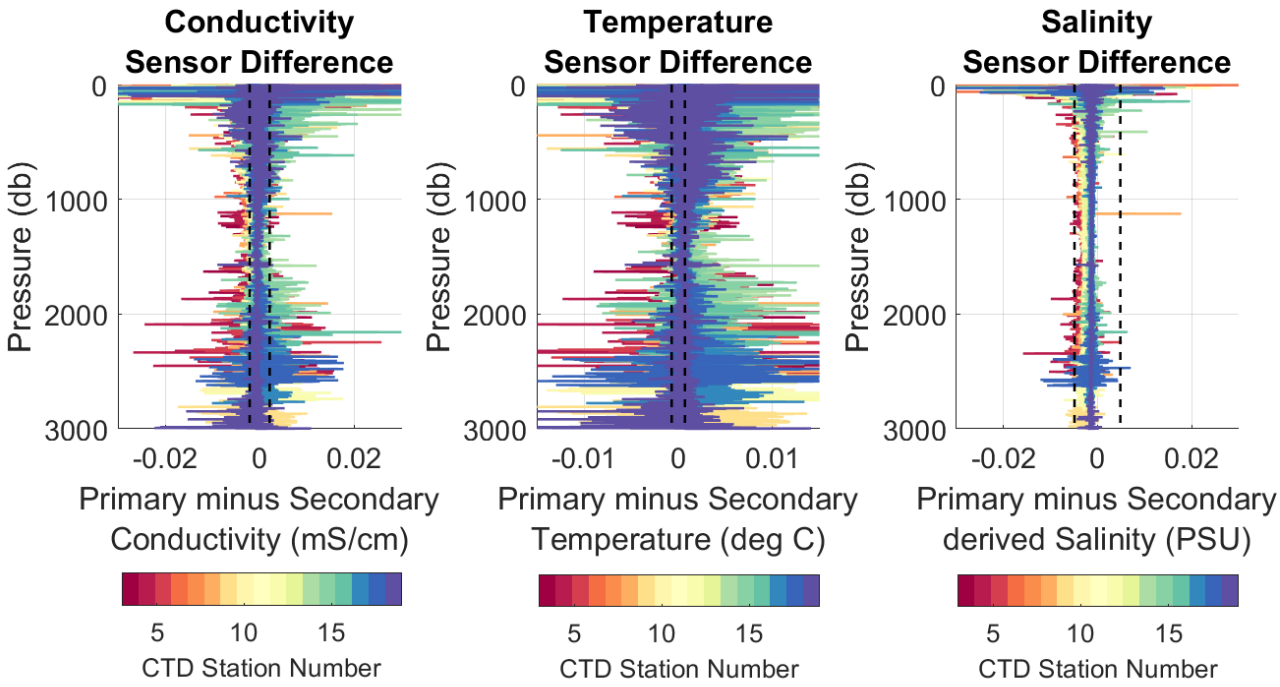
The CTD, pylon, and Niskins worked well throughout the cruise. However, the salinometer did not. After extensive troubleshooting (documented in the OOI Irminger-11 cruise report), including communication with shore-side support, we pulled out the PortoSal from the hold and used this throughout the cruise. TBD if this will be sufficient for lowered CTD calibration.

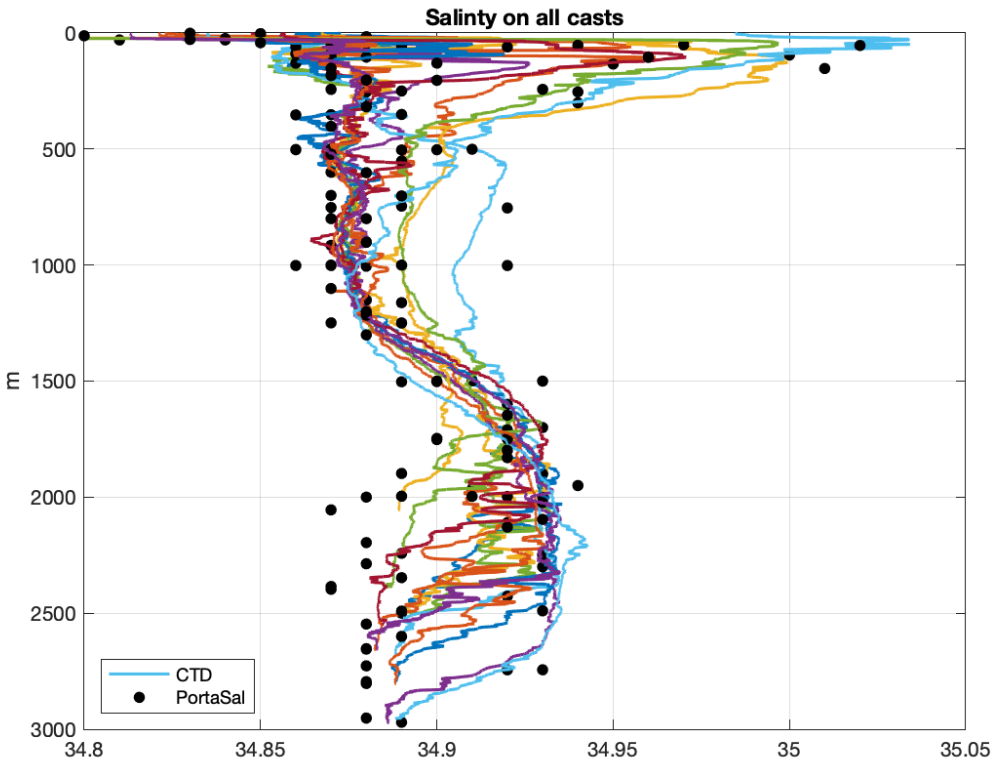
Plots of each cast's raw salinity and oxygen profiles, and salt and oxygen sample depth and value are shown below. Only casts with salinity or oxygen sampling are plotted, e.g., cast #004 had salt sampling only. Casts #006, 011, and 013 had no salt or oxygen sampling, and were considered 'BGC' casts only, thus not polted.

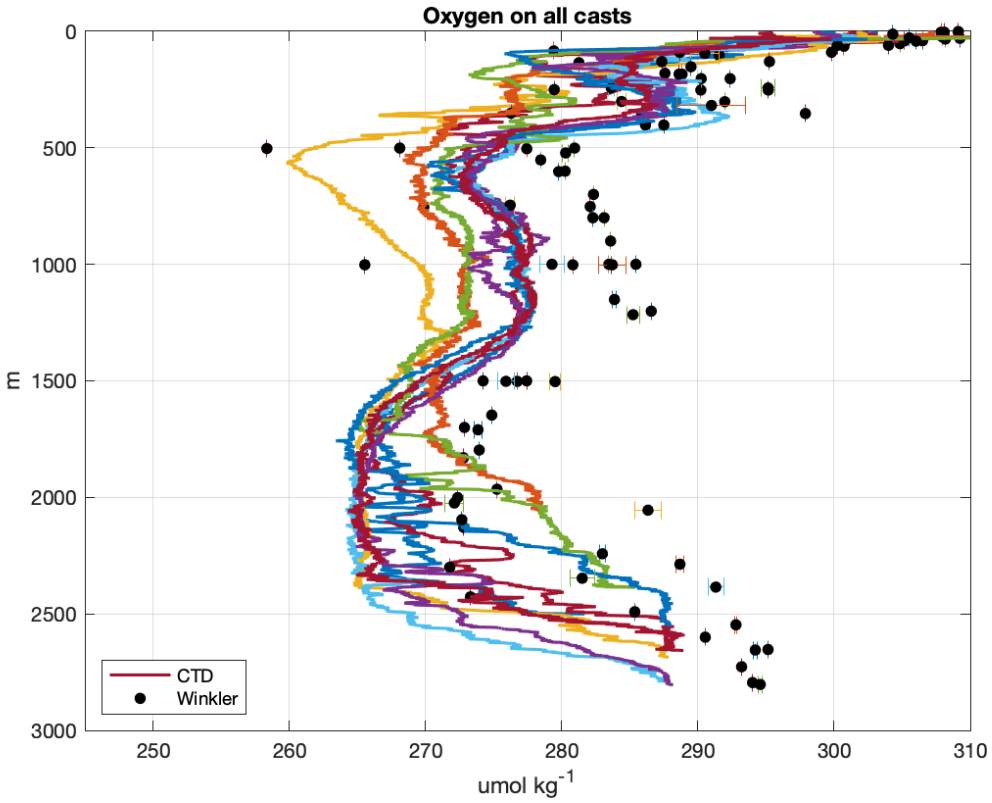
CTD station table

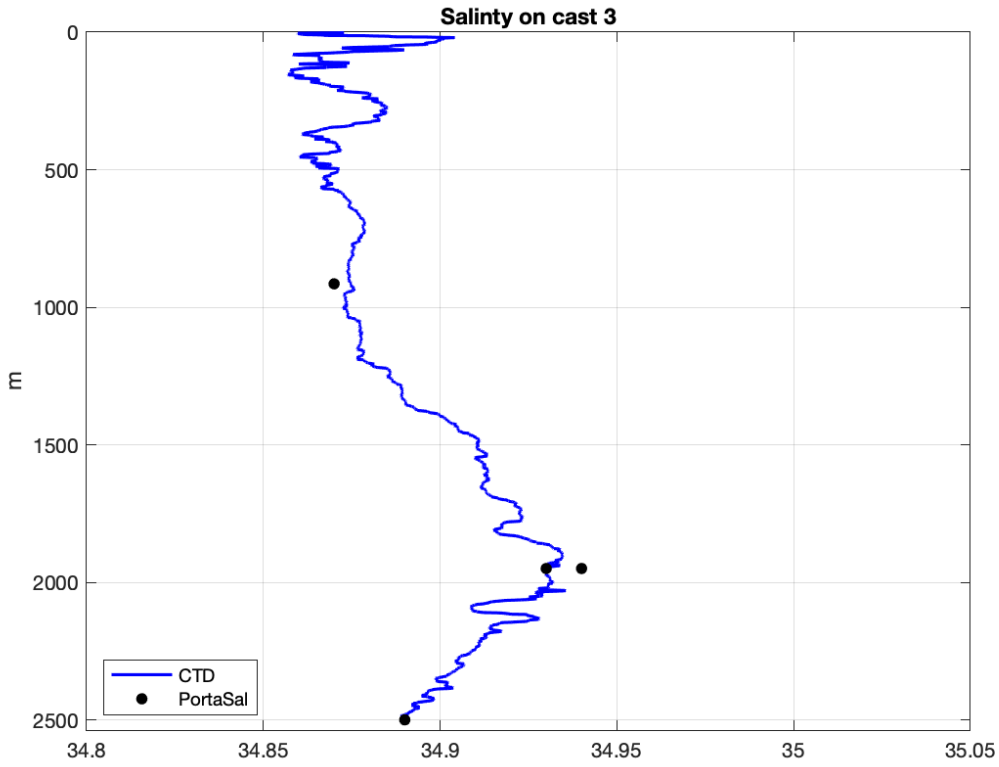
CTD Number	Location/relevance	Date	Start Time (UTC)	Lat (degN)	Lat (minN)	Lon (degW)	Lon (minW)	Bottom depth (m)	Water Samples	Comments
1	SBE18 test cast	2-Jun-24	23:01	41	39	-69	9	174	Salts, POC, DOC	pH sensor on rosette, fired all niskins and niskins 9 and 10 leaked
2	Acoustic release test	7-Jun-24	11:35	51	33.65	-47	53.42	3580	Salts, oxygen	All niskins fired, no leaks
3	Acoustic release test	9-Jun-24	10:51	59	55.88	-39	38.32	2652	Salts, oxygen	Acoustic release test
4	Acoustic release test	9-Jun-24	14:12	59	56.80	39	39.11	2637	Salts	Acoustic release test
5	OOI SUMO	11-Jun-24	9:01	59	56.40	-39	31.35	2680	Salts, oxygen, chl, nitrate, DIC-TA OOI, DIC-TA BGC, POC	OOI SUMO calibration cast, acoustic release test
6	BGC SUMO	11-Jun-24	20:00	59	56.37	-39	31.30	2677	POC, DOC, DIC-TA BGC	Auxillary BGC cast, to 1150m with pH sensor on rosette
7	Glider box	12-Jun-24	10:38	59	54.22	-39	16.81	2760	Salts, oxygen, chl, nitrate, DIC-TA BGC, POC	Glider calibration cast, with pH sensor on rosette
8	OSNAP caldip	12-Jun-24	16:19	60	18.03	-39	29.88	2674	Salts, Oygen	ONAP calibration dip with optodes, microcats, and acoustic release test
9	M4	13-Jun-24	15:47	59	38.16	-38	33.50	2988	Salts, Oxygen	OSNAP M4 validation cast, Microcat calibration dip, acoustic release test
10	OOI FLMA	14-Jun-24	16:19	59	46.14	-39	51.67	2696	Salts, Oxygen, DIC-TA, Nitrate, Chl	OOI FLMA calibration cast
11	BGC FLMA	14-Jun-24	21:06	59	46.13	-39	51.72	2696	DIC-TA BGC, DOC, POC	Auxillary BGC cast, to 1150m with pH sensor on rosette
12	OOI FLMB	15-Jun-24	15:47	59	43.01	-39	20.19	2824	Salts, Oxygen, DIC-TA, Nitrate, Chl	OOI FLMB calibration cast, several misfired niskins not sampled
13	BGC FLMB	15-Jun-24	21:05	59	42.75	-39	20.35	2826	DIC-TA BGC, POC	Auxillary BGC cast, to 1150m with pH sensor on rosette
14	M1	17-Jun-24	10:01	59	54.42	-41	7.27	2072	Salts, Oxygen, DIC-TA BGC	OSNAP M1 validation cast
15	M2	17-Jun-24	14:29	59	52.15	-40	41.40	2402	Salts, Oxygen, DIC-TA BGC	OSNAP M2 validation cast
16	M3	17-Jun-24	18:24	59	49.23	-40	16.41	2556	Salts, Oxygen, DIC-TA BGC	OSNAP M3 mooring validation cast, issues with winch slowed cast to 30m/min
17	OSNAP cal dip at FLMB	19-Jun-24	14:53	59	44.81	-39	18.64	2817	Salts, Oxygen	OSNAP calibration dip with optodes, run at max 30m/min
18	OOI HYPM, OSNAP cal dip	23-Jun-24	10:15	59	44.87	-39	18.78	2671	Salts, Oxygen, Chl, DIC-TA BGC, POC, DOC	OOI HYPM calibration cast, OSNAP calibration dip, run at max 30m/min
19	transit OSNAP cal dip	28-Jun-24	9:21	61	37.45	-33	44.85	2962	Salts	OSNAP and OOI FLMA microcat cal dip

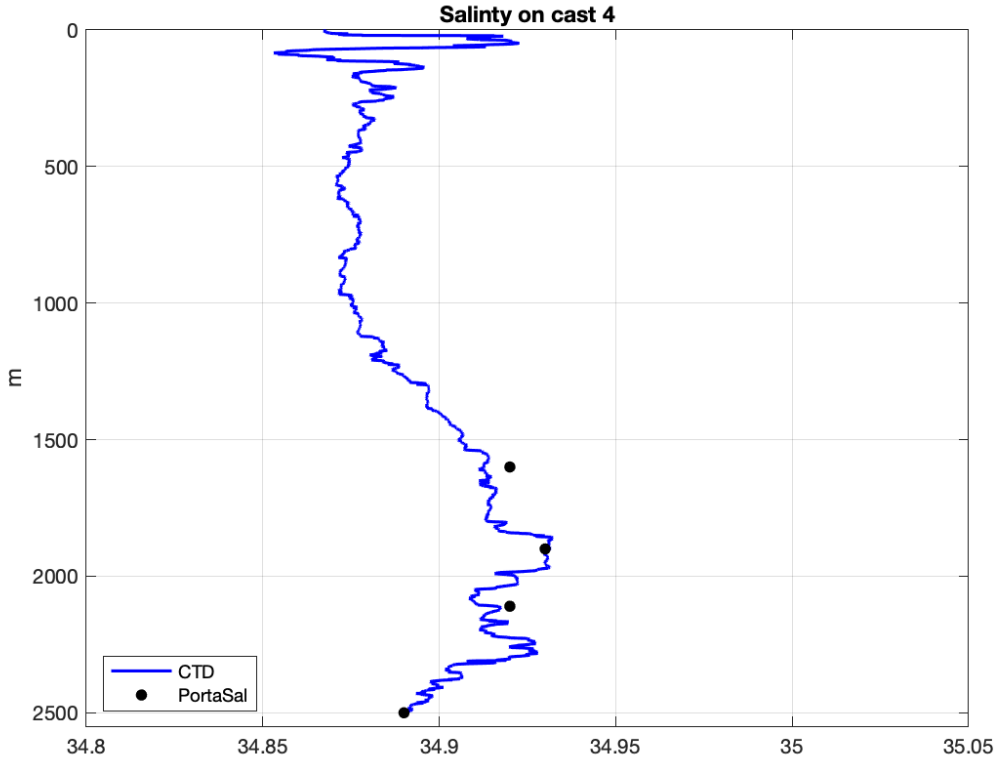
Master sampling spreadsheet created by Meg Yoder is availabel on cruise drive, 'Irminger11 Master Record of Samples_final.xlsx'.

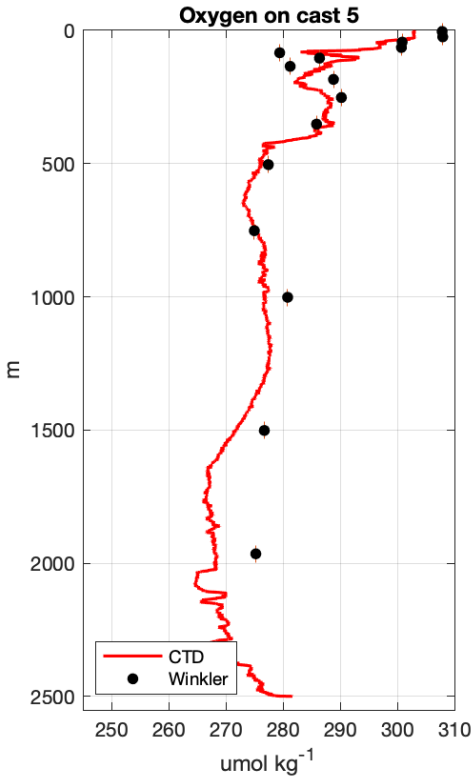


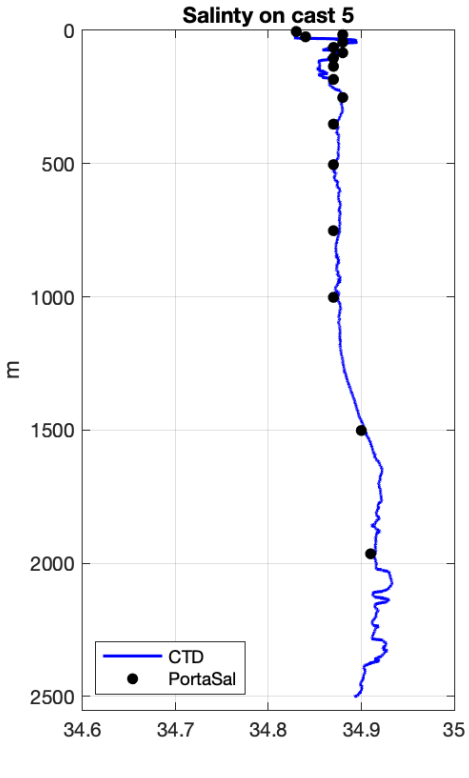

Salinty on all casts
m
0
500
1000
1500
2000
2500
3000
34.8
34.85
34.9
34.95
35
35.05
CTD
PortaSal

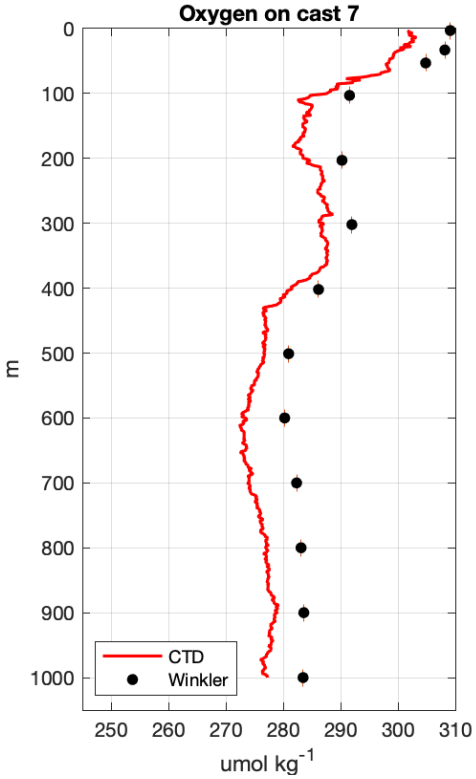

Oxygen on all casts
m
0
500
1000
1500
2000
2500
3000
250
260
270
280
290
300
310
umol kg-1
CTD
Winkler

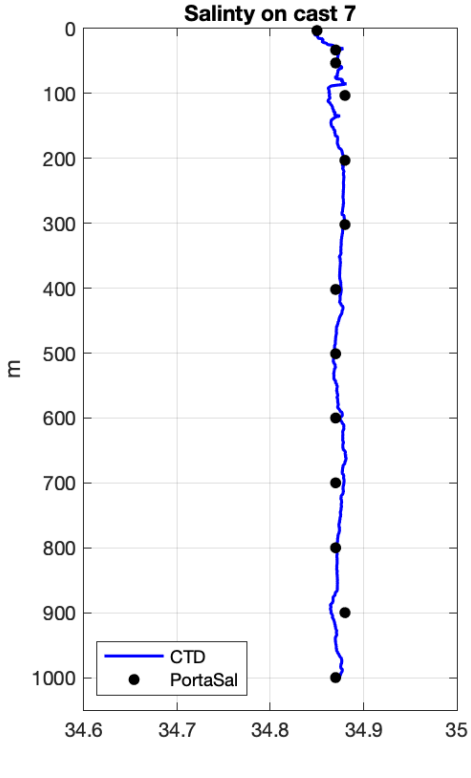

Salinty on cast 3
0
500
1000
1500
2000
2500
m
34.8
34.85
34.9
34.95
35
35.05
CTD
PortaSal

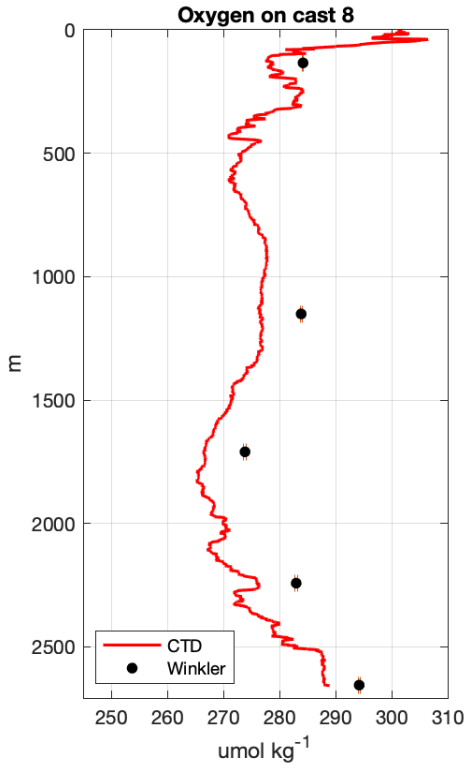

Salinty on cast 4
0
500
1000
1500
2000
2500
m
34.8
34.85
34.9
34.95
35
35.05
CTD
PortaSal

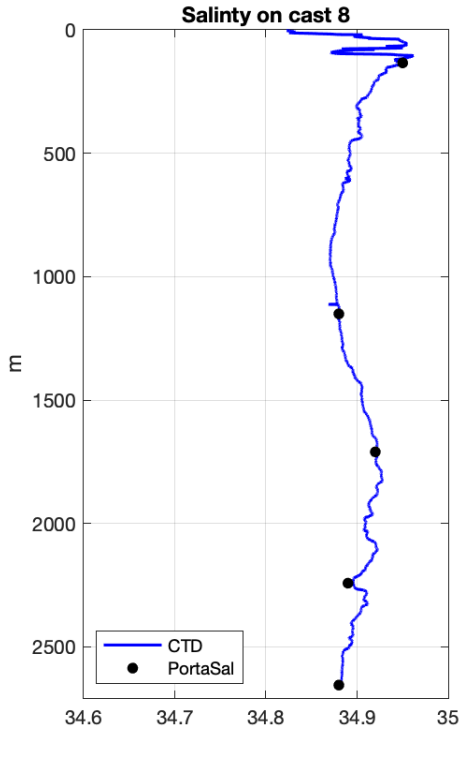

Oxygen on cast 5
0
500
1000
1500
2000
2500
m
250
260
270
280
290
300
310
umol kg-1
CTD
Winkler

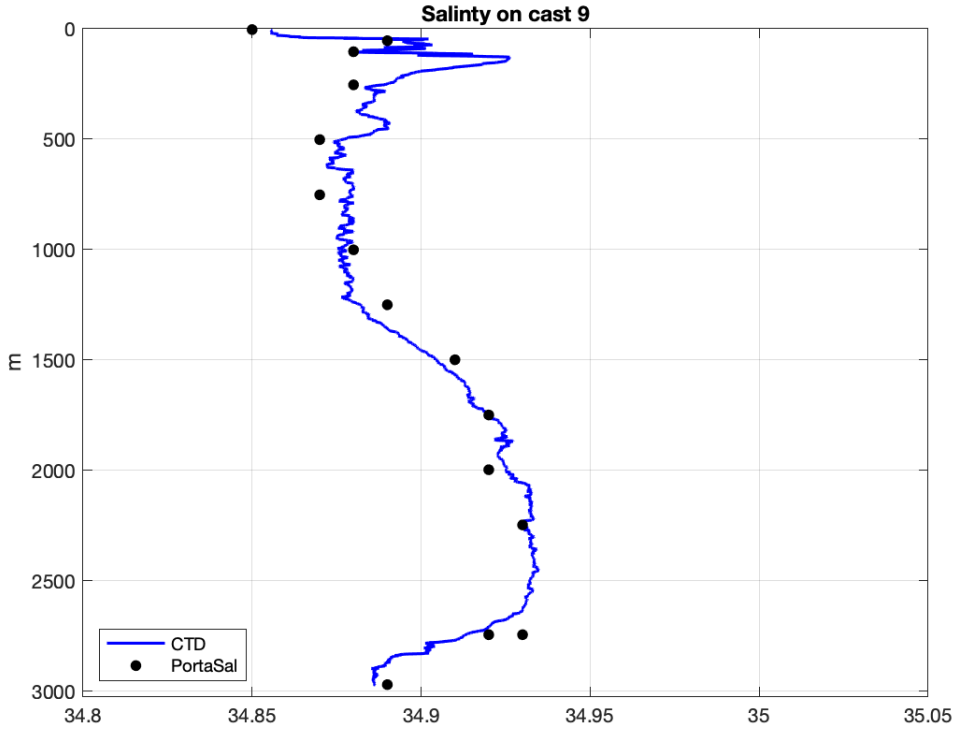

Salinty on cast 5
0
500
1000
1500
2000
2500
m
34.6
34.7
34.8
34.9
35
CTD
PortaSal

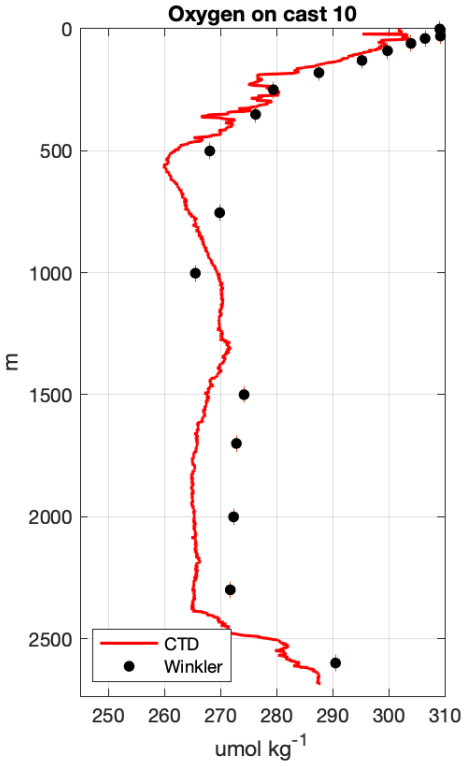

Oxygen on cast 7
0
100
200
300
400
500
600
700
800
900
1000
m
250
260
270
280
290
300
310
umol kg-1
CTD
Winkler

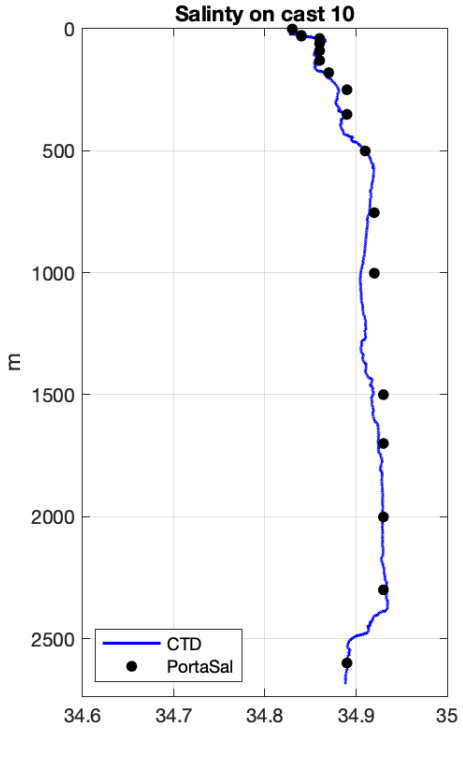

Salinty on cast 7
0
100
200
300
400
500
600
700
800
900
1000
m
34.6
34.7
34.8
34.9
35
CTD
PortaSal


Oxygen on cast 8
m
umol kg-1
CTD
Winkler


Salinty on cast 8
m
CTD
PortaSal


Salinty on cast 9
m
CTD
PortaSal


Oxygen on cast 10
0
500
1000
1500
2000
2500
m
CTD
Winkler
250
260
270
280
290
300
310
umol kg-1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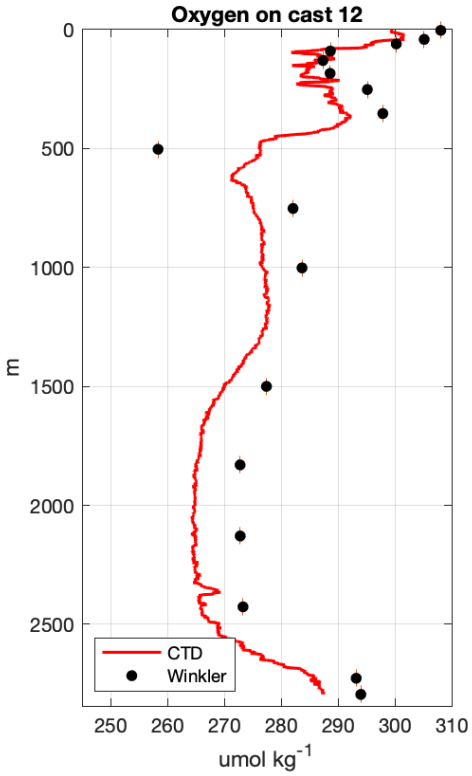
0
500
1000
1500
2000
2500
m
CTD
PortaSal
34.6
34.7
34.8
34.9
35


Oxygen on cast 12
0
500
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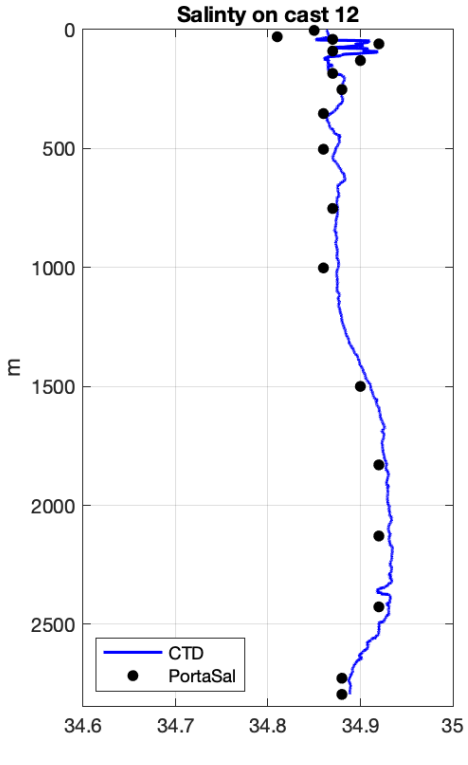
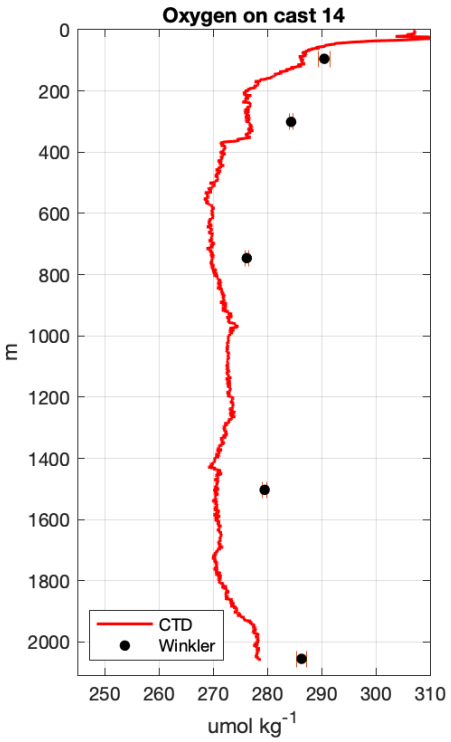
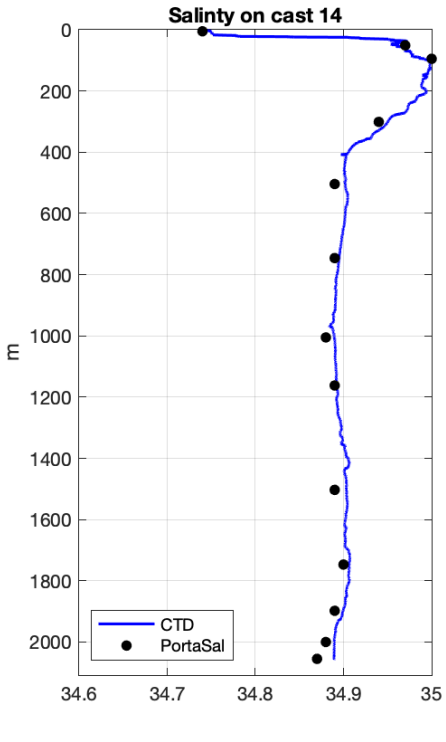
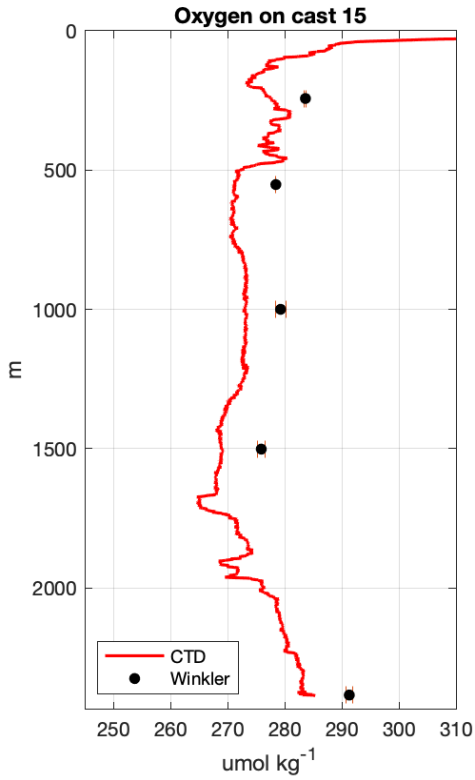
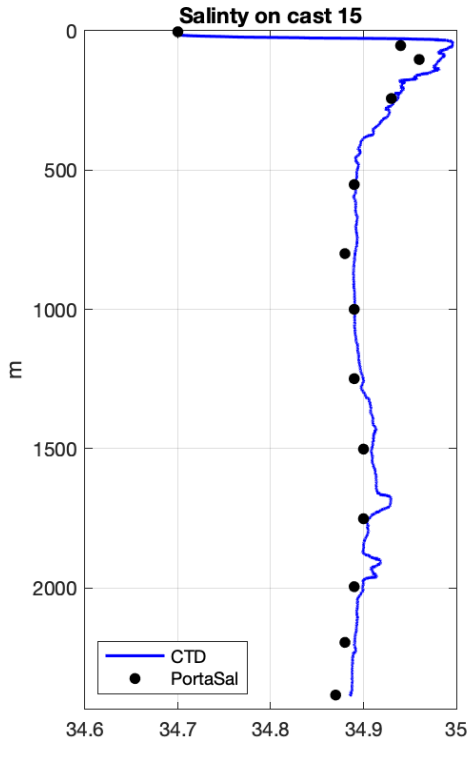
1500
2000
2500
m
CTD
Winkler
250
260
270
280
290
300
310
umol kg-1

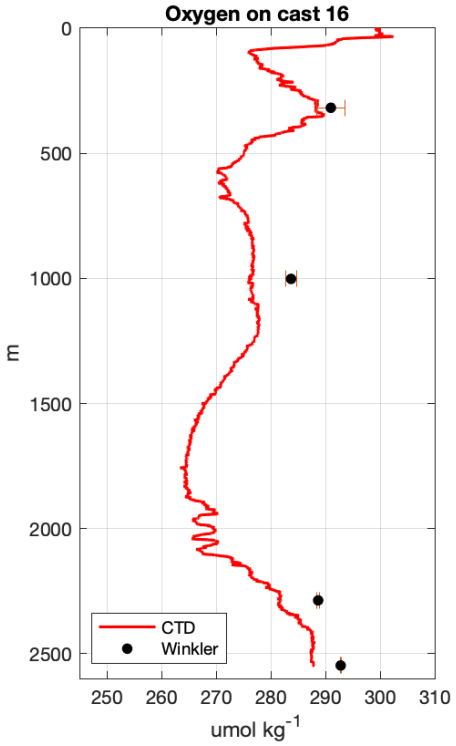

Salinty on cast 12
0
500
1000
1500
2000
2500
m
CTD
PortaSal
34.6
34.7
34.8
34.9
35

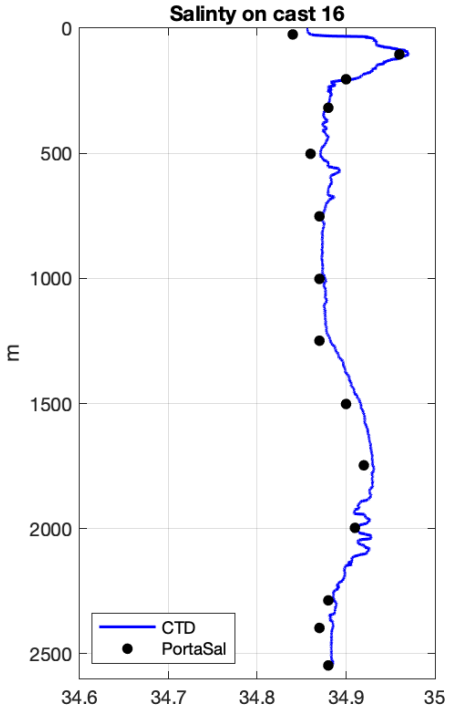

Oxygen on cast 14
m
umol kg-1
CTD
Winkler

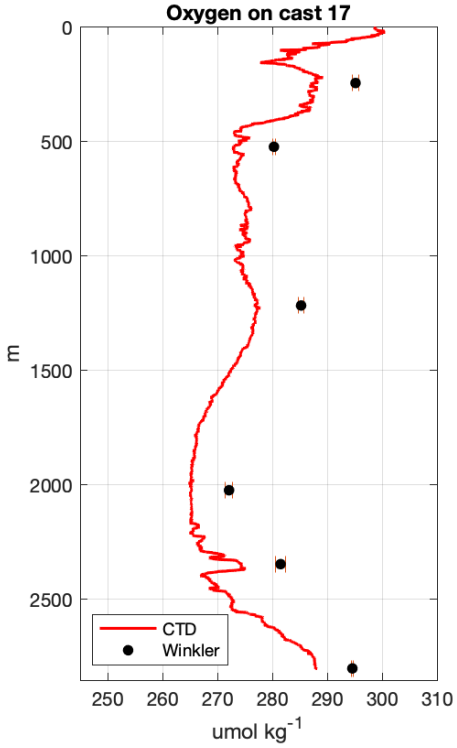

Salinty on cast 14
m
CTD
PortaSal

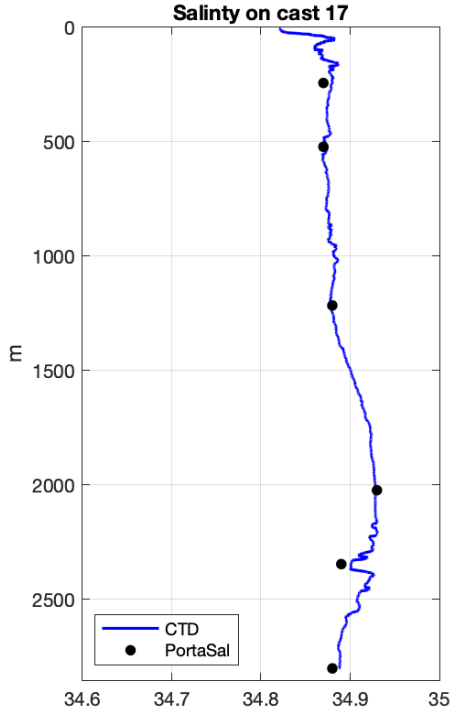

Oxygen on cast 15
m
umol kg-1
CTD
Winkler

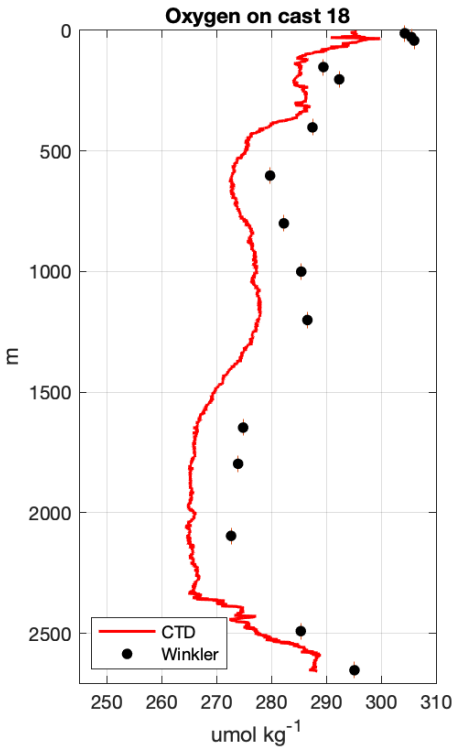

Salinty on cast 15
m
CTD
PortaSal

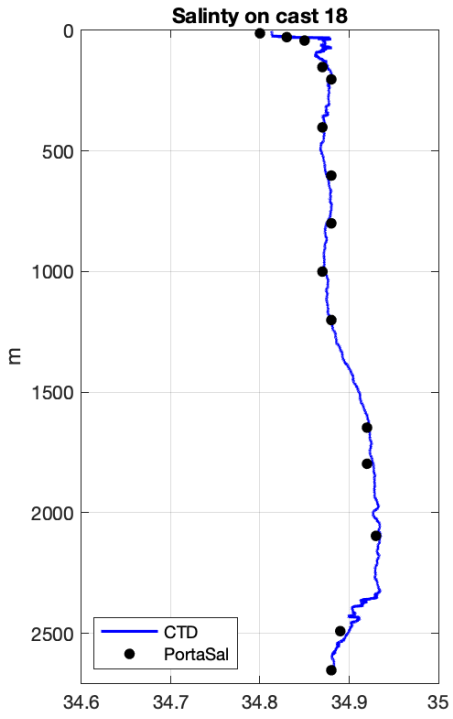

Oxygen on cast 16
m
umol kg-1
CTD
Winkler

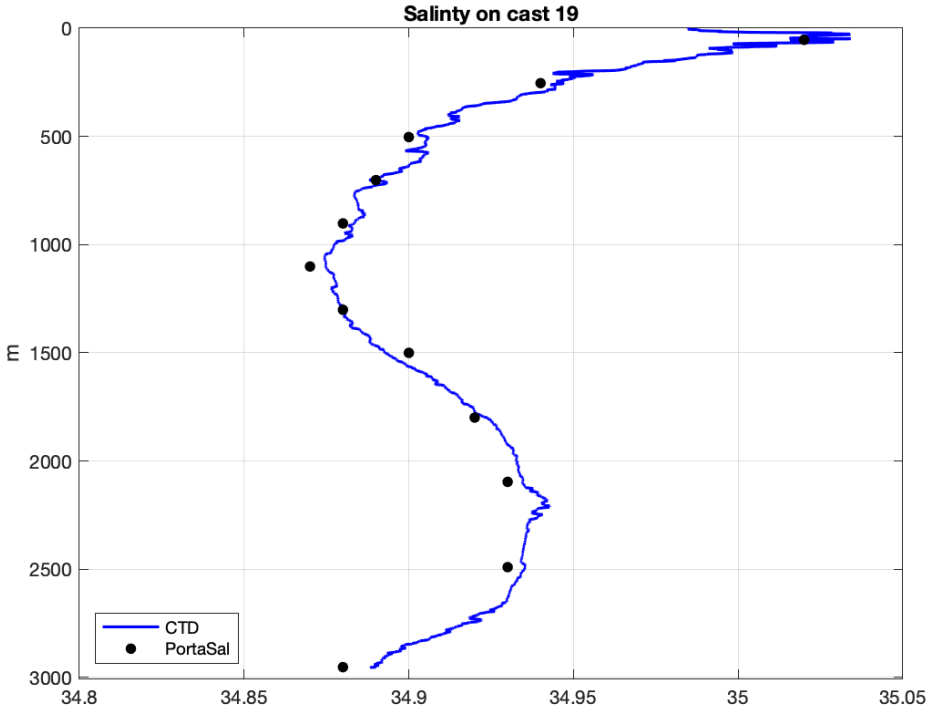

Salinty on cast 16
m
CTD
PortaSal


Oxygen on cast 17
m
umol kg-1
CTD
Winkler


Salinty on cast 17
m
CTD
PortaSal


Oxygen on cast 18
m
umol kg-1
CTD
Winkler


Salinty on cast 18
m
CTD
PortaSal


Salinty on cast 19
m
CTD
PortaSal