Ellett Array 2024 – an Atlantic Climate and Environment Strategic Science (AtlantiS) & Overturning in the Subpolar North Atlantic Programme (OSNAP) expedition

Cruise Report No. 301 for RRS Discovery DY181,
3rd July to 28th July 2024

Principal Scientist: Penny Holiday

Chief Scientist: Kristin Burmeister

Deputy Chief Scientist: Yvonne Firing

Co-chief Scientist: Tiago Segabinazzi Dotto

Editor: Kristin Burmeister

Scottish Association for Marine Science, Year 2025

DOCUMENT DATA SHEET

Author Kristin Burmeister, Tiago S. Dotto and Yvonne Firing	**Publication Date**
Title Ellett Array 2024 – an Atlantic Climate and Environment Strategic Science (AtlantiS) & Overturning in the Subpolar North Atlantic Programme (OSNAP) expedition: Cruise report No 301 for RRS Discovery Expedition DY181	
Reference Burmeister, Kristin, Tiago S. Dotto, Yvonne Firing (2025): Ellett Array 2024 – an Atlantic Climate and Environment Strategic Science (AtlantiS) & Overturning in the Subpolar North Atlantic Programme (OSNAP) expedition: Cruise report No 301 for RRS Discovery Expedition DY181, 3rd July – 28th July 2024, Oban, Uk: Scottish Association for Marine Science, Oban, 224p	

Abstract

The primary objective of the expedition was to service the Ellett array of moorings that are deployed across the subpolar North Atlantic to measure the variability of the Atlantic Meridional Overturning Circulation (AMOC). The main measurements required are of temperature, salinity, current speed. On this expedition there are two main groups of moorings measuring these variables: one for the Rockall Trough (RTEB1, RTWB2, RTWB1, RHADCP) and one in the Iceland Basin (IB5, IB4, IB3 – discontinued from 2024 onwards). In addition, a CTD section was undertaken between the Scottish continental shelf and 57°58.84'N, 025°40.57'W, just west of the discontinued mooring IB3.

The specific measurement objectives of the cruise were:

- Recover and redeploy the Ellett array of moorings (RTEB1, RTWB2, RTWB1, RHADCP IB5, IB4, IB3 – IB3 is discontinued from 2024 onwards)
- Four days of DY181 were dedicated to acoustic telemetry testing for WP3 Task B of the RAPID-Evolution project, part of the CCROC program.
- A new drift free pressure sensor was deployed on a lander at the IB4 site and data was downloaded from a similar instrument installed at the RTEB1 side in 2022.
- A mooring to observe particles falling to the sea floor (sediment trap and ADCP) was serviced at the Darwin Mounds Marine protected Area.
- Additional instruments were deployed on moorings to measure oxygen, pH and nutrients.
- To calibrate the moored instruments a number of CTD profiles were made measuring temperature, salinity and oxygen. Water samples were taken and analysed for salinity and oxygen, nutrients, DIC and total alkalinity.
- 6 Argo floats were deployed. These are a part of the international Argo program (http://www.argo.net/).
- Two projects were supported through the AtlantiS berth of opportunity programme: i) Lab-on-Chip sensor was installed to automate water sampling for surface carbon chemistry parameters. ii) A gas-tight carbonate seawater sampler was tested.
- A CTD section was undertaken to survey an eddy close to the Ellett Array sections in the Iceland Basin.

Keywords

AtlantiS, Ellett Array, OSNAP, AMOC, Moorings, North Atlantic, mooring array, CTD, Telemetry, Autonomy, Bottom Pressure Sensors

Issuing Organisation

Scottish Association for Marine Science (SAMS)

(This page is intentionally left blank.)

Table of Contents

1 Scientific and Ship's Personnel

	Family Name	Given Names	Position	Affiliation
1	MACKAY	STEWART MACDONALD	Master	
2	MAHON	ANDREW	Chief Officer	
3	STRINGFELLOW	GRAHAM ROBERT	2nd Officer	
4	BROWN	JONATHAN ROBERT	3rd Officer	
5	MC COY	GARRY THOMAS	Chief Engineer	
6	HAY	DEREK BRIAN	2nd Engineer	
7	GHEISARI-MIANDOAB	JONATHAN	3rd Engineer	
8	FOWLER	BENJAMIN JOHN	3rd Engineer	
9	FISHER	CHARLES GEORGE JOHN	ETO	
10	BULLIMORE	GRAHAM	Purser	
11	PHILLIPS	LEANNA EVA ROSE	Deck Cadet	
12	HARDING	HARRIET	Deck Cadet	
13	SMITH	STEPHEN JOHN	CPOS	
14	COOK	STUART CLIVE	CPOD	
15	RILEY	KEVIN PETER	POD	
16	BURKE	TERRY	POS	
17	WRIGHT	MARTIN KARL	SG1A	
18	STALKER	LUKE	SG1A	
19	PEPPIN	CHRISTOPHER	SG1A	
20	QUENAULT	PAUL LEE	ERPO	
21	LYNCH	PETER ANTHONY	Head Chef	
22	BURGESS	NEIL ROBERT	Chef	
23	CARRILHO MANTINHA	CLEMENTINA MARIA	Steward	
24	DARKE	ANTHONY	Assistant Steward	
25	BALLINGER	THOMAS JOSEPH	Technician	NOC/NMFSS
26	POWELL	TIMOTHY DAVID	Technician	NOC/NMFSS
27	CROWE	CHRISTIAN LEE	Technician	NOC/NMFSS
28	CHILDS	DAVID MATTHEW	Technician	NOC/NMFSS
29	COTMORE	ANDREW JOHN	Technician	NOC/NMFSS
30	BRIDGER	MARTIN JOHN	SST	NOC/NMFSS
31	SOUGIOULTZOGLOU	FINNEGAN	Technician	NOC/NMFSS
32	FIRING	YVONNE LEILANI	Deputy Scientist	NOC
33	DOTTO	TIAGO SEGABINAZZI	Co-Chief Scientist	NOC
34	BURMEISTER	KRISTIN	Chief Scientist	SAMS
35	CASTLE	SAMUEL TIMOTHY	Scientist	NOC
36	TRUCCO PIGNATA	PABLO NICOLAS	Scientist	NOC
37	SPERLING	ANNEKE	PhD Student	UNEDIN/NOC
38	CLARK	MATTHEW PHILIP	Scientist	NOC
39	DUMONT	ESTELLE	Science Tech	SAMS
40	HEWETT	ZARINA	PhD Student	UCL
41	PALOCZY	ANDRE	Scientist	NOC
42	SMITH	HELEN	Science Tech	SAMS
43	WALK	JOHN ANTHONY	Scientist	NOC
44	ELLIOTT-WALKER	ISABELLA ELAINE	Undergraduate	UHI
45	MARRIS	CHARLOTTE MARIA	PhD Student	Uni. Of Oxford
46	BRUNNER	LARS	Science Tech	SAMS
47	CARDWELL	CHRISTOPHER LEONARD	Scientist	NOC
48	JONES	SAM	Scientist	SAMS
49	ABELL	RICHARD	Science Tech	SAMS
50	GARNER	JADE ELIZABETH	Technician	NOC/NMFSS
51	WEEKS	MARTIN	Technician	NOC/NMFSS

2 Cruise Narrative

Date	Operation	Start time (UTC)	End time (UTC)	Durat (hrs:min)	Latitude (°N)	Longitude (°W)	Notes
Wed 03 Jul	Depart Aberdeen	12:30					
	CTD 1	19:10	19:28	00:18	57.398003	-1.342781	CTD test - 118m
Thu 04 Jul	CTD 2	18:02	20:00	01:58	59.712873	-6.635171	CTD test - 500m, SUNA cal dip 0
	CTD 3	21:41	22:55	01:14	59.803149	-6.932419	Darwin Mound cal dip 1 - 1037m
Fri 05 Jul	DMLTM Recovery	07:05	08:17	01:12	59.860917	-7.035751	
	DMLTM Deployment	10:00	10:17	00:17	59.861056	-7.044733	Setup dist 500m, 60m - Line deployed by hand, no winch
	DMLTM Trilateration	10:42	12:10	01:28			
Sat 06 Jul	CTD 4	06:53	09:18	02:25	57.231775	-10.048964	Station N, cal dip 1 - 2120 m
	CTD 5	09:48	12:37	02:49	57.231774	-10.048959	Station N, cal dip 2 - 2105 m
	Argo float 1	12:59			57.22705	-10.026407	WHOI NAVIS BGC Argo SN1565
	AZA Fetch Download	14:46	15:44	00:58	57.100153	-9.55314	RTEBL1 download
Sun 07 Jul	Pick up Kristin	08:00					Excurse to Oban
	CTD 6	16:00	16:32	00:32	56.808487	-8.16561	Station 14G - 129m
	CTD 7	17:21	17:48	00:27	56.838131	-8.331893	Station T - 136 m
	CTD 8	18:34	19:00	00:26	56.883324	-8.497703	Station 15G -129 m
	CTD 9	20:29	20:47	00:18	56.950878	-8.783848	Station S - 128 m
	vmADCP slope survey	22:30	05:16	06:46	57.099612	-9.176033	Slope current survey, repeated section between 280m - 1000m

Mon 08 Jul	Teletest1 mooring D	07:49	08:06	00:17	57.135658	-9.594539	
	Teletest1 trilateration	08:40	09:48	01:08			1nm radius
	100 m testing	10:23	14:52	04:29	57.137599	-9.593558	Communication test 100m from mooring
	900 m testing	14:52	18:17	03:25	57.139733	-9.629729	Communication test 900m from mooring, moving ship USBL range test
	CTD 10-33	19:55	05:37	09:42	57.10021	-9.278954	CTD YOYO in slope current core - 412 m
Tue 09 Jul	Teletest1 mooring R	07:14	08:24	01:10	57.135945	-9.59818	Very close to ship - strong current?
	CTD 34	11:47	12:10	00:23	56.950126	-8.783417	Station S - 126 m
	CTD 35	13:28	13:59	00:31	56.999403	-8.996676	Station R - 133
	CTD 36	15:05	15:38	00:33	57.051305	-9.218879	Station Q - 317m
	CTD 37	16:36	18:13	01:37	57.100897	-9.418527	Station P - 1418m
	CTD 38	19:42	21:08	01:26	57.149869	-9.700384	Station O - 1931m
	CTD 39	23:00	00:49	01:49	57.231567	-10.047613	Station N - 2106 m
Wed 10 Jul	CTD 40	03:32	05:04	01:32	57.087443	-9.548069	EB1 Pre - 1797m
	RTEB1 Recovery	06:03	08:42	02:39	57.095338	-9.569732	
	RTEB1 Deployment	11:50	15:57	04:07	57.102368	-9.561014	Setup dist 3nm bc inductive wire, 7 techs for buoy attachment, ave ship speed ~0.6knots planned for 1knot, advise on speed?
	RTEB1 Trilateration	16:17	17:33	01:16			1nm radius
	CTD 41	17:43	19:09	01:26	57.10397	-9.591995	EB1 Post - 1830m
	CTD 42	22:23	00:07	01:44	57.301219	-10.381558	Station M - 2212m
Thu 11 Jul	CTD 43	01:33	03:19	01:46	57.367025	-10.666407	Station L - 2106m
	CTD 44	04:37	05:29	00:52	57.367029	-10.666403	Station K - 788m
	CTD 45	06:44	07:32	00:48	57.448004	-11.085497	Station J - 587m

	RTWB2 Recovery	11:46	13:45	01:59	57.473288	12.304189	NW 0.5kn current, strong westerlies pushed start and end of mooring like U together
	RTWB2 Deployment	14:51	16:37	01:46	57.470152	12.313058	strong pull on mooring bc 0.5kn NE current plus moderate westerlies, hence ship speed 0.5 kn, long tow, generally setup dist of 1nm should be sufficient
	RTWB2 Trilateration	17:14	18:19	01:05			0.8nm radius
	CTD 46	21:10	23:49	02:39			Station H - 2017m - caldip MC, releaser, 6 stops@10min
Fri 12 Jul	CTD 47	01:11	01:56	00:45	57.468269	11.317396	Station I - 747m
	CTD 48	04:13	05:56	01:43	57.492395	11.848779	Station G - 1794m
	RTWB1 Recovery	09:20	11:24	02:04	57.446543	12.725863	
	RTWB1 Deployment	13:03	15:12	02:09	57.471478	12.706308	No wind, no current, 1.5nm setup dist, started with 1.5 knots ship speed, too fast, then slowed down under 0.5 knots, too slow, ended up with 30min tow, watch depth for anchor drop - steep slope
	RTWB1 Trilateration	15:39	16:35	00:56			0.8 nm radius
	CTD 49	18:14	20:01	01:47	57.507218	-12.245347	Station F - 1810m
	CTD 50	21:42	23:35	01:53	57.532755	-12.632262	Station E - 1651 m
Sat 13 Jul	CTD 51	00:36	01:38	01:02	57.54223	-12.866037	Station D - 1077m
	CTD 52	02:29	03:04	00:35	57.548789	-12.995448	Station C - 299 m
	CTD 53	04:27	04:56	00:29	57.567154	-13.331493	Station B - 177m
	CTD 54	06:10	06:34	00:24	57.583234	-13.631667	Station A - 111m
	CTD 55	09:14	09:49	00:35	57.592905	-14.269678	Station RAG 160 - 186m
	CTD 56	12:20	12:55	00:35	57.604878	-14.897647	Station RAG 159 - 464m
	CTD 57	15:26	16:38	01:12	57.614303	-15.52877	Station RAG 158 -1038m
	CTD 58	19:15	20:20	01:05	57.624456	-16.166123	Station RAG 157 - 1173m

	CTD 59	22:42	23:50	01:08	57.636432	-16.798489	Station RAG 156 - 1200m
Sun 14 Jul	RHADCP Recovery	07:00	07:36	00:36	57.616946	-15.40243	
	IB4L1 comms test	08:09	08:58	00:49	57.614788	-15.399869	Lowered starboard from CTD wire, 50m-70m comms test, comms with SAM good after USBL adjustm., no range in RANGER2
	RHADCP Deployment	12:40	12:45	00:05	57.614083	-15.401826	80m planned fallback, no setup distance
	RHADCP Trilateration	12:45	14:13	01:28			0.8nm radius
	CTD 60	21:51	23:07	01:16	57.647595	-17.432407	Station RAG 155 - 1228m
Mon 15 Jul	CTD61	01:32	02:52	01:20	57.657374	-18.061322	Station RAG 154 - 1066m
	CTD 62	05:23	06:21	00:58	57.665486	-18.697934	Station O17 - 715m
	IB5 Recovery	08:41	10:05	01:24	57.798173	-19.177474	
	IB5 Deployment	12:00	13:29	01:29	57.8184	-19.206768	1.5nm setup dist., 125m planned fallback, ship speed around 1kn throughout - 30 min tow bc ~15 min faster with mooring assembly compared to JC238
	IB5 Trilat	13:57	14:46	00:49			0.8nm radius
	CTD 63	15:37	16:55	01:18	57.729526	-19.227597	Station O18 - 912m
	CTD 64	18:48	19:58	01:10	57.792035	-19.745948	Station O19 - 1303m
	CTD 65	21:48	23:32	01:44	57.837074	-20.140744	Station O20 - 1560
Tue 16 Jul	CTD 66	03:47	06:57	03:10	57.981155	-21.166855	Station IB4 pre - 2937m
	IB4 Recovery	07:29	11:03	03:34	57.990437	-21.155849	took about 1h to surface completely
	Depth Survey	11:48	11:55	00:07			betw. IB4 to IB4L1 targets as bathymetry from DY120 and JC238 notably different
	IB4L1 Deployment	12:47	14:21	01:34	57.99219	-21.131893	port usbl for Ranger2, starboard USBL for SAM, good comms in both from 10m water depth

	CTD 67	15:53	19:34	03:41	57.954281	-21.197173	Station O23 (caldip, 9 stops a 10 min) - 2952 m
	CTD68	21:15	23:03	01:48	57.915062	-20.852412	Station O22 - 2001 m
Wed 17 Jul	CTD 69	00:49	02:53	02:04	57.878361	-20.497074	Station O21 - 2257 m
	Argo float	02:53	03:06	00:13	57.878558	-20.497102	WHOI NAVIS BGC Argo SN F1533
	IB4 Deployment	07:47	10:45	02:58	58.013578	-21.063458	Setup 3nm, first streaming with 1.5 knot, then slowed down, 30 min tow
	IB4 trilateration	11:04	12:12	01:08			
	IB4L1 download	12:33	13:04	00:31	57.990837	-21.130522	Good connection in R2 and SAM straight away
	CTD 70	13:39	15:48	02:09	57.981512	-21.12874	Station IB4 post - 2861m
	CTD 71	18:25	21:02	02:37	57.95788	-21.856691	Station O24, wire scroll problems @ 3100m wire out - 3022 m
	CTD 72	23:41	02:21	02:40	57.957918	-22.513659	Station O25, problems could be minimised, still present, no active heave - 2993 m
Thu 18 Jul	IB3 recovery	08:56	14:34	05:38	58.019969	-24.417401	01:20h from release to begin of recovery on deck, huge tangle with long line caused 3h delay
	CTD 73	19:25	21:39	02:14	57.980541	-25.674723	Station O30 - for DY182 - 2723 m
Fri 19 Jul	CTD 74	00:07	02:26	02:19	57.973701	-25.012723	Station O29 - for DY182 - 2756 m
	Argo float	02:38	02:53	00:15	57.973778	-25.010678	Met office float SN 9599
	CTD 75	04:30	06:46	02:16	57.961264	-24.487241	Station O 28 - 2826 m
	Argo float	06:46	07:05	00:19	57.961425	-24.469974	WHOI NAVIS BGC Argo SN F1566
	CTD 76	09:13	12:51	03:38	57.958934	-23.834299	Station O27 - caldip - 2946 m
	CTD 77	15:37	18:00	02:23	57.960992	-23.173636	Station O26 - 2999 m
Sat 20 Jul	CTD 78	01:06	04:02	02:56	57.961339	-21.053978	Station 22b - 2633 m - Scrolling issues from approx 03:00-04:35
	CTD 79	04:46	06:24	01:38	57.942858	-20.935063	Station O22a - 2242 m

	Tele Test 2 Deployment	08:05	08:22	00:17	57.956948	-21.077295	Distance in Google Earth half of true one, delay bc we had to move 2.5km further south to be 5km away from IB4L1 - 2685 m
	Communication test USBL	08:22	09:45	01:23	57.958847	-21.077324	
	Buoy Deployment	09:45	09:47	00:02	57.960311	-21.07734	Floaty - wave glider simulator buoy
	Communication test buoy	09:47	12:38	02:51	57.961287	-21.077354	Vessel drifting with buoy
	Buoy Recovery	12:38	12:41	00:03	57.945368	-21.086187	
	Buoy Deployment	13:19	13:23	00:04	57.97573	-21.072301	
	Buoy Recovery	15:52	16:02	00:10	57.97553	-21.073508	
	Comms test USBL	16:36	18:09	01:33	57.960687	-21.075443	200m away from anchor drop
	Tele Test 2 Trilateration	18:09	19:05	00:56	57.956948	-21.077295	0.8nm radius
	CTD 80	20:38	23:15	02:37	57.903955	-20.700538	Station 21b - 2109 m - Scrolling issues 21:30-22:17 - deep tow
Sun 21 Jul	CTD 81	00:06	02:32	02:26	57.894283	-20.582305	Station 21a - 2381 m - deep tow
	CTD 82	03:33	05:02	01:29	57.865259	-20.35162	Station 20b - 2136mm - deep tow
	Buoy Deployment	08:23	08:26	00:03	57.958392	-21.074382	Floaty - wave glider simulator buoy
	Buoy Recovery	11:27	11:34	00:07	57.951939	-21.071951	
	Comms test Dunker	11:34	13:54	02:20	57.951939	-21.071951	
	Buoy Deployment	13:54	13:56	00:02	57.958978	-21.076508	
	Buoy Recovery	17:10	17:17	00:07	57.954409	-21.075245	
	CTD 83	20:10	21:31	01:21	57.850761	-20.249607	Station 20a - 1800 m - deep tow

	CTD 84	22:44	01:44	03:00	57.810132	-19.92855	Station O19a - 1396 m - deep tow - 23:05 CTD deployed with caps on, noticed at 100m and recovery requested. Recovery sign misunderstood by winch driver and EM stops pressed. 00:25 EM stops released. CTD online and recovered to deck. CTD aborted
Mon 22 Jul	CTD 85	00:35	01:44	01:09	57.810046	-19.928469	Station O19a - 1414 m - deep tow
	CTD 86	02:58	03:51	00:53	57.778826	-19.639752	Station O18 b - 1198 m - deep tow
	CTD 87	04:38	05:29	00:51	57.759688	-19.499859	Station O18 a - 998 m - deep tow
	Tele Test 2 Recovery	11:45	12:19	00:34	57.956692	-21.075413	500m away from trilaterated mooring position
	Mauri Channel Survey	12:38	06:39	18:01	57.661508	-22.542212	vmADCP survey to investigate cyclonic eddy in satellite figures and multibeam survey for depth check for wire streaming
Tue 23 Jul	Wire Streaming	07:06	11:28	04:22	57.666722	-22.535311	Stream Max. wire 5793m at 6kn - depth 3000m
	Eddy vmADCP survey	14:04	18:15	04:11	57.614197	-22.692386	second vmADCP survey to investigate mesoscale feature - smaller scale feature identified in vmADCP data not visible in satellite
	CTD 88	19:52	22:17	02:25	57.666969	-24.000171	Station Eddy 1 - 2896 m - back on ctd wire
	CTD 89	23:52	02:21	02:29	57.666942	-23.817581	Station Eddy 2 - 2918 m
Wed 24 Jul	CTD 90	03:51	06:23	02:32	57.666728	-23.632598	Station Eddy 3 - 2953 m
	CTD 91	07:58	10:36	02:38	57.667076	-23.45271	Station Eddy 4 - 2992 m
	CTD 92	11:55	14:29	02:34	57.666617	-23.273103	Station Eddy 5 - 3014 m
	CTD 93	16:16	18:30	02:14	57.667144	-23.090102	Station Eddy 6 - 3008 m
	CTD 94	20:18	22:33	02:15	57.666553	-22.908497	Station Eddy 7 - 3008 m
	CTD 95	23:48	02:26	02:38	57.666616	-22.726595	Station Eddy 8 - 3012 m

Thu 25 Jul	CTD 96	03:35	06:13	02:38	57.666784	-22.545177	Station Eddy 9 - 3024 m
	CTD 97	07:34	10:10	02:36	57.666693	-22.363386	Station Eddy 10 - 3020 m
	CTD 98	11:37	14:34	02:57	57.666796	-22.18117	Station Eddy 11 - scrolling issues - 3021 m
	CTD 99	16:24	18:15	01:51	57.666761	-21.999137	Station Eddy 12 - scrolling check ctd, no water samples - 3065 m
	CTD 100	18:37	21:13	02:36	57.666664	-21.999099	Station Eddy 12 - 3065 m
Fri 26 Jul	CTD 101	11:35	13:20	01:45	60.000245	-21.775692	Station Argo CTD
	Argo float	13:40	13:47	00:07	60.009434	-21.770492	WHOI NAVIS BGC Argo SN F1567
	Argo float	20:15	20:23	00:08	60.999731	-21.007005	Met office float SN 9470
	Transit						
Sat 27 Jul	Transit						
Sun 28 Jul	Arrive Reykjavik	07:30					

3 Introduction

This cruise serviced the Ellett Array moorings in the eastern Subpolar North Atlantic. The Ellett Array from 2024 onwards consists of 6 moorings (RTEB1, RTWB2, RTWB1, RHADCP, IB5, IB4) and is the UK contribution to the international Overturning in the Subpolar North Atlantic Programme (OSNAP, http://o-snap.org/). OSNAP began in 2014, with the aim of continuously measuring the strength and structure of the subpolar North Atlantic circulation between Newfoundland and Scotland using a purposefully designed mooring array. The array is supplemented by Seaglider missions and makes use of data from a number of measurement programmes such as Argo and satellite measured sea-surface heights. Using these measurements, the OSNAP programme can quantify the strength of the Atlantic meridional overturning circulation and associated transports of energy and elements (fresh-water, carbon, nutrients). The AMOC is a major component of Earth's climate system and has been predicted to slow in 21st Century under the influence of global warming. Such a slowing represents a major shift in Earth's climate. Severe impacts throughout the North Hemisphere are expected on sea-levels, rainfall patterns, temperatures, sea-ice distribution, atmospheric weather patterns and agricultural productivity. It is considered vital to obtain a better understanding of the dynamics and variability inherent in this system and provide the data necessary for building confidence in predictions of climate evolution in the 21st Century.

3.1 Cruise Objectives

The primary objective of the expedition was to service the Ellett array of moorings that are deployed across the subpolar North Atlantic to measure the variability of the Atlantic Meridional Overturning Circulation (AMOC). The main measurements required are of temperature, salinity, current speed. On this expedition there are two main groups of moorings measuring these variables: one for the Rockall Trough (RTEB1, RTWB2, RTWB1, RHADCP) and one in the Iceland Basin (IB5, IB4, IB3 – discontinued from 2024 onwards). In addition, a CTD section was undertaken between the Scottish continental shelf and 57°58.84'N, 025°40.57'W, just west of the discontinued mooring IB3.

The specific measurement objectives of the cruise were:

- Recover and redeploy the Ellett array of moorings (RTEB1, RTWB2, RTWB1, RHADCP IB5, IB4, IB3 – IB3 is discontinued from 2024 onwards)
- Four days of DY181 were dedicated to acoustic telemetry testing for WP3 Task B of the RAPID-Evolution project, part of the CCROC program.
- A new drift free pressure sensor was deployed on a lander at the IB4 site and data was downloaded from a similar instrument installed at the RTEB1 side in 2022.
- A mooring to observe particles falling to the sea floor (sediment trap and ADCP) was serviced at the Darwin Mounds Marine protected Area.
- Additional instruments were deployed on moorings to measure oxygen, pH and nutrients.
- To calibrate the moored instruments a number of CTD profiles were made measuring temperature, salinity and oxygen. Water samples were taken and analysed for salinity and oxygen, nutrients, DIC and total alkalinity.
- 6 Argo floats were deployed. These are a part of the international Argo program (http://www.argo.net/).
- Two projects were supported through the AtlantiS berth of opportunity programme: i) Lab-on-Chip sensor was installed to automate water sampling for surface carbon chemistry parameters. ii) A gas-tight carbonate seawater sampler was tested.
- A CTD section was undertaken to survey an eddy close to the Ellett Array sections in the Iceland Basin.

3.2 Data Management Plan

The Data Management Plan was prepared in discussion the British Oceanographic Data Centre; BODC). BODC will be involved through the life of the project to ensure consistent and safe data management.

Arwen Bargery is the BODC Data Manager for this cruise. A Cruise Summary Report detailing the measurements was completed on-board and forwarded to the BODC Data Manager directly after the cruise. A cruise report (this report) will be published within six months of cruise end. Following appropriate quality control all data will be submitted to the BODC archive within 12 months of collection. BODC curates the UK-OSNAP mooring data (i.e. Ellet Array) and the Extended Ellett Line (EEL) data set.

UK-OSNAP data: http://dx.doi.org/10/c7qv

EEL data: https://www.bodc.ac.uk/resources/inventories/edmed/report/644/

3.3 Environmental Impact Assessment

An assessment of the interaction of NERC marine science with the environment (NERC Marine Environment Interaction Policy, 12/7/2018) was conducted prior to the cruise by Anna Bird, NERC Marine Environment Appraiser (May 2024). The purpose of the Environmental Impact Assessment (EIA) is to assess the environmental impacts associated with the scientific research activities during the research cruise DY181 occurring in the North East Atlantic Ocean. A set of recommended mitigation measures Marine Environmental Mitigation Integration Policy (MEIP) was produced for the purpose of undertaking the project in a way that will be of minimal detriment to the marine environment, and in a way that is reasonable and commensurate with achieving the stated scientific objectives. This EIA and associated MEIP have been prepared based on the information provided by the Principal Investigator in the SME and associated questionnaire. A copy is available from Anna Bird.

As part of the MEIP, a member of the scientific party (Anneke Sperling) was responsible for carrying out and recording MMO activities. All acoustics were started in shallow water in minimum power setting, shortly after leaving the port. Care was taken to avoid switching off the acoustic instruments for more than 10 minutes.

3.4 Funding statement

This work contributes to U.K. Natural Environment Research Council (NERC) National Capability programme Atlantic Climate and Environment Strategic Science (AtlantiS) (NE/Y005589/1) and Climate Linked Atlantic Sector Science (CLASS) (NE/ R015953/1), and NERC grants U.K. Overturning in the Subpolar North Atlantic (OSNAP) (NE/K010875/1 and NE/K010875/2), U.K. OSNAP Decade (NE/T00858X/1 and NE/T008938/1), RAPID-Evolution (NE/Y003551/1) and Coccolithophore controls on ocean alkalinity (CHALKY) (NE/Y004434/1 and NE/Y004736/1) and to the European Union's Horizon Europe Programme under Grant Agreement No. 101094716 Next generation multiplatform Ocean observing technologies for research infrastructures (GEORGE).

3.5 Previous OSNAP-CLASS-AtlantiS cruises

Cruise	Vessel	Year	Report
KN221-02	*R/V Knorr*	2014	Cunningham, S. A. (2015), R/V Knorr Cruise KN221-02, 9th July - 1st August 2014. OSNAP Mooring Cruise Report *Rep.*, 1-54pp, Scottish Association for Marine Science.
DY017	*RRS Discovery*	2014	Painter, S. C. (2015), RRS Discovery Cruise DY017, 20 OCT -06 NOV 2014, Outer Hebrides process

			cruise, *Cruise Report Rep.*, National Oceanography Centre, Southampton.
JR302	*RRS James Clark Ross*	2014	King, B., and N. P. Holliday (2015), RRS James Clark Ross Cruise 302. 06 JUN - 21 JUL 2014. The 2015 RAGNARRoC, OSNAP and Extended Ellett Line cruise Report, *Cruise Report Rep. 35*, National Oceanography Centre.
PE399	*R/V Pelagia*	2015	Cunningham, S. A. (2016), R/V Pelagia Cruise PE399 16th June to 8th July 2015, Southampton, UK to Reykjavic, Iceland. Scottish Association for Marine Science, Oban.
DY053	*RRS Discovery*	2016	Cunningham, S. A. (2016), RRS Discovery Cruise DY053 16 JUNE - 23 JULY 2016. Scottish Association for Marine Science, Oban.
DY078	*RRS Discovery*	2017	Holliday, N. P. (2017), RRS Discovery Cruise DY078/079 06-28 May 2017. Extended Ellett Line 2017 occupation and OSNAP Rockall Trough mooring refurbishment cruise *Rep.*, National Oceanography Centre, Southampton.
AR30-04	*R/V Armstrong*	2018	Cunningham, S. A. (2018), RV Neil Armstrong Cruise AR30-04 01-29 JUL 2018 OSNAP moorings cruise report. Scottish Association for Marine Science, Oban.
DY108	*RRS Discovery*	2019	Huvenne, V. A. I., and B. Thornton (2020), RRS Discovery Cruise 108, 6 September - 2 October 2019. Darwin Mounds Marine Protected Area habitat monitoring, BioCAM equipment trials and BLT pilot study, Cruise Rep., 224 pp, National Oceanography Centre, Southampton.
DY120	*RRS Discovery*	2020	Cunningham, S. A. (2020), RRS Discovery Cruise DY120 8 - 24 October 2020. OSNAP moorings cruise report. Scottish Association for Marine Science, Oban.
JC238	*RRS James Cook*	2022	Moat, B., Burmeister, K. and Firing, Y. (2022), RRS James Cook Cruise JC238, 12 – 31 July 2022. CLASS and OSNAP report for JC238, Cruise Rep. 78, National Oceanography Centre, Southampton
DY181	*RRS Discovery*	2024	This report.

4 Ships Systems Computing and Underway Instruments

Martin John

The information in this section has been taken from the NMF Scientific Ship Systems Cruise Report where full details can be found.

4.1 Scientific Computer System - Underway data acquisition

Data from the suite of ship-fitted scientific instrumentation was aggregated onto a network drive on the ship's file server. This was available throughout the voyage in read-only mode to permit scientists to work with the data as it was acquired. A Public network folder was also available for scientists to share files.

Table 1: Data acquisition systems used on this cruise.

Data acquisition system	Usage	Data products	Directory system name
Ifremer TechSAS	Continuous	NetCDF ASCII pseudo-NMEA	`/TechSAS/`
NMF RVDAS	Continuous	ASCII Raw NMEA SeaDataNet NetCDF (Testing)	`/RVDAS/`
Kongsberg SIS (EM122)	Continuous	Kongsberg .all	`/Acoustics/EM-122/`
Kongsberg EA640	Continuous	None, redirected to Techsas/RVDAS RAM	`/Acoustics/EA-640/`
UHDAS (ADCPs)	Continuous	ASCII raw, RBIN, GBIN, CODAS files	`/Acoustics/ADCP/`
Sonardyne Ranger2	Discrete	None, redirected to Techsas/RVDAS RAM	`/Acoustics/USBL/`

4.2 Significant acquisition events and gaps

On this cruise, the NMF Event Logger/BAS Event Logger was used with CSV records of events saved to the cruise data directory.

Table 2: Summary of main events

Date	Time start*	Time end*	Event
2024-06-27	14:38		Cruise Start / Logging Started
2024-07-29		09:00	Cruise End / Logging Stopped

Table 3: Summary of data gaps

Date	Time start	Time end	Event
2024-07-16	10:10:00	10:30:00	Restarted Techsas1 (Techsas 2 and RVDAS unaffected)

4.3 Internet provision

Satellite communications were provided with Starlink, and VSAT systems.

**Note: OneWeb should have been the main high-speed internet link instead of Starlink, but it is still not fully operational.

The ship operated with bandwidth controls to prioritise business use.

4.4 Instrumentation

Martin John

4.4.1 GPS Position and attitude

GPS and attitude measurement systems were run throughout the cruise. For all scientific purposes, unless otherwise stated, the coordinate system is referenced with the central reference point at the ship's centre of gravity, Frame 44 which is 26.4m forward from Frame 0 at 0.6m framespacing, centreline is centre of keel, main deck which is 7.4m up from baseline/ship's bottom most longitudinal. Frame 0 is aft-most frame, 6m forward from stern, centreline (centre of keel), baseline (ship's bottom-most longitudinal).

Table 4: Position, attitude and time

Component	Purpose	Outputs	Headline Specifications
Applanix PosMV	Primary GPS and attitude.	Serial NMEA to acquisition systems and multibeam	Positional accuracy within 0.15 m.
Kongsberg Seapath 330	Secondary GPS and attitude.	Serial and UDP NMEA to acquisition systems and multibeam	Positional accuracy within 1 m.
Oceaneering CNav 3050	Correction service for primary and secondary GPS and dynamic positioning.	RTCM to primary and secondary GPS	Positional accuracy within 0.15 m.
Fugro Seastar / MarineStar	Correction service for primary and secondary GPS and dynamic positioning.	Corrections to primary and secondary GPS	Positional accuracy within 0.15 m.
Meinberg NTP Clock	Provide network time	NTP protocol over the local network.	

4.4.2 SURFMET

The NMF Surfmet system was run throughout the cruise, excepting times for cleaning, entering and leaving port, and whilst alongside (Table 5).

Table 5: Components of Surfmet system

Component	Purpose	Outputs

Inlet temperature probe (SBE38)	Measure temperature of water at hull inlet.	Serial to Interface Box.
Drop keel temperature probe (SBE38)	Measure temperature of water in drop keel space.	Serial to Interface Box.
Thermosalinograph (SBE45)	Measure temp. and conductivity at sampling board. Salinity is calculated.	Serial to Interface Box.
Interface Box (SBE90402)	Signals management.	Serial to Moxa.
Debubbler	Reduces bubbles through instruments.	None.
Transmissometer (CST)	Measure of transmittance.	Analogue to NUDAM.
Fluorometer (WS3S)	Measure of fluorescence.	Analogue to NUDAM.
Air temperature and humidity probe (HMP45A, HMP155)	Temperature and humidity at met. platform.	Analogue to NUDAM.
Ambient light sensors (PAR, SKE510; TIR, CMP6)	Ambient light at met. platform.	Analogue to NUDAM.
Barometer (PTB110, PTB210)	Atmospheric pressure at met. platform.	Analogue to NUDAM.
Anemometer (Windsonic)	Wind speed and direction at met. platform.	Serial to Moxa.
NUDAM	A/D converter.	Serial NMEA to Moxa.
Moxa	Serial to UDP converter.	UDP NMEA to Surfmet VM.
Surfmet Virtual Machine	Data management.	UDP NMEA to TechSAS, RVDAS.

Table 6: Surface water sampling board maintenance

Date	Time start*	Time end*	Event	Trans high (V)	Trans low (V)	Fluoro (V)	Salinity (PSU)
2024-07-20	09:45:00	09:54:00	Cleaning	4.8	0.0	0.1	35.24
2024-07-24	12:28:00	12:35:00	Cleaning	4.8	0.0	0.12	35.28

The system was cleaned before and after the cruise.

4.4.3 Hydroacoustic Systems

The EA-640 single-beam, the EM-122 mulitbeam echo-sounder and both the 75 and 150 kHz ship ADCP's were run consistently during the cruise. Sound velocity profiles were measured directly with a Midas SVP, derived from CTD or calculated from the WOA13 model using Ifremer DORIS (Table 8). USBL used with scientist supplied equipment (modem functionality to communicate with AZA Fetch and other NOC comms equipment)

Table 7 List of Hydroacoustic Systems used

Component	Purpose	Operation and Outputs
10/12 kHz Single beam (Kongsberg EA-640)	Primary depth sounder	Continuous NMEA over serial, raw files
12 kHz Multibeam (Kongsberg EM-122)	Full-ocean-depth multibeam swath.	Continuous Binary swath, centre-beam NMEA, *.all files, optional water column data
Drop keel sound velocity sensor	Provide sound velocity at transducer depth	Continuous Value over serial to Kongsberg SIS.
75 kHz ADCP (Teledyne OS75)	Along-track ocean current profiler	Continuous (via UHDAS)
150 kHz ADCP (Teledyne OS150)	Along-track ocean current profiler	Continuous (via UHDAS)
USBL (Sonardyne Ranger2)	Underwater positioning system to track deployed packages or vehicles.	Discrete NMEA over serial

Table 8: Sound velocity profiles.

Datetime	Method	Filename	Datetime SVP applied to SIS / Ranger2
2024-07-05	CTD 003	DY181_CTD003_SV_10m.asvp/pro	2024-07-05 14:37:00
2024-07-06	CTD 005	DY181_CTD005_SV_10m.asvp/pro	2024-07-08 10:42:07
2024-07-10	CTD 040	DY181_CTD040_SV_10m.asvp/pro	2024-07-10 08:05:56
2024-07-11	CTD 043	DY181_CTD043_SV_10m.asvp/pro	2024-07-11 16:28:59
2024-07-13	CTD 050	DY181_CTD050_SV_10m.asvp/pro	2024-07-13 13:59:31

2024-07-16	CTD 066	DY181_CTD066_SV_10m.asvp/pro	2024-07-16 08:14:44
2024-07-19	CTD 076	DY181_CTD076_SV_10m.asvp/pro	2024-07-19 14:48:17

4.4.4 Other systems

Winch activity is monitored and logged using the CLAM system.

5 Scientific Computing Systems

Yvonne Firing

5.1 Workstation Setup and Archiving

Three linux workstations were configured for data processing. The primary data processing computer was akeake, running CentOS 7. Workstation koaekea was used only for backup and as a remote terminal to ssh to akeake. Workstation kolea running Ubuntu was configured as a potential alternate but the main data processing was performed on akeake, with users accessing via ssh from either the other workstations or their own laptops.

A set of shell scripts (bash and csh) was run on the workstation to create the cruise data directories, configure user accounts and paths, mount and make links to shared data directories and configure access to the RVDAS underway database, and perform regular syncs of data from shared drive, and backups of cruise processed data to the alternate workstations and to external hard drives. These scripts are in git repository mexec_exec (not currently publicly available). Significant changes on the cruise included the completion of scripts to configure new user accounts, and a new script to sync only a selection of mooring data between an archive disk and the workstation (for use both at the start and at the end of the cruise).

For the first time, each user was given their own account on the workstations, with links to configure the same working directory, paths and environment for all. All users were members of group pstar, and had a default umask allowing group +rw permissions, but Matlab appears to source its umask somewhere else, so it was necessary to add a set of scripts to regularly change permissions of newly-created files. A sudoer is still required to mount external drives, configure secure access to the shared drives, and run these scripts (as well as to configure new user accounts).

5.2 Hydrographic Data Processing Code

CTD and underway nav/bathy/met/surface ocean data processing used the ocp_hydro_matlab git repository (https://github.com/NOC-OCP/ocp_hydro_matlab), commits 4e12c69a through 6bc7c231. The major update on this cruise was in the process of creating and storing a lookup table for underway (RVDAS) streams, variables, and units from the RVDAS database and .json files exported from the metadata database. In addition, because of one CTD cast where acquisition had to be stopped and restarted, a facility to combine two raw data files in processing was added. A bug fix related to tracking sensor serial numbers was also added. Data processing is described in sections 8 and 9.

LADCP data were processed using the LDEO-IX-14 toolbox (Sectyion 10), and VMADCP data using the CODAS toolbox (Section 8.7).

5.3 Mooring Processing Toolbox

Data from mooring deployments and calibration dips were processed using the m_moorproc_toolbox repository (https://github.com/ScotMarPhys/m_moorproc_toolbox), dy181 branch. Changes on the cruise included expanding the use of central path-setting to more scripts, to update ADCP processing for a new instrument type, and to remove calls to (ambiguous) function "julian" in more places (replacing with Matlab's datenum function). The plotting and MicroCAT data QC functionality was also improved.

6 NMF CTD Operations

Thomas J. Ballinger, Jade E. Garner, Finnegan Sougioultzoglou

6.1 CTD Summary

DY181 CTD work supported the turnaround of the Ellett Array and Darwin Mounds moorings with the CTD being utilised for pre and post recovery calibration casts while also giving the opportunity to test acoustic releases prior to deployment.

101 CTD casts were undertaken with an NMF 24-way Stainless Steel CTD frame with 12 off 10l Niskin water samplers. Only the odd bottles were fitted leaving 12 bottle positions free for Microcat clamps which were utilised for calibrations casts. 24 off 10l Niskin water samplers were used from cast 088 to cast 101. Dual SBE 43 dissolved oxygen sensors were used. The primary temperature, conductivity and dissolved oxygen sensors were fitted to the 9 plus with the secondary sensors mounted on the vane. A SBE 35 was mounted to a vertical stanchion of the CTD frame and programmed to average 8 samples which supplemented the CTD temperature data.

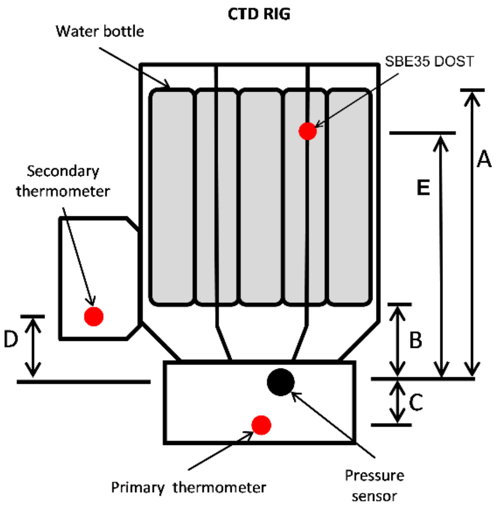
The CTD was operated out of the hangar using the overhead gantry to position the CTD for deployment. The preferred method for this is to disconnect the CTD wire from the swivel and use a master link to connect the gantry hook to the swivel, this prevents subjecting the swivel to any lateral load. The CTD was deployed using CTD wire storage drum 2, CTD 2 has a lot of surface corrosion for the top 1000m.

AHC was used for the majority of the CTD casts, this significantly improved the CTD's speed through the water and reduced the tension seen on the wire. There should be confidence in this system across the board now as it is proven to be working very well. There were a number of issues with the scrolling on both CTD2 and the Deep Tow winches. It was thought that the AHC may be the cause of these issues however similar issues were experiences when the AHC was not active. These scrolling issues need to be addressed as they are occurring more and more frequently. The working parameters for the active heave need to be finalised and implemented across both ships, there are still questions over operational speed of the winch etc.

There was a number of fouling events throughout the cruise. Both primary and secondary sensors were flushed with a Triton – x solution and a bleach solution followed by a thorough MilliQ rinse. The SBE43's also required stripping and cleaning numerous times as fouling was clearly visible on the membrane.

After each cast the primary and secondary sensors were flushed three times with MilliQ. Periodically the optical sensors were cleaned with MilliQ and Optic Prep wipes. The SBE 32 Latch assembly was rinsed well daily to prevent any latches sticking.

There were no major issues with the Stainless Steel CTD suite during the DY181.



ID	Vertical distance from pressure sensor (m positive-up)
A	1.2 (Top of water samplers)
B	0.34 (Bottom of water samplers)
C	-0.075 (Primary T mounted on 9p)
D	0.085 (Secondary T mounted on Vane)
E	1.025 (SBE35 DOST probe sheath tip)

Figure 1: Stainless Steel CTD Frame Geometry

6.2 CTD Configuration

One CTD system was prepared with frame geometry and CTD sensor locations shown in Figure 1. The water sampling arrangement was a 24-way stainless steel frame system fitted with 12 off 10 ltr Ocean Test Equipment (OTE) Niskin bottles (positions 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21 and 23 with remaining positions reserved for 12 brackets for attaching SBE37's) and MDS titanium CTD swivel. Sensor information and serial numbers for all underwater components are given in APPENDIX A.

Two self-logging Teledyne RDI Workhorse 300kHz ADCP's were installed on the Stainless Steel CTD frame and used for all CTD casts. The down-looking unit (S/N: 24465) was cited in the centre of the frame with its transducers just above the bottom tube of the CTD frame. The upward-looking unit (S/N: 24466) was fitted within an outrigger directly opposite the vane. Both instruments were powered with NMF Workhorse Battery Pack serial number WH008T.

6.3 SBE setup and processing

Details of the SBE setup and processing routines run by the NMF technicians can be found in APPENDIX B to APPENDIX D.

For the lADCPs, all casts were setup using BBTalk software run via a laptop in the Deck Lab. The command script can be found in APPENDIX E. In between casts the battery pack was charged using a bench top power supply, once fully charged the battery pack was left connected to the power supply with a trickle voltage applied to maintain the pack.

7 Salinometry

Thomas J. Ballinger, Jade E. Garner, Finnegan Sougioultzoglou

7.1 Salinometer

S/N 68958 was set up as the main Autosal for DY181, during the analysis of the 28th crate a fault occurred and the Autosal flooded internally. Due to the number of samples being taken from each cast s/n 71185 was used to continue analysis while the issues with s/n 68958 were investigated. A leak at the peristatic pump is believed to have been the issue, this was resolved and s/n68958 was ready for use.

Two crates were analysed using s/n 71185, on the last sample the inlet to the conductivity cell became blocked. Visual inspection through the window showed the inlet tubing to be kinked reducing the flow into the conductivity cell. The tubing was removed and the damaged section removed, it was also noticed that there was another kink further up the line, it was not possible to remove this and still have enough length for the cell. This requires changing when back at base. During the repair the belt for the circulation paddle was also changed. In total 33 Crates were analysed using s/n 68958 and 2 using s/n 71185.

Figure 2: Kinked tubing at conductivity cell inlet.

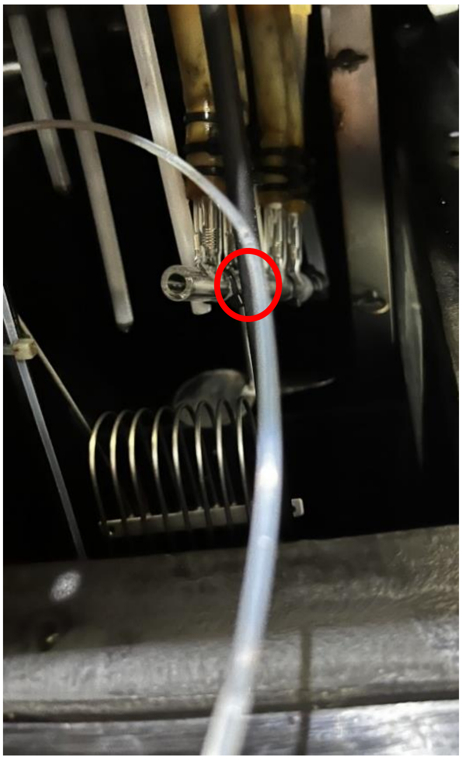


Figure 3: Kink in the tubing further up the system.

7.2 Salinity Analysis

The salinometer was standardised once at the start of the cruise, then bottles of standard seawater (OSIL batch P168, K15 = 0.99993) were analysed throughout the salinometer runs to monitor instrument drift. The samples were stored in crates equilibrate to the temperature controlled laboratory for at least 24 hours before analysis.

8 Processing of underway data

8.1 Overview

A watch keeping log was filled out every ~4 hours (around the clock during most of the cruise or between 0800 and 2000 ship time when on daytime-only operations) to check that a number of the underway systems were functioning as expected over the course of the day. Bottle samples from the underway system were taken for salinity (one per watch log, ~every 4 hours).

Access to the RVDAS database of underway data streams, and the list of streams and variables to process, was configured at the start of the cruise (see Section 5). Each day, uway_daily_proc.m was run in Matlab to process the data from the previous day, applying preliminary quality control and appending the day’s data to a file. Further processing was run on multiple days’ data to produce averaged files, as described below. Data were acquired and processed from 3 – 28 July.

8.2 Navigation

Navigation and attitude data were read in and data from the POSMV, were combined and averaged to 30 s intervals to produce a “bestnav” file.

8.3 Bathymetry

Anneke Sperling

Bathymetric data is collected by a single-beam echosounder (EA640) and a multi-beam echosounder (EM122) on-board RRS Discovery. For processing of this bathymetry data, first the raw data of the individual instruments (in /pstar/data/cruise/data/bathy/ea640(em122)_dy181_all_raw.nc) is automatically despiked using the *mday_01_edit.m*, and then visually inspected and manually edited by running the *uway_daily_proc.m* through the *mday_02_av* stage. Data from the singlebeam are corrected for the local climatological speed of sound profile using the Carter tables (while data from the multibeam are acquired using an up to date sound speed profile). Only compound noise (see Figure 4 left-hand side) significantly impacts the later stage of data processing (averaging) as the spikes do not have a common/similar mean. Therefore, compound noise should be edited out, while systematic noise (Figure 4 right-hand side) can remain.

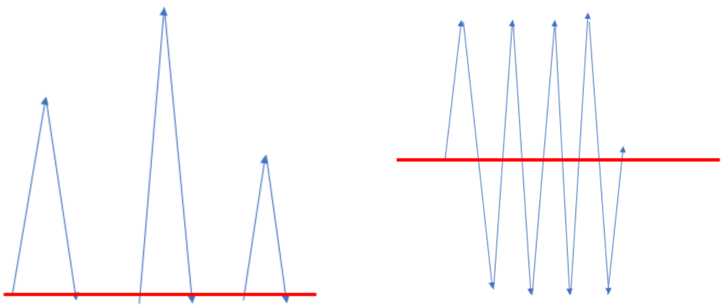


Figure 4: Compound noise (left-hand side) and systematic noise (right-hand side)

The single-beam measures water depth from surface and from transducer (the transducer has an approximate vertical offset of 5m) but in this case only the depth from transducer was processed as the depth from surface was deemed unreliable. The processed data is saved as ea640(em122)_dy181_all_edt.nc in /data/pstar/cruise/data/bathy/. After processing the individual beams, they are averaged (*mday_02_merge_av.m*), compared and manually edited if necessary. The processed data is again saved as bathy_dy181.nc in /data/pstar/cruise/data/bathy/.

8.4 TSG samples

Anneke Sperling

Underway temperature and salinity are measured by a ThermoSalinoGraph in the underway lab. Salinity measurements are calibrated against underway bottle samples taken at ~4h intervals throughout the cruise. Underway temperature measurements are checked against temperature measurements obtained from the drop keel temperature sensor (whenever deployed) and additionally compared to surface (3-5m) CTD measurements, but no adjustment was applied.

The underway salinity data shows a slight offset (0.003) as well as a drift which is corrected for by interpolating between the first data point - 0.003 (0) and last data point in the timeseries of the difference between TSG-salinity and bottle salinity.

In both timeseries (T and S), after excluding times when the underway uncontaminated seawater supply pumps were off, only isolated spikes are removed in the manual editing using *mday_01_edit.m* (called by *uway_daily_proc.m*).

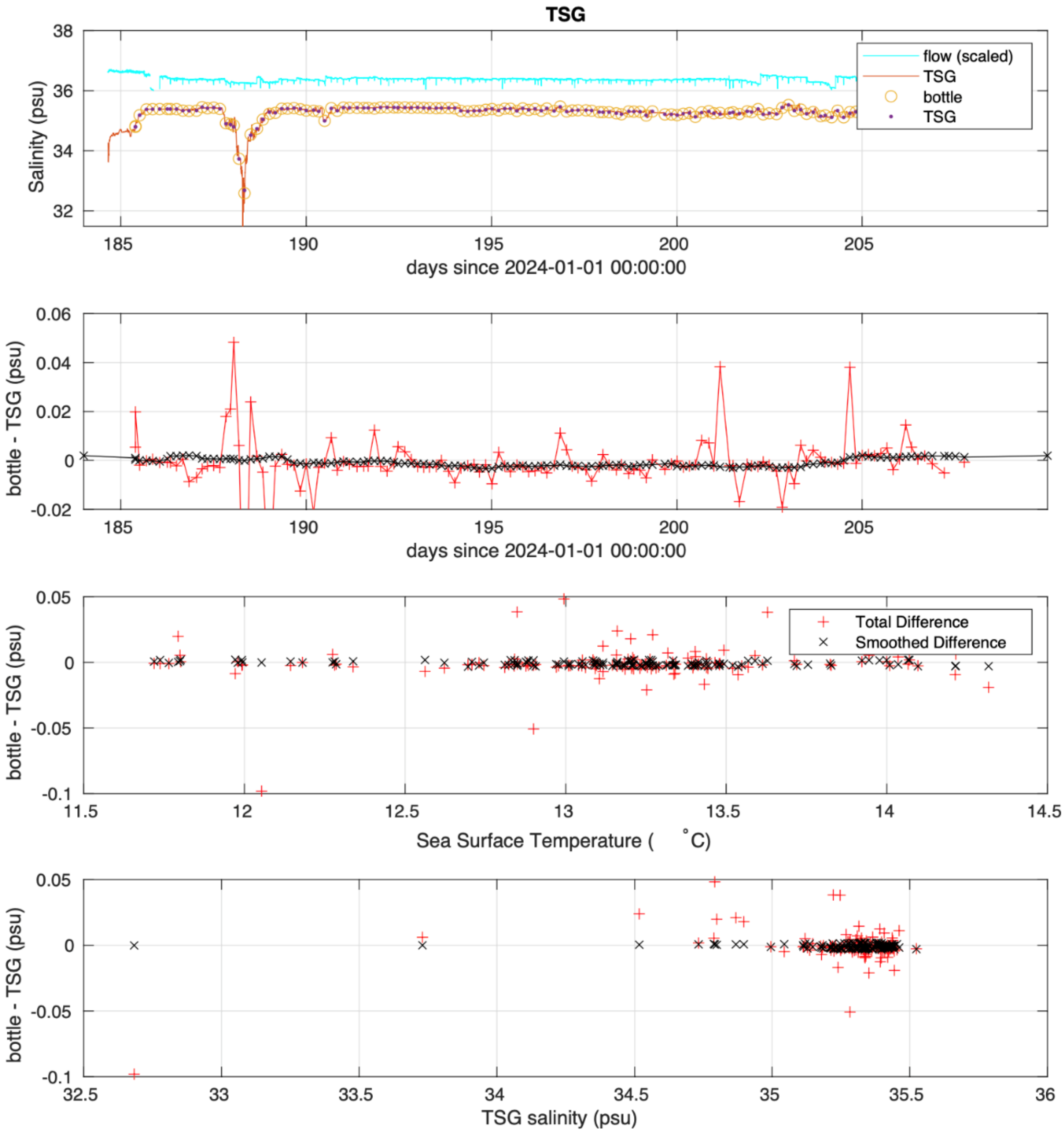


Figure 5: TSG calibration

8.5 Fluorescence and transmissivity

Anneke Sperling

Fluorescence and transmissivity are measured in the underway lab. No bottle samples have been collected actively (for calibration purposes), but comparison might be possible with samples taken through the Lab on Chip sensor (Section 19.6). Around year day 202 the water intake was cleaned which significantly changed fluorescence and transmissivity measurements. Generally, fluorescence and transmissivity are negatively correlated, and the anti-correlation during DY181 is R = -0.4971.

Calibrations for fluorescence and transmissivity have been applied using the coefficients determined by the most recent calibration certificates for the respective sensors (calibration details are changed in *opt_dy181.m*).

8.6 PAR and TIR

Anneke Sperling

PAR (Photosynthetically Active Radiation) and TIR (Total Incident Radiation) are measured on the surface meteorology platform on the forecastle of RRS Discovery, at ~23m from sea level on both sides, port and starboard. There is a slight discrepancy between starboard and port measurements of both PAR and TIR (see Figure 6), which mostly shows as a positive offset of the starboard PAR and TIR measurements but no correction was needed because deviations were small.

Calibrations for PAR and TIR have been applied using the coefficients determined by the most recent calibration certificates for the respective sensors (calibration details are changed in *opt_dy181.m*).

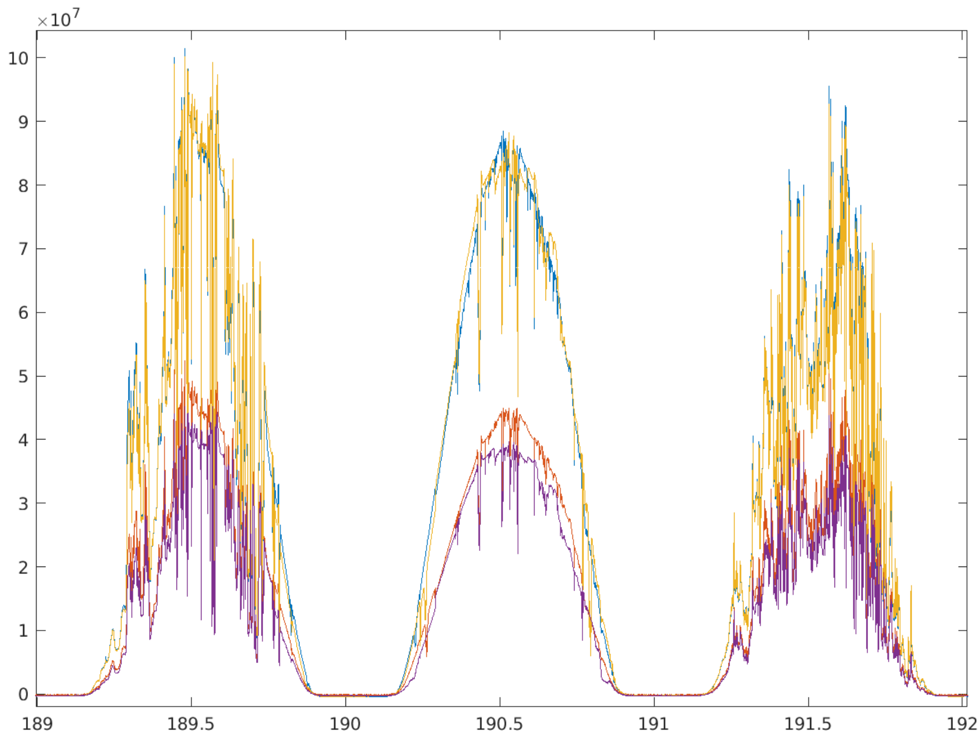


Figure 6: PAR and TIR offset.

8.7 Vessel mounted Acoustic Doppler Current Profiler (vmADCP)

Andre Paloczy

The Discovery is fitted with two RDI OceanSurveyor ADCPs (75 kHz and 150 kHz). GPS position and heading data from a reliable gyrocompass and accurate heading devices (PosMV, Seapath, Ashtech), along with the ADCP ping data are logged by the University of Hawaii Data Acquisition System (UHDAS), running on a dedicated Linux server. Single-ping data is processed automatically with UHDAS/CODAS on that server and made available on the ship's shared science drive.

The total ADCP measured velocities are dominated by the ship's underway velocity. Therefore, the accuracy of ADCP-derived ocean velocities also depends critically on the accuracy of the ship's position/speed and heading. This information is measured continuously by a reliable heading device (a gyrocompass used for rotating ADCP velocities beam- Earth) and a more accurate heading device (*e.g.*, posMV, Seapath), and time-stamped alongside the ADCP stream by UHDAS. That data is calibrated either by bottom track-derived velocities (when the bottom is within the ADCP's range) or by watertrack-derived velocities (cruise segments where ship manoeuvres such as sharp turns at the end of transects of CTD casts). More information can be found on the UHDAS/CODAS documentation (https://currents.soest.hawaii.edu/docs/adcp_doc/codas_doc/introduction.html).

CODAS post-processing was done incrementally on a separate workstation during the cruise, to identify potential problems with the data. A final fresh post-processing was done after the cruise for both ADCPs (os150nb and os75nb).

8.7.1 Underway data checks

The serial streams ("monitor" tab on the UHDAS GUI), 5 min Bridge Plot, and contour plots from both sonars (os150nb and os150nb) were checked every 4 hours as part of the underway data rounds.

Following recommendations from the 2022 CLASS-OSNAP cruise onboard the RSS James Cook (JC238), daily checks were also performed on the integrity of the raw data streams being logged by UHDAS, to identify any potential problems early on during the cruise (*e.g.*, delayed serial messages, large differences between accurate heading instruments, corrupted files or UHDAS computer crashes). Some of the CODAS commands used to check the status of the UHDAS database were:

Checking overall integrity of the UHDAS database. There should be the same number of raw data files for each GPS and heading instrument:

uhdas_info.py --overview dy181_uhdas/uhdas_data/DY181/

Checking that different heading instruments are working properly.

There should be no major differences in heading across instruments or gaps in messages:

plot_rbins.py --markersize 4 --ser1 seapath:sea --ser2 posmv:pmv DY181

plot_rbins.py --markersize 4 --ser1 seapath:gps --ser2 posmv:gps DY181

cnav, posmv, seapath position:

ggatime_diagnostics.py --zoomname auto DY181/rbin/cnavgps/*.gps.rbin

ggatime_diagnostics.py --zoomname auto DY181/rbin/posmv/*.gps.rbin

ggatime_diagnostics.py --zoomname auto DY181/rbin/seapath/*.gps.rbin

posmv heading:

plot_posmv.py DY181/rbin/posmv/*pmv.rbin

Underway manual editing of the data was performed daily, using 5 min averages of the single-ping data. Masking of any bad data points was performed (*dataviewer.py -e*). Amplitude and phase corrections were applied at the end of the cruise (to make use of all watertracking calibration points), and the additional GPS-ADCP horizontal offset determined by quick_adcp.py's guessing algorithm.

Comparing the data from the two sonars (os75nb and os150nb) over their overlapping range (roughly 400 m) using *dataviewer.py -c* during the cruise revealed an excess along-track velocity bias of a few cm/s on the os150nb relative to the os75nb (Figure 7 shows an example). The cause of this excess bias could be due to the uncertainty in the watertrack calibration parameters applied on the two sonars.

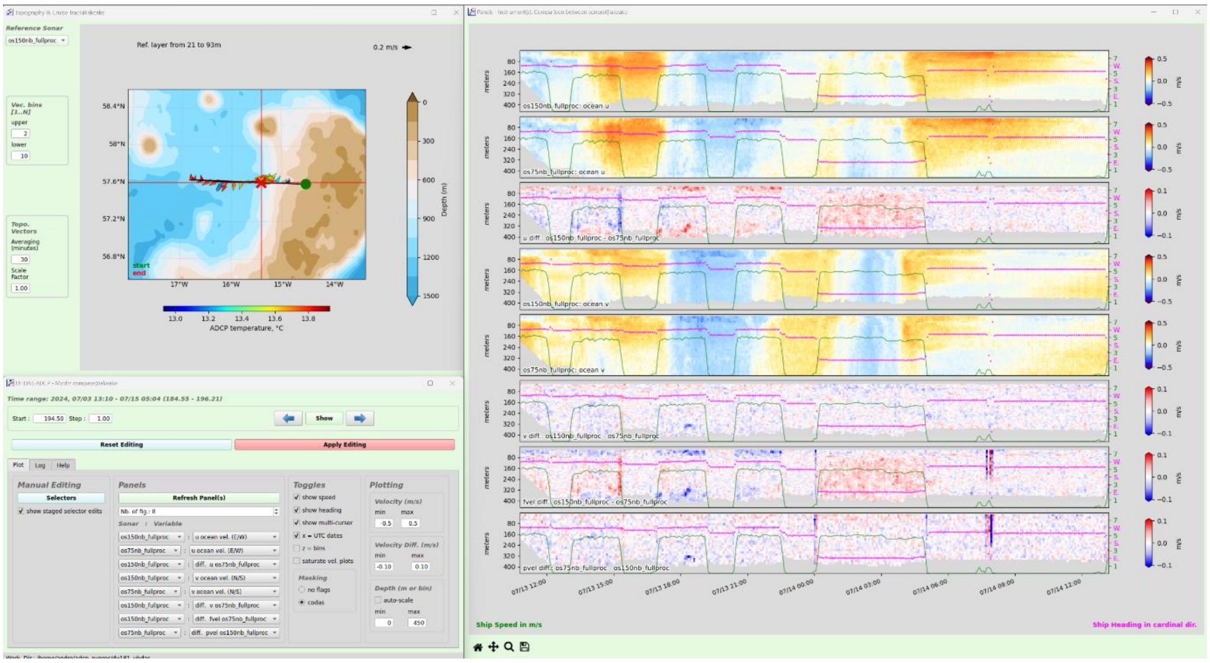


Figure 7: Example of differences in along-track velocity biases. From top to bottom, the panels on the right-hand window are: u from os150, u from os75, and their difference; same for v; forward and port velocity differences.

8.7.2 Velocity transects

Velocity sections for different segments of the cruise are shown in 104APPENDIX G. Figure 61 to Figure 64 show, respectively, the segments in Rockall Trough, Rockall Plateau, eddy survey in the Iceland Basin and transit towards Iceland.

9 CTD Processing and Calibration

Yvonne Firing, Matthew P. Clark

9.1 CTD Data processing

Processing of the data from this cruise follows other OSNAP cruises including the most recent JC238 in July 2022, as well as other cruises that use the standard suite of Mexec scripts.

After each CTD cast, the CTD technicians use SeaBird Data Processing to convert the .hex files into .cnv (ASCII) format. Where bottles were fired, data from the SBE35 are downloaded using SeaTerm. Data are mirrored from the NMF computers to the cruise data server (current_cruise).

Each cast is then processed by the physics team through a series of standardised Matlab scripts, ocp_hydro_matlab (Section 5) also including some manual processing and quality control steps. Firstly, *ctd_all_part1* is run. This applies some basic processing. Then, '*mdcs_03g'* is run which allows the user to confirm (or adjust if necessary) the start, bottom and end of a CTD cast based on pressure sensor measurements. At this stage, the Niskin sampling log is checked to see if there were any leaking or misfired Niskins, and if there were then flags are added on the '*opt_dy181'* script, under the '*nisk_proc*' case. After this is complete, '*ctd_all_part2*' is run which separates the CTD casts into up/downcasts, averages, and confirms the bottle firing files. The next half of processing uses *'mctd_checkplots'* to produce summary figures. This, in conjunction with further plots produced by running '*mctd_rawshow'* are used to identify spikes (electrical noise) or bad ranges from the data. If necessary, the script '*mctd_rawedit*' can be run which gives the user the option to box-select noise and flag them as bad values. If manual edits have been performed, the script '*ctd_all_postedit*' was run to update the cast and Niskin sampling files. Selection of calibrations, any data editing (e.g. editing out bad data due to a clogged CTD) as well as user-flagged bad measurements of salinity and oxygen samples are stored in the '*opt_dy181'* file.

Processed data are saved in a set of NetCDF files, with some information about processing steps (including, e.g. calibration functions applied) recorded in the global attributes.

9.2 Water samples for calibration and evaluation of Niskin quality

The CTD rosette contained 12 Niskin water sampling bottles for most of the cruise, and 24 from cast 88 on. Niskins were fired on all but 36 of the 101 casts – the major exception being the 'yo-yo' castss -- and samples for a subset of parameters were collected on 65 of the casts. A graphic summary for the Niskin bottles of all 101 CTD cast is given in Figure 8.

The Niskin bottles were set up by the CTD operators/technicians before deployment. After coming back on deck, a visual check for leaks or misfires was performed by both the technicians and the sampling team. The rate of failure was very low, with three misfires and six leaks. Leaking of Niskin 6 on casts 88 and 89 was detected based on the oxygen draw temperature being several degrees higher than expected, and the other probable leaks were detected by comparison of several bottle sample values (salinity, oxygen, and nutrients) with CTD and smoothed profiles from neighbouring data, using *checkbottles_02.m*.

Water samples were collected from Niskins for analysis for dissolved oxygen (Section 12), dissolved inorganic carbon and total alklalinity and inorganic nutrients (Section 13), and salinity (described below). The distribution of samples is shown in Figure 8. Sampling was performed in this order, and until cast 77, a salinity sample was taken from every Niskin depth (after this salinity samples were limited, but still taken from every depth where a carbon sample was taken).

When drawing samples for salinity analysis, the Niskin valves were opened, and 200ml glass bottles were rinsed 3 times using the water, before filling the bottle to the shoulder. The bottle mouth and neck, inside and out, including the screw thread, were dried thoroughly with blue roll. Once dry, the bottle was stoppered with a plastic insert and then capped with a clean, dry lid. The sample bottle numbers were recorded by hand onto the CTD sampling log sheets, which were then scanned to the *science_public* drive and the physical copies stored in a ring binder. After a bottle crate became full, it was put into the salinometer room for at least 24 hours to temperature equilibrate. Samples were analysed on two Guildline Autosals by NMF technicians, with a new bottle of standard seawater (batch P168) run at the start and end of each crate of up to 24 samples (see Section 7 for details and Section 9.3 for exceptions). For each sample (or standard) three readings, corresponding to three separate fills of the salinometer cell, were recorded. Overall, 653 salinity samples were collected and analysed, of which 636 were flagged as good (Section 9.3).

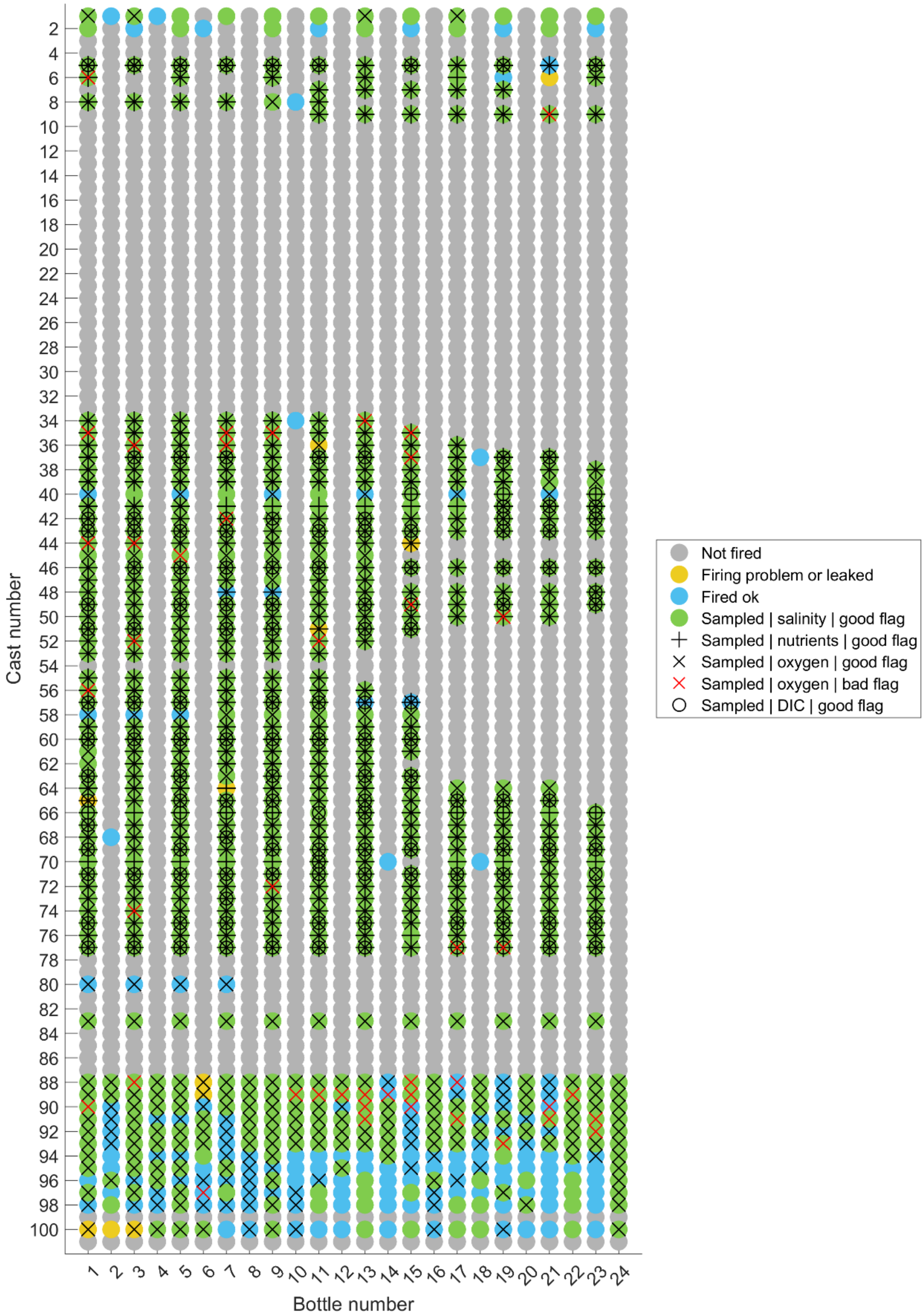


Figure 8: Niskin bottle summary for all CTD casts on DY181.

9.3 CTD conductivity calibration

After salinity samples were analysed by salinometer (Section 7), the sample bottle numbers were matched with the CTD cast and Niskin number and assigned a sample number made up of the cast number x 100 + the Niskin number (eg: sample number 5401 would be cast 54, Niskin 1). These sample numbers were added to .csv files containing analysed values (produced by software interfacing with the Autosals) in the /data/pstar/cruise/data/ctd/BOTTLE_SAL directory. Filenames were assigned so that they would match the order in which the salt samples were processed. All available files were read into Matlab using '*msal_01*'. Offsets based on the standard seawater samples run at the start and end of each crate of bottles were listed in opt_dy181.m, and applied (by msal_01) using a linear interpolation between pairs of standards where possible. Two days worth of samples were unfortunately run without standards, and in several other cases a suspicious standard value (possibly from an already-opened bottle) was discarded from the values to be interpolated, instead applying a constant offset to one or more crates. The standards offsets applied varied from $-7.5\text{x}10^{-5}$ to $+7\text{x}10^{-5}$ counts.

Sample values were then checked for outliers using checkbottles_01.m and mctd_evaluate_sensors.m, with flags added to opt_dy181.m under 'botpsal'.

To determine the calibration to apply to a given CTD conductivity sensor, mctd_evaluate_sensors.m converts bottle salinity values to conductivity at the corresponding CTD temperature, then plots the ratio of bottle to CTD conductivity as functions of station number or day, temperature, and pressure. Bottle values can be compared to both upcast and density-matched downcast CTD data as an additional check. A calibration function varying slowly in one or two of the independent variables is chosen and added to opt_dy181 under 'ctd_proc', specified based on the CTD conductivity sensor serial number. When switched on in opt_dy181, it is applied by re-running ctd_all_postedit.m. In this case, the functions applied are listed in Table 9.

Table 9: CTD calibration functions

Param.	S/N	function
temp	34116	dcal.temp = d0.temp+interp1([1 101],[1e-3 0e-3],d0.statnum) - 5e-4 +interp1([0 3100],[1e-3 -0.8e-3],d0.press);
temp	35838	dcal.temp = d0.temp+interp1([0 3100],[1.8e-3 0.8e-3],d0.press) - 5e-4;
cond	42580	dcal.cond = d0.cond.*(1+interp1([0 3100],[-0.5e-3 -0.5e-3],d0.press)/35);
cond	43258	dcal.cond = d0.cond.*(1+interp1([1 101],[-6e-3 -4e-3],d0.statnum)/35 + interp1([0 3100],[0 -1.5e-3],d0.press)/35);
oxygen	432061	dcal.oxygen = d0.oxygen.*interp1([0 3100],[1.045 1.065],d0.press);
oxygen	432068	dcal.oxygen = d0.oxygen.*interp1([0 3100],[1.035 1.045],d0.press).*interp1([1 52 53 79 80 101],[0.99 0.99 1.02 1.02 1 1],d0.statnum);

Comparisons between bottle (where flagged good) and calibrated CTD conductivity are shown in Figure 9.

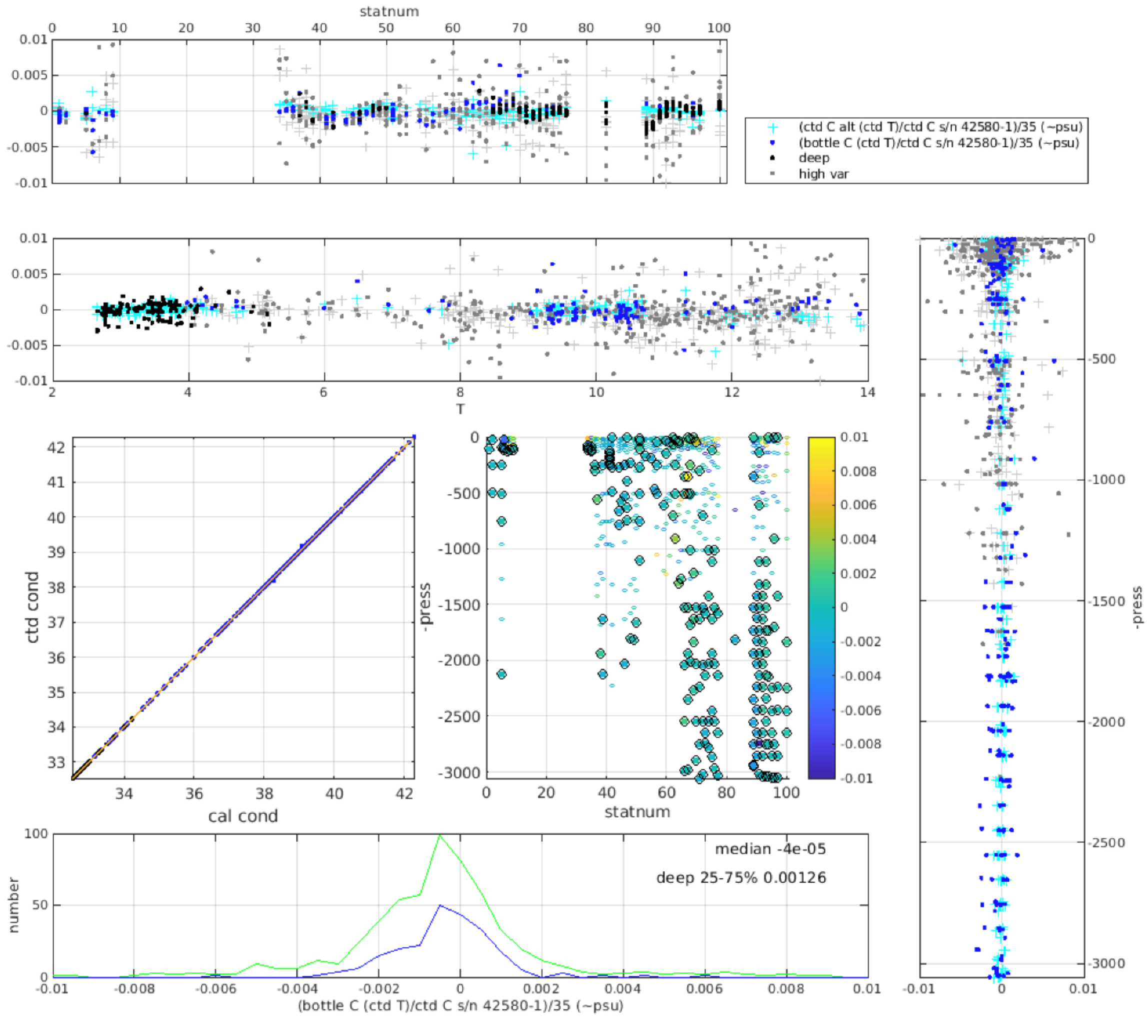


Figure 9: Differences between calibrated conductivity on the CTD (primary sensor) and conductivity from salinity bottle samples

9.4 CTD temperature quality control

The CTD rosette had a vertically-mounted SBE35 temperature probe that took the average of 13 measurements, independently of the main CTD temperature sensors 1 and 2, each time a bottle was fired. The SBE35 measurements were then used to check for drift in the continually logging CTD temperature sensors. Comparisons were made by running '*mctd_evaluate_sensors'* and checking the sensor deviations as functions of day/station number and pressure on scatter plots. Temperature offsets for each of the two sensors (by serial number) were added to opt_dy181 under 'ctd_proc', 'ctd_cals'. Comparisons between SBE35 and CTD temperature are not shown; adjustments applied are in Table 9 above.

9.5 CTD oxygen processing and calibration

CTD oxygen data have the SBE default correction for oxygen hysteresis applied using *ocp_hydro_matlab* scripts. Initially the default SBE oxygen hysteresis parameters were applied by scripts called by mctd_02.m. After inspection of downcast and upcast oxygen profiles, coefficients were adjusted to reduce offsets. The new coefficients used were H1=-0.03, H2=7000, H3=1450 for sensor S/N 43-2061, and H1=-0.033, H2=6500, H3=1450 for sensor S/N 43-2068.

Analysed bottle oxygen data from the chemistry team were extracted using the *moxy_01.m* script. They were checked for consistency of replicates in *moxy_01*, then checked vs the CTD oxygen profiles using *mctd_evaluate_sensors*, *checkbottles_01*, and *checkbottles_02*. Flags were added in *opt_dy181* under 'botoxy' and the comparisons to CTD data repeated. The calibration functions for oxygen are listed in Table 9 above.

Comparisons to calibrated CTD oxygen are shown in Figure 10.

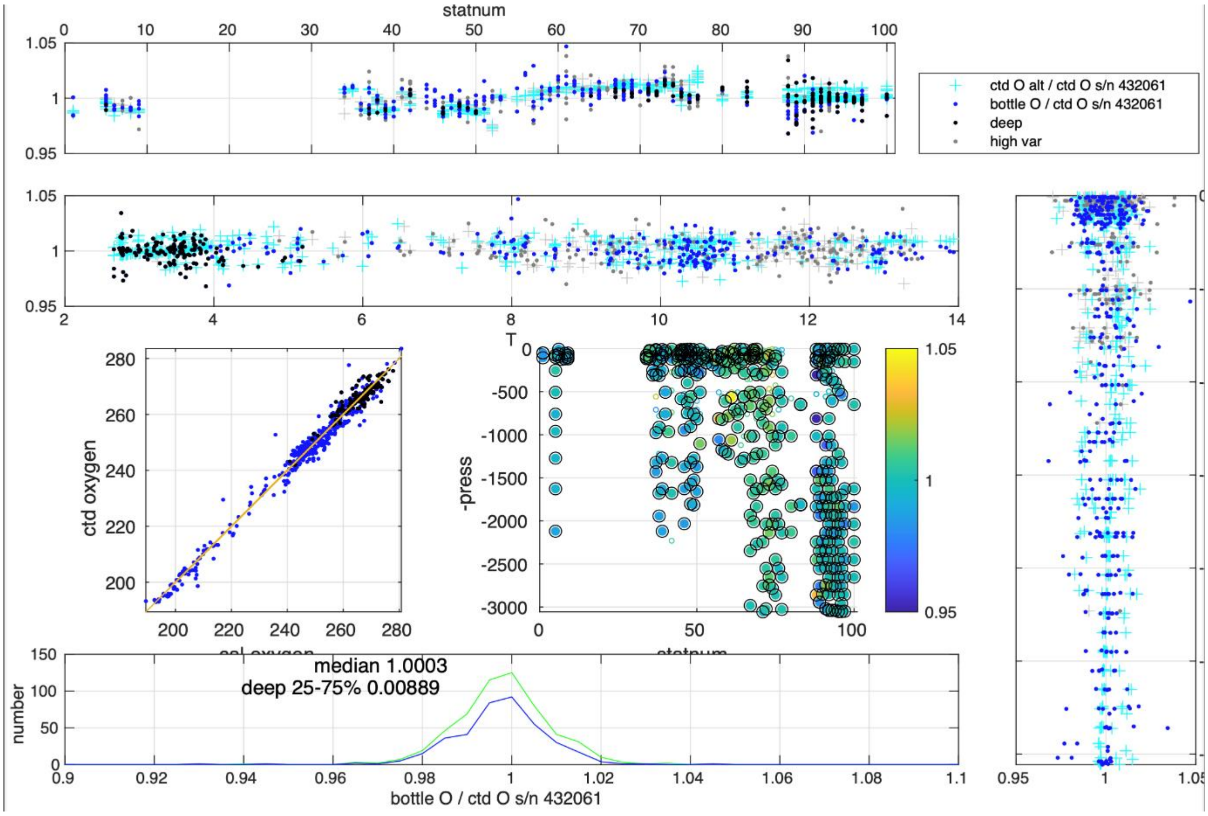


Figure 10: Differences between calibrated oxygen sensor (primary sensor) and bottle oxygen.

10 Lowered ADCP Processing

Yvonne Firing and Charlotte M. Marris

The LADCP data for each CTD cast was processed using the MATLAB package 'LDEO_IX .14' developed at Lamont-Doherty Earth Observatory (LDEO) by Martin Visbeck and maintained by Andreas Thurnherr. The LDEO_IX software implements the velocity-inversion method for processing both horizontal and vertical velocities, to calculate velocity profiles from the LADCP data by applying different constraints, including:

1) GPS – ship navigation and position data; *This provides an accurate constraint for barotropic velocities*
2) BT – bottom-tracking velocities; *This provides a constraint for velocities when in range of the bottom*
3) SADCP – velocities from the shipboard (vessel-mounted) ADCP; *This provides a constraint for velocities in the upper ocean*

Data for horizontal (zonal and meridional) velocities from the down-looking (DL) and up-looking (UL) were first processed separately and then combined (DLUL). The following constraints were then applied consecutively to the combined DLUL profiles:

1) DLUL-GPS (ship navigation)
2) DLUL-GPS-BT (ship navigation and bottom-tracking)
3) DLUL-GPS-BT-SADCP (ship navigation, bottom-tracking, and shipboard ADCP data)

The differences in velocity profiles resulting from adding each constraint in succession is explored in Section 10.2.

10.1 Processing warnings for the LADCP casts

Casts 1, 86, and 99 were not processed (cast 1 was a test, and casts 86 and 99 were aborted). Out of the remaining casts processed, the LDEO software produced the following 12 warnings:

Cast 2: “removed 14 pressure spikes during: 2 scans”

Cast 5: “cast duration differs in down-looker/up-looker data”

Cast 9: “cast duration differs in down-looker/up-looker data”

Cast 35: “cast duration differs in down-looker/up-looker data”

Cast 42: “cast duration differs in down-looker/up-looker data”

Cast 44: “cast duration differs in down-looker/up-looker data”

Cast 55: “weak down-looking beam 3”

Cast 56: “cast duration differs in down-looker/up-looker data”

Cast 58: “cast duration differs in down-looker/up-looker data”

Cast 61: “large compass deviation 15.2614”

Cast 77: “cast duration differs in down-looker/up-looker data”

Cast 82: “shifted ADCP timeseries by 10 seconds”

Please also see comments in the spreadsheet “LADCP_processing errors” saved in the folder “CTD_LADCP_underway_figures” on the science_public drive.

10.2 Data Analysis

The depth-mean and standard deviation of the zonal and meridional velocities for the combined DLUL profiles under the three constraints detailed above are plotted in Figure 11 and Figure 12:

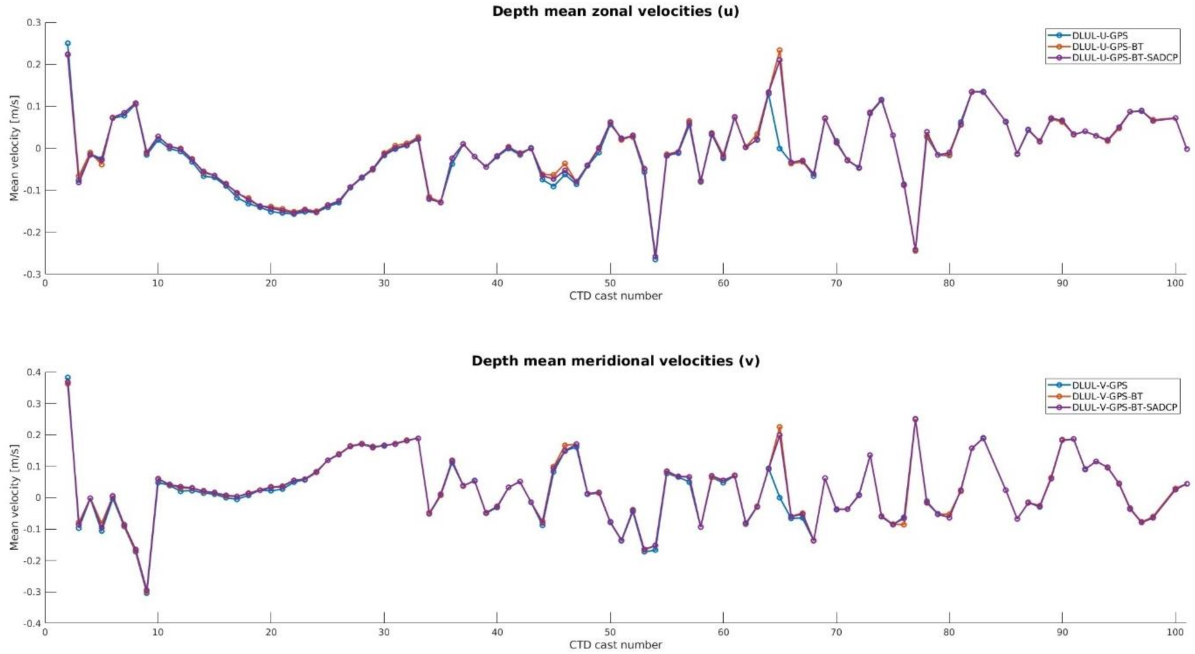


Figure 11: Depth-mean zonal (upper panel) and meridional (lower panel) velocities for CTD casts 2:101 (excluding casts 86 and 99). Shown for three constraints: DLUL-GPS (blue line); DLUL-GPS-BT (red line); DLUL-GPS-BT-SADCP (purple line).

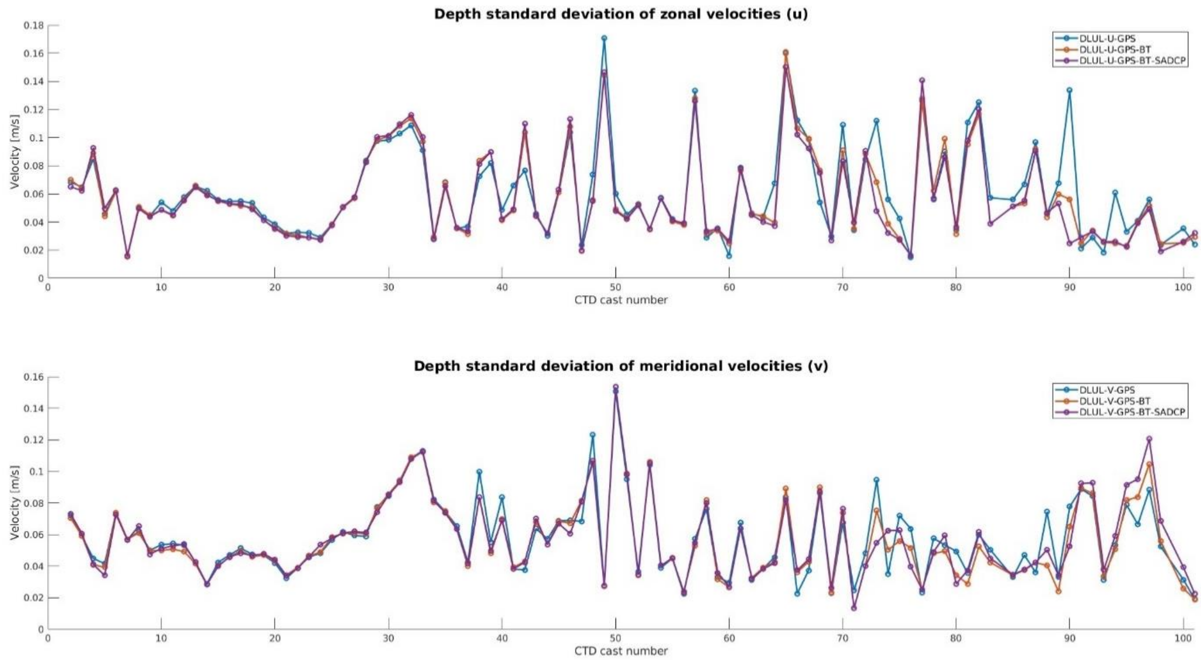


Figure 12: Standard deviation of zonal (upper panel) and meridional (lower panel) velocities for CTD casts 2:101 (excluding casts 86 and 99). Shown for three constraints: DLUL-GPS (blue line); DLUL-GPS-BT (red line); DLUL-GPS-BT-SADCP (purple line).

The depth-mean vertical shear in zonal and meridional velocities under three different constraints is plotted in Figure 13.

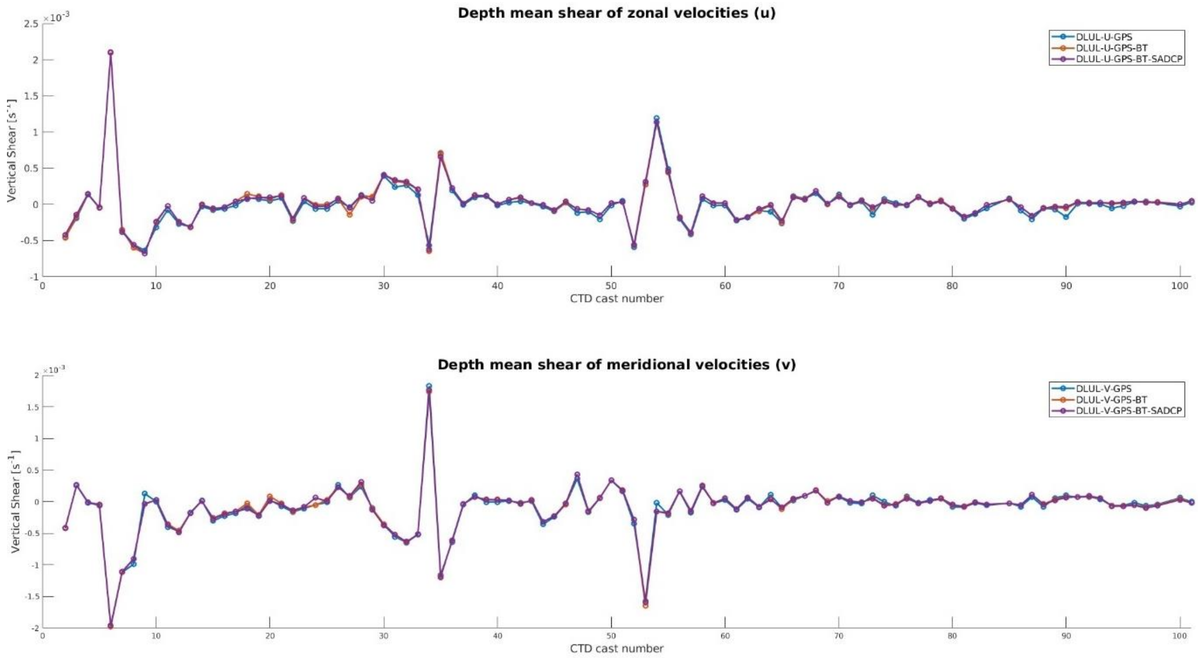


Figure 13: Depth-mean vertical shear in zonal (upper panel) and meridional (lower panel) velocities for CTD casts 2:101 (excluding casts 86 and 99). Shown for three constraints: DLUL-GPS (blue line); DLUL-GPS-BT (red line); DLUL-GPS-BT-SADCP (purple line).

11 Preliminary Results

11.1 Ellett Array section

11.1.1 Temperature, salinity, oxygen, velocity sections

Anneke Sperling

Practical salinity and potential temperature measured by the CTD were converted to Absolute Salinity (SA) and Conservative Temperature (CT) using the Matlab Gibbs Seawater toolbox. Contour plots of the main Ellett Array section were plotted (Figure 14 to Figure 16). T-S diagrams were plotted for the Rockall-Trough (RT), Rockall-Hatton Plateau (RH) and Iceland Basin (IB) to visualise different water masses (Figure 17 and Figure 19). Bottle oxygen was plotted over CTD oxygen to visualise discrepancies between measurements (Figure 20), motivated by continuous issues with the CTD oxygen sensor (probably due to recurring blockage by jelly fish). SA, CT and CTD oxygen were also compared to measurements from JC238 (2022) to assess temporal changes (Figure 21 to Figure 23). This is possible as DY181 and JC238 both occurred in July, so seasonal bias is assumed to be minimal.

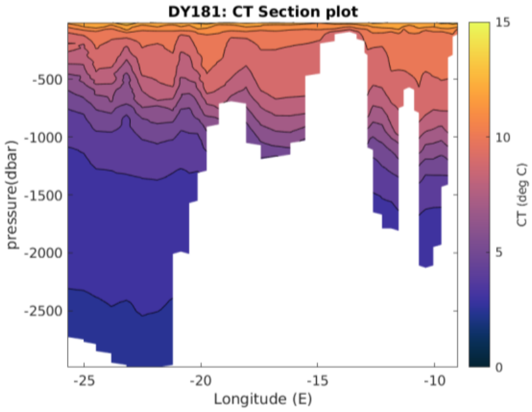


Figure 14: CT along the Ellett Array section.

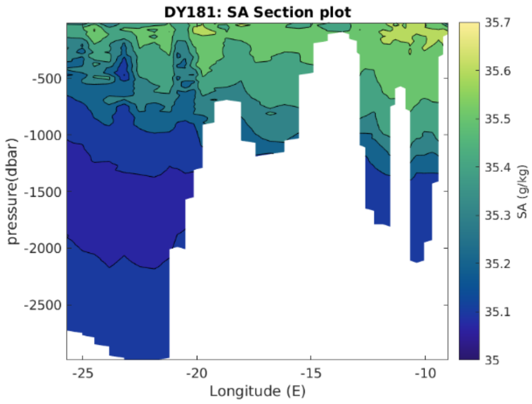


Figure 15: SA along the Ellett Array section.

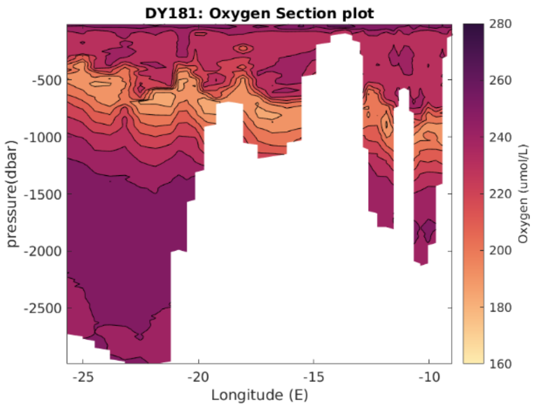


Figure 16: Oxygen along the Ellett Array section.

11.1.2 TS Diagrams – figures updated 26.07. 11:15UTC

The upper ocean in the RT as well as over RH is warmer and saltier (Figure 17 and Figure 18), representative of the Eastern North Atlantic Water (ENAW) which characteristically flows northward through the RT and over RH (Penny Holliday et al., 2000; Pollard et al., 2004). Generally, T and S evolution is very uniform in the RT and over RH whereas it is much more dispersed in the IB (Figure 19). The IB is also the only basin where the deepest water shows an increase in salinity again whilst still decreasing in temperature, creating this 'hook-shape'. Oxygen minima can be found within a similar density space (between sigma 27.2 kg m^{-3} and 27.6 kg m^{-3}) in all basins although they are more confined in the RT and over RH.

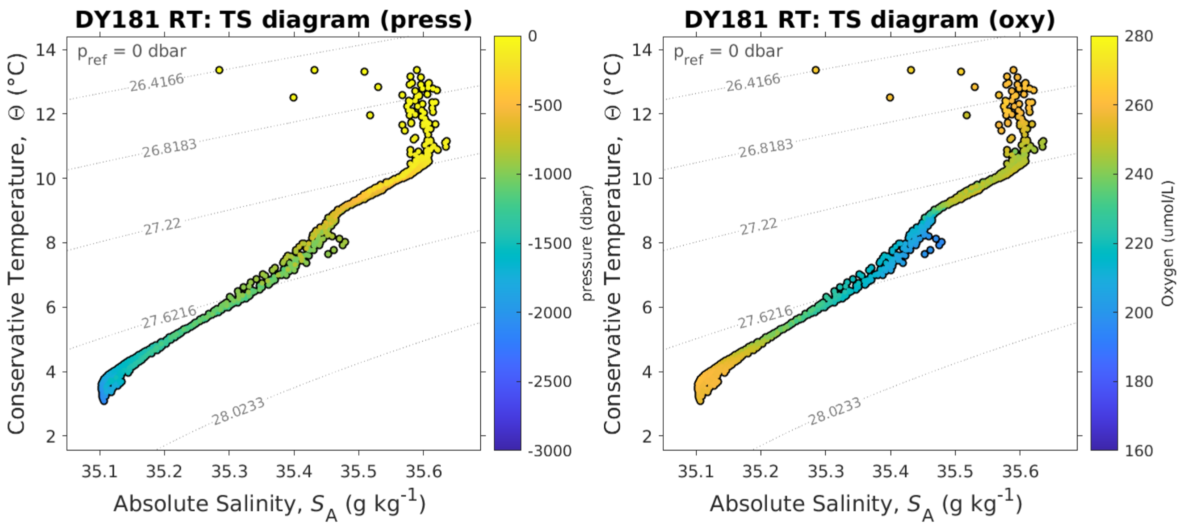


Figure 17: The left-hand figure shows the T-S diagram for RT coloured by pressure. The right-hand figure shows the T-S diagram for RT coloured by oxygen.

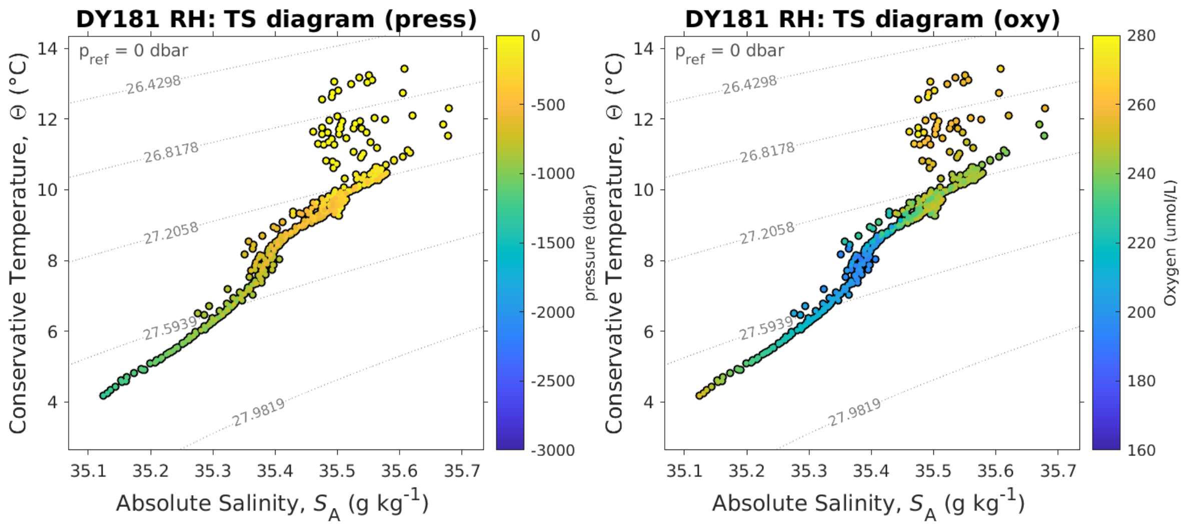


Figure 18: The left-hand figure shows the T-S diagram for RH coloured by pressure. The right-hand figure shows the T-S diagram for RH coloured by oxygen.

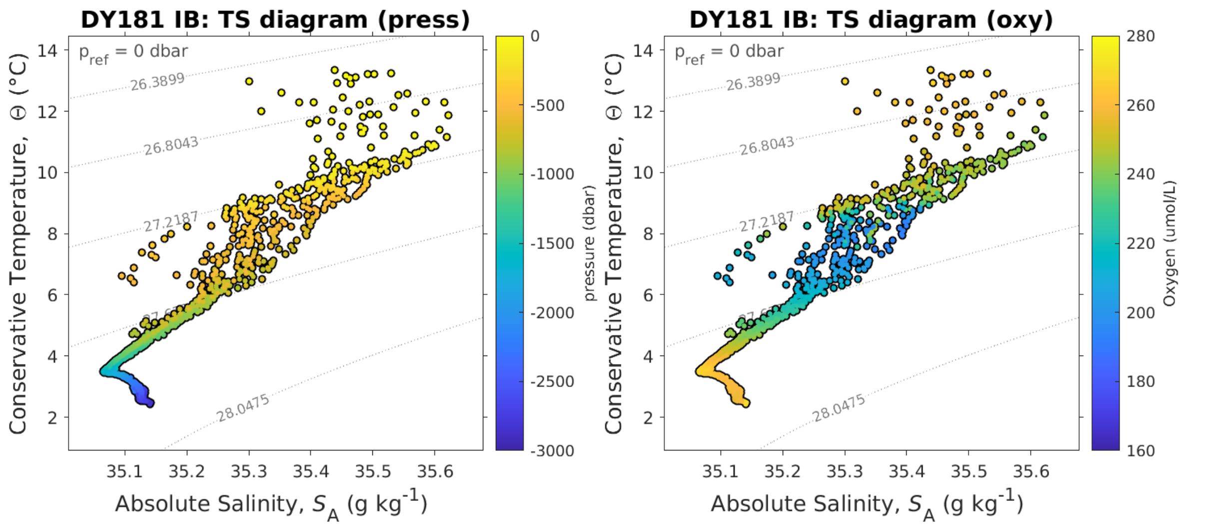


Figure 19: The left-hand figure shows the T-S diagram for IB coloured by pressure. The right-hand figure shows the T-S diagram for IB coloured by oxygen.

11.1.3 Comparison of bottle oxygen with CTD-measured oxygen

Bottle oxygen and CTD-oxygen compare reasonably well although the CTD-measured oxygen has a negative bias relative to the bottle oxygen, even after compensation for the well-known 4% negative offset of the CTD (Figure 20). Discrepancies between CTD-measured oxygen and oxygen derived from water samples are smaller in the oxygen minimum zone and larger in areas of higher oxygen.

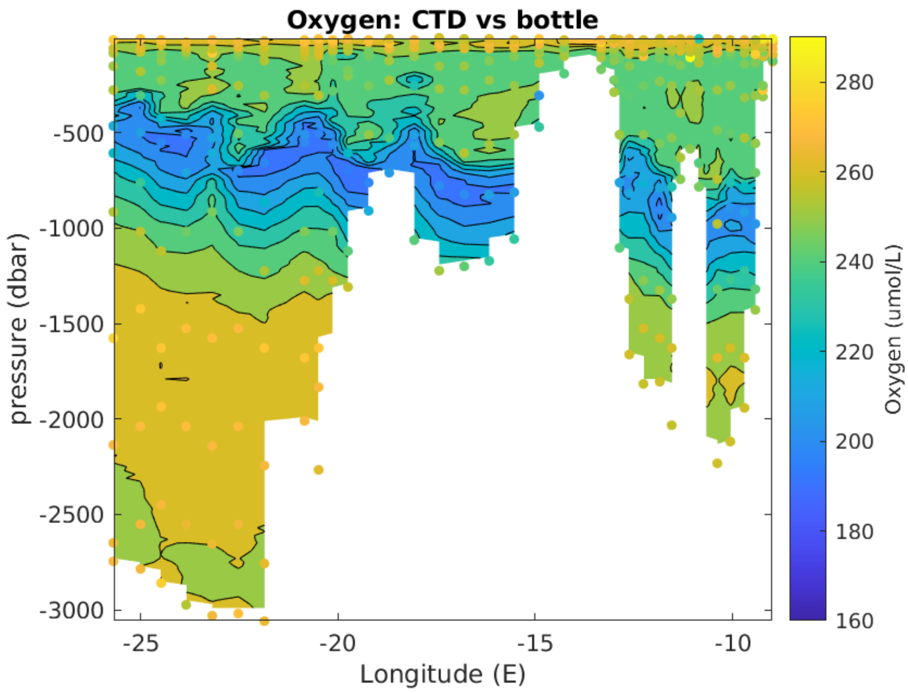


Figure 20: A contour plot of the CTD-measured oxygen, overlain by scatters coloured according to the oxygen content measured from the bottle samples.

11.1.4 Comparison to JC238 – plots updated 26.07. 11:15 UTC

The comparison of CT from DY181 and JC238 (Figure 21) shows temperature increases of up to 1.5 deg C at mid-depth in the eastern Rockall Trough and up to 2 deg C in the upper ocean in the western Iceland Basin, whereas the western and eastern parts of the respective basins experience a temperature decrease of around 1 deg C and in the case of the eastern IB this decrease extends from the surface to the bottom.

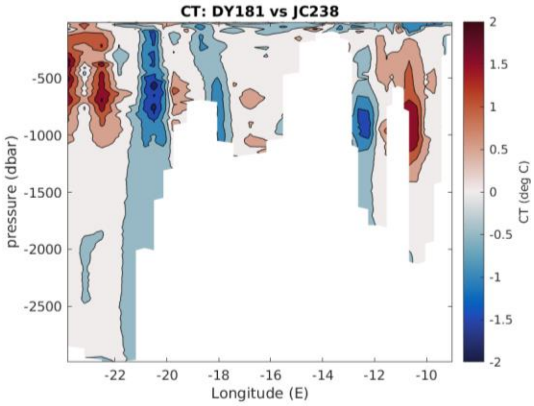


Figure 21: Change in CT between July 2022 (JC238) to July July 2024 (DY181).

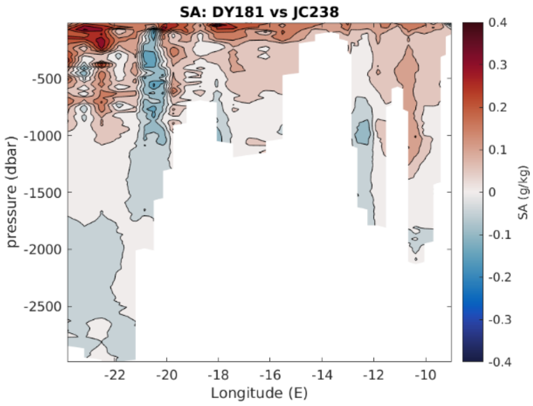


Figure 22: Change in SA between July 2022 (JC238) and 2024 (DY181).

Generally, there is a pronounced positive salinity trend in the surface ocean along the entire section (Figure 21) with the increase in salinity being most pronounced in the upper 500dbar of the western IB (+0.3 g/kg). At greater depths some freshening can be observed in the IB and western RT.

The comparison between CTD oxygen measured in July 2022 and July 2024 (Figure 23) shows intermittent increases between 15-30 umol/L following the slope around the 8 deg C isotherm. These increases are interspersed with more pronounced decreases (-50 to -60 umol/L) along the same isotherm. Apart from the localised increased oxygen concentrations the rest of the water column along the section exhibits a downward trend in oxygen concentrations, which is more spatially variable and intense in the upper-mid ocean and more uniform and less pronounced in the deep ocean. These results should be interpreted with caution due to the ongoing issues with the CTD oxygen sensor on DY181.

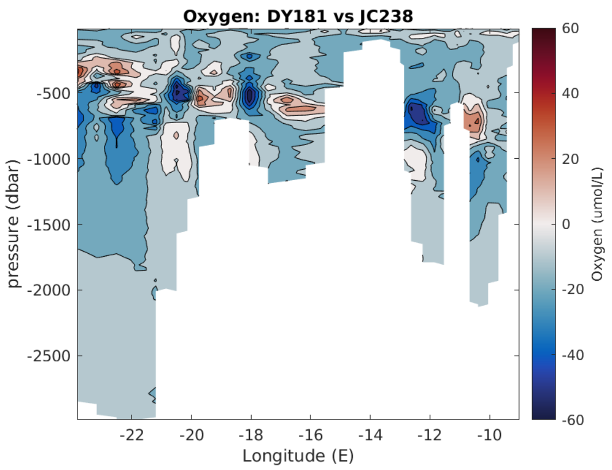


Figure 23: Change in CTD oxygen between July 2022 and July 2024

11.2 lADCP observation of the European Slope Current

Charlotte M. Marris

CTD casts 10-33 were carried out at a single location (57.1 °N, 9.27 °W), situated on the continental shelf at the eastern boundary of the Rockall Trough. This was done to collect continuous velocity profiles and investigate the dynamic properties of the European Slope Current. The CTD was repeatedly lowered to a depth of 400m and then raised to just below the sea surface. The resulting LADCP data over the duration of these casts provides insight into how the horizontal velocities in the region are changing over small timescales (~hours).

Figure 24 shows depth profiles for each CTD cast during the yoyo, coloured by velocity. This shows the flow is predominantly north-westward, as expected for the European Slope Current. Also evident is a tidal component that propagates through the water column.

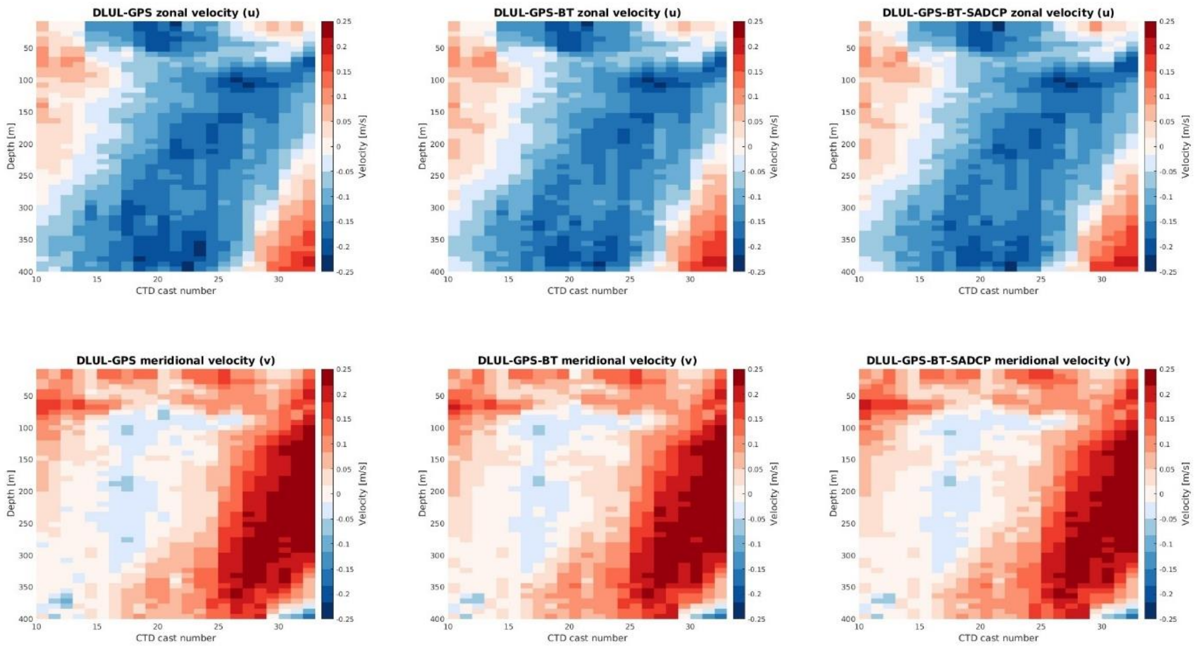


Figure 24: Depth profiles during Yo-Yo CTD casts (10-33). Top row: zonal velocities (red = positive/east, blue = negative/west). Bottom row: meridional velocities (red=positive/northward, blue = negative/southward). Shown for each constraint: DLUL-GPS (left), DLUL-GPS-BT (centre), and DLUL-GPS-SADCP (right).

The plots in Figure 25 and Figure 26 depict the zonal and meridional velocities for each of the yo-yo CTD casts, at fixed depth intervals (48m, 96m, 200m, 400m).

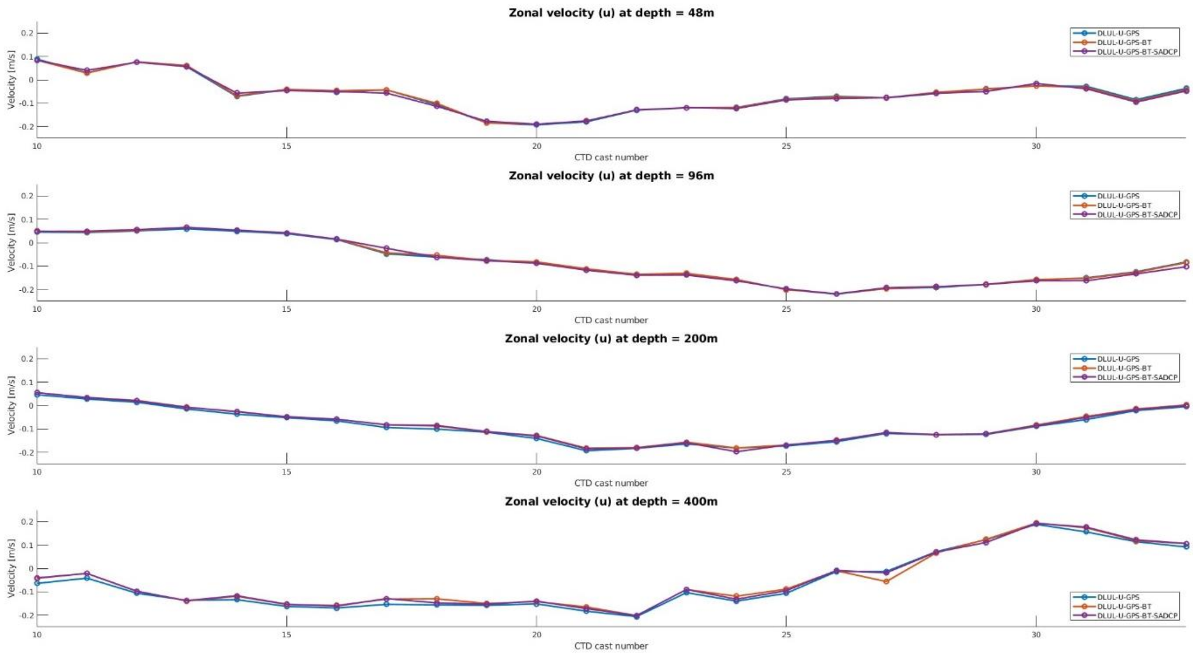


Figure 25: Zonal velocities at fixed-depth intervals (top to bottom): 48m, 96m, 200m, 400m, for yo-yo CTD casts (10:33). Shown for three constraints: DLUL-GPS (blue line); DLUL-GPS-BT (red line); DLUL-GPS-BT-SADCP (purple line).

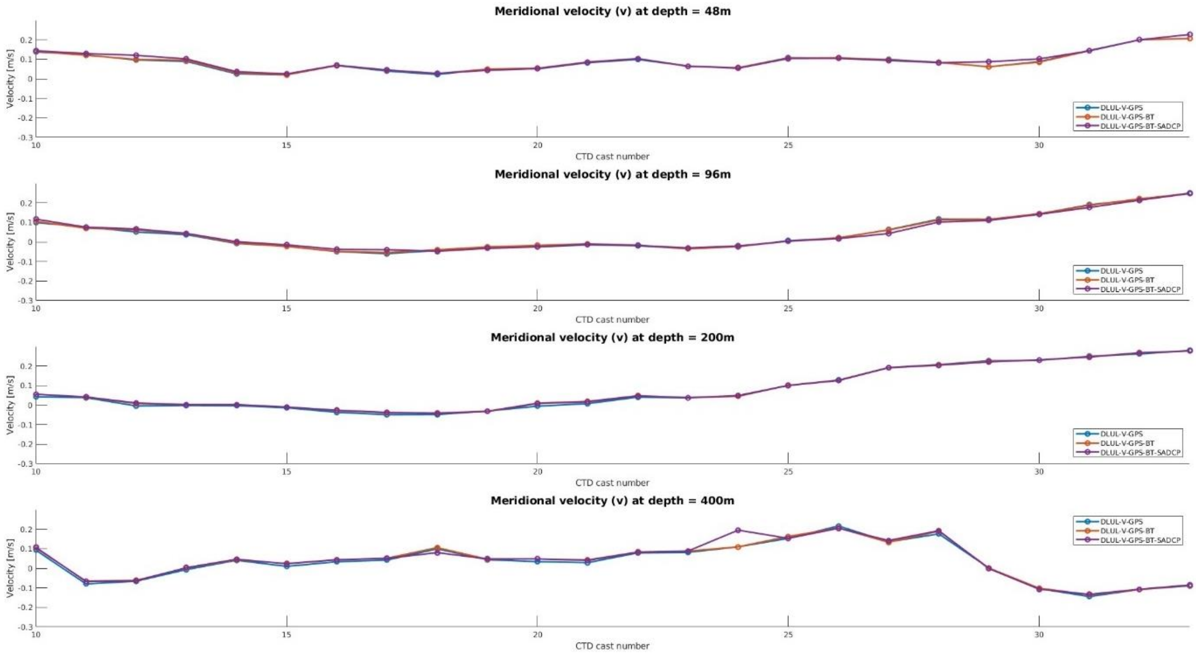


Figure 26: Meridional velocities at fixed-depth intervals (top to bottom): 48m, 96m, 200m, 400m, for yo-yo CTD casts (10:33). Shown for three constraints: DLUL-GPS (blue line); DLUL-GPS-BT (red line); DLUL-GPS-BT-SADCP (purple line).

11.3 Eddy search with SWOT data

Andre Paloczy

Towards the end of the cruise, a dedicated mesoscale survey of an eddy-like feature in the Iceland Basin was carried out. Along-track sea surface height anomaly data from the Surface Water and Ocean Topography (SWOT) mission's KaRIn (Ka-band Radar Interferometer) wide-swath instrument (two 50 km-wide swaths with a 20 km gap in between) was examined to supplement the lower-resolution L4 objectively mapped altimetry and shipboard ADCP data in locating the center of the feature. We used the 2km resolution SWOT_L2_LR_SSH_2.0 product distributed by the Physical Oceanography Distributed Active Archive Center (PODAAC): https://doi.org/10.5067/SWOT-SSH-2.0.

Figure 27 shows two periods (July/14-17 and July 17/20) with SWOT overpasses in the survey area closest to the time of the survey. The depressed sea surface feature associated with cyclonic flow is seen around the ship track, which is plotted until the morning of the 23rd (five days later than the closest SWOT overpass, which happened on the 18th). Preliminary results from the vmADCPs are shown in Figure 63.

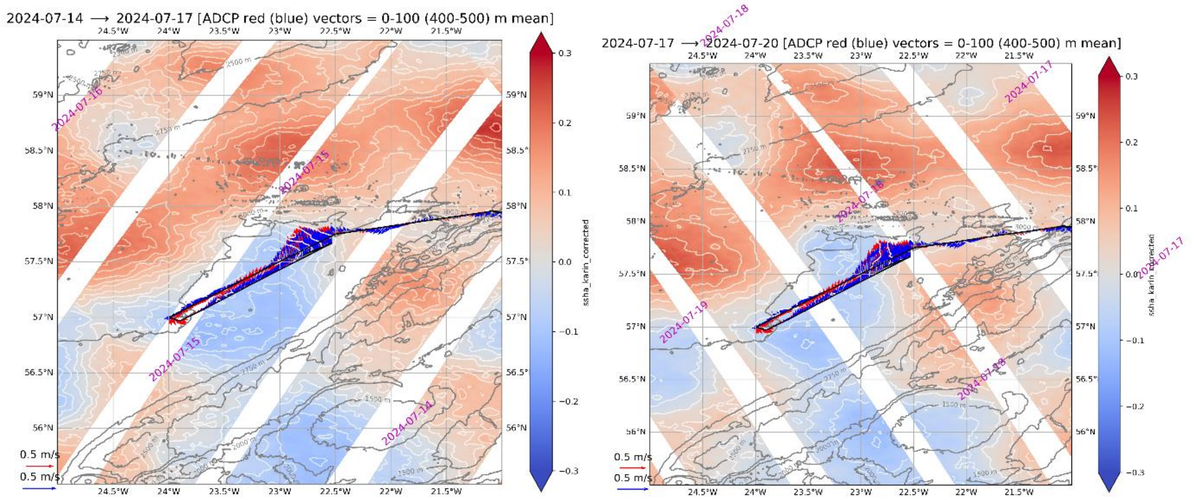


Figure 27: SWOT sea surface height anomaly plots in the Iceland Basin eddy survey. Red (blue) arrows are 0-100 m (400-500 m) depth-averaged velocity vectors from the 75 kHz vessel-mounted ADCP (os75nb). Gray lines are the 100, 500, 1000, 1500, 2000, 2250, 2500, 2750, and 3000 m isobaths from the SRTM15+ dataset.

12 Dissolved Oxygen Sampling and Analysis

Zarina Hewett, Isla Elliott-Walker, Lars Brunner and Richard Abell

12.1 Summary:

On-board seawater sampling and Winkler titrations were used to calibrate CTD measurements of dissolved oxygen. A total of 536 seawater samples from were analysed on-board throughout DY181. Offsets between bottled seawater samples and CTD measurements remained steady at ~10umol/kg, except for some near-surface samples where offsets increased. Replicates were taken for 10% of all samples.

12.2 Methodology:

The methods outlined below follow GO-Ships protocol (Langdon, 2010) and are based on standard methodologies described in Carpenter (1965) adapted for large-scale oceanographic surveys (e.g., Culberson, 1991; Dickson, 1995).

12.2.1 Collection and Fixing of Seawater Samples

Seawater was collected into volume-calibrated bottles with unique identifiers corresponding to each Niskin bottle/depth. Seawater was dispensed into the bottles with a 30cm length of silicon tubing. Prior to sampling, a spare bottle was filled with water from the CTD and allowed to get to temperature, after which the water was removed and replaced, and the draw temperature taken. During this process, air pockets in the silicon tubing were pinched out of the tubing. The samples were then fixed as follows:

1. Sample bottle rinsed 3 times with water from the CTD.

2. Bottle filled with water from CTD, careful not to introduce bubbles into sample.
3. Sample bottle allowed to overfill by 2-3 times its volume, water stream reduced, and tubing removed.
4. Added 1ml manganese chloride (Winker A).
5. Added 1m sodium hydroxide/sodium iodide mix (Winkler B).
6. Carefully replaced bottle stopper at angle to ensure bubbles in bottle cap were removed.
7. Sample inverted several times before being placed in sample rack.
8. After half an hour, bottles were shaken again for 30 seconds, then left for 2+ hours to get to room temperature.

12.2.2 Standardisation.

Standardisation of the sodium thiosulfate was done at the start of each analytical session and for each new bottle of the sodium thiosulfate titrant used. Two commercial available potassium iodate standards were used; OSIL 0.001667M as well as a certified solution JT Baker 0.01667M giving indistinguishable results. New sodium thiosulfate was prepared days in advance to allow the solution to reach equilibrium and avoid erratic results during standardisation. Standardisation accuracy was better than 0.3% (1 standard deviation).

12.2.3 Titration

Samples were allowed to reach room temperature prior to analysis. A stir bar was added to the sample followed by 1ml sulfuric acid (75% conc.), after which it was then placed onto the stirrer plate until the precipitate disappeared. Measurements were conducted using a volumetric titrator (5ml Metrohm 848 Titrino Plus; "Eric") using method from Holley and Hydes, 1994. The probe, burette, and stirrer were rinsed with MQ water between each measurement.

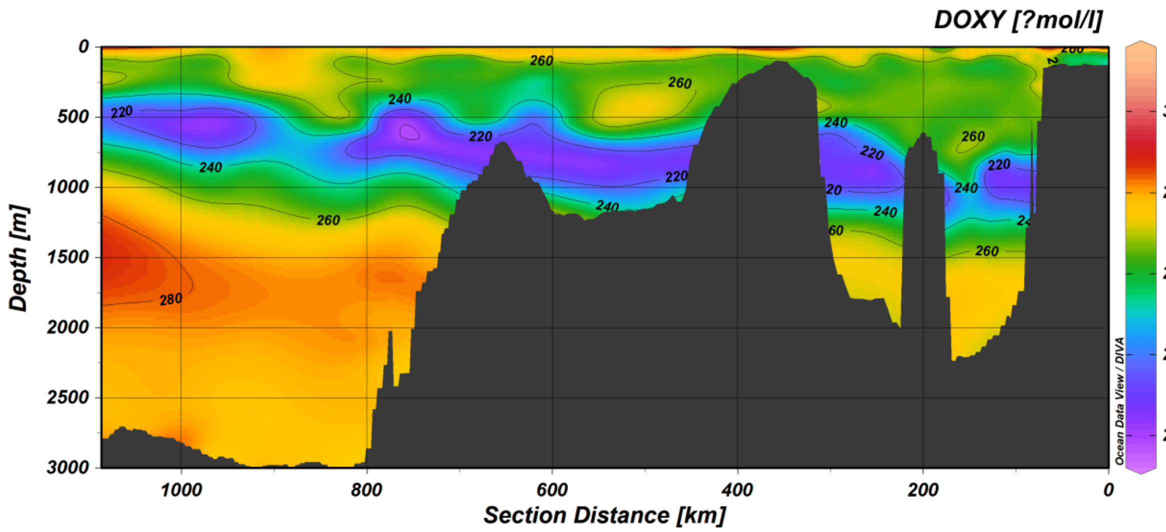


Figure 28: Dissolved oxygen section derived from bottle sample data along part of the DY181 cruise track.

13 Dissolved Inorganic Carbon and Nutrients Sampling and Analysis

Richard Abell, Isla Elliott-Walker, Zirina Hewett and Lars Brunner

The concentrations of biogeochemically important dissolved seawater nutrients silicate (silicic acid [$Si(OH)_4$]), phosphate, nitrate and nitrite were determine on board during DY181 operations. Dissolved Inorganic Carbon (DIC) was sampled and stored for analysis on shore. The nutrient analysis was performed using a Seal AA500 continuous bubble segmented flow auto-analyser following well established techniques to accurately determine sub-micromolar nutrient concentrations along hydrographic sections. (e.g., Ree et al., 2019).

13.1 Dissolved Inorganic Carbon Methodology

Sampling: within 10 minutes of sampling for Dissolved Oxygen, seawater samples were drawn from Niskin bottles via a short length of silicon tubing, ensuring bubbles did not enter the 250 cm3 glass sample bottles. Excess seawater (at least one bottle volume) was flushed through the pre-labelled sample bottles to clean them and assist bubble removal. Ground glass lid stoppers were put on tightly, again ensuring no bubbles were trapped within the sample. To allow for water expansion, 2.5 cm^3 seawater was removed using a pipette.

Storage: To preserve the samples until analysis, 50 µl ~7 % $HgCl_2$ was added by dispensing from a pipette below the sample surface in order not to introduce bubbles. A small amount of Apiezon® L grease was applied to the ground glass stoppers which were then replaced in the bottles and turned to ensure a good seal. PVC tape was bound tightly around each bottle and stopper, and the secured sample bottles were placed upright in cushioned crates to be stored at room temperature in the dark until analysis.

13.2 Nutrients Methodology.

Sampling of 12 Niskin CTD bottles was commenced immediately after collection of dissolved gases. Samples were prefiltered with an AcroPak/Cytiva 0.45um gravity capsule filter to remove particulates and any zooplankton. The filter was flushed prior to collecting the final sample and sample vials (pre cleaned in de-ionised water and leached in 10% HCl, followed by a further rinse) were rinsed three times directly with the Niskin sample before final collection of sample for nutrient analysis. Samples were refrigerated at 4^oC in the dark until being brought to room temperature prior to analysis. The analysis was conducted within 12 hours of collection with the exception of 4 underway samples that were frozen for 24 hours, defrosted to room temperature and then measured.

Silicate was determined using Seal method no. A-006-19 Rev.3 based on the reduction of silico-molybdate in acidic solution to molybdate blue using ascorbic acid measured at 820nm. Oxalic acid was used to minimise interference from phosphates. Nitrite using Seal method no. A-003-18 Rev.3 whereby nitrite reacts with sulfanilimide under acidic conditions to form a diazo compound. The colouring agent N-1-napthylethylenediamine dihydrochloride is added to form a purple azo dye which is measured at 540nm. On a separate channel, the total oxidised nitrogen (nitrate + nitrite) was determined via the reduction of nitrate to nitrite on a copper-cadmium column buffered with ammonium chloride at pH8.5 (Armstrong et al., 1967). Nitrate is determined by subtraction of the nitrite concentration from the total oxidised nitrogen concentration. Cadmium column efficiency was tested prior to every run using recovery of separate15uM nitrite and nitrate solutions to ensure efficiency was >98% and the column was reconditioned if this efficiency was noted to have dropped. Phosphate was measured as orthophosphate by reaction with molybdate and antimony followed by reduction with ascorbic acid at pH < 1 (Murphy and Riley, 1962). The reduced blue phosphor-molybdate complex was measured at 880nm. The $[H^+]$: [Mo] ratio of the reactants was optimised (Drummond and Maher, 1995).

Quality assurance and data control was carried out using repeat measurements of certified reference material KANSO LOT-CS (Japan Agency for Marine-Earth Science and Technology (JAMSTEC)), two sets of calibration standards both prepared in house from pure salts (potassium dihydrogen phosphate Merck Supraure 99.999%, potassium nitrate Merck Suprapure 99.995%, potassium nitrite Alfa Aesar 99.999%, Sodium Hexafluorosilicate Alfa Aesar 99+%) and external OSIL nutrient standards (Osil, Havant, UK). Between run checks were also carried out using repeat samples of deep water from

'Station N' frozen and defrosted prior to batch analysis. Reproducibility of CRM and Check standards was better than 3% for all nutrients in line with GO-SHIPS QA/QC requirements (Becker et al., 2020). No 'normalisation' of the raw nutrient data was performed.

A broad overview of the TOXN and Silicate data from 713 samples along the DY181 transect are shown in Figure 29.

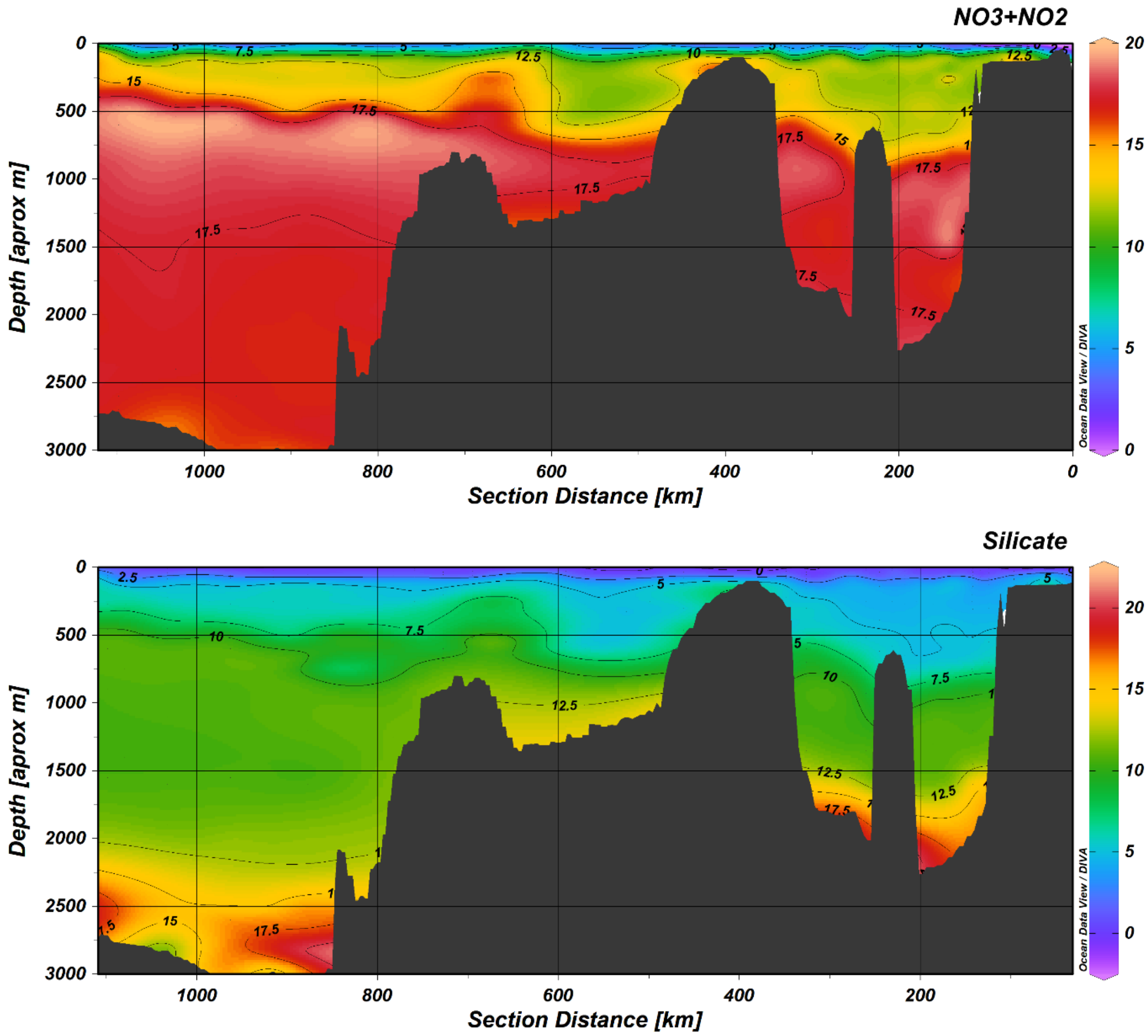


Figure 29: Overview of the TOXN and Silicate data from 713 samples along part of the DY181 transect.

14 Argo Float Deployment

Tiago S. Dotto

Four Seabird BGC NAVIS floats (provided by the Woods Hole Oceanographic Institute, USA) and two Teledyne APEX Standard floats (provided by the Met Office, UK) were deployed during the expedition (Table 10). All deployments were made in water depths deeper than 2000 m. Four deployments were co-located with CTD stations for further comparison and calibration. Before deployment of the BGC NAVIS, the optical sensors were cleaned with deionised water and sensor lens wipes and then dried with lens paper. The deployment occurred with the ship moving at a speed of 0.5 kn after it moved away from the CTD station location by ~1km. All floats were lowered slowly into the water from the stern using a line that was tied at one end to a cleat and the other end of the line passed down through the hole in the float's deployment disk. For floats that were not co-located to CTD stations, the ship reduced its speed to 0.5 kn for the deployment.

Table 10: BGC NAVIS and APEX Standard floats deployment

Float serial number	Date	Time (UTC)	Latitude	Longitude	CTD profile
NAVIS F1565	6 July 2024	13:00	57˚ 13.565' N	010˚ 01.426' W	CTD 005, Site N
NAVIS F1533	17 July 2024	03:06	57˚ 52.709' N	020˚ 29.856' W	CTD 069, Site O21
APEX 9599	19 July 2024	02:40	57˚ 58.407' N	026˚ 00.170' W	CTD 074, Site O29
NAVIS F1566	19 July 2024	07:04	57˚ 57.678' N	024˚ 28.071' W	CTD 075, Site O28
NAVIS F1566	26 July 2024	13:45	60˚ 00.544' N	021˚ 46.294' W	CTD 101, Site Argo
APEX 9470	26 July 2024	20:20	60˚ 59.982' N	021˚ 00.156' W	-

15 Mooring and Instrumentation

15.1 Mooring deck operations

Tim Powell

15.1.1 Deck setup

The deck mounted counter sheave, hydraulic double barrel winch and both new and old reeling winches were positioned on the aft deck slightly to port of the ship's centreline allowing enough room for the large syntactic spheres to be moved to and from the red deck.

A Lebus 5 tonne deck winch was positioned starboard aft in line with the ship's aft gantry 5 tonne hanging sheave.

A 2 tonne mooring sheave was suspended from the starboard pedestal crane's fixed hook.

15.1.2 Recoveries

Moorings were released using an Ixsea TT801 deck unit connected to the ships fitted transducer located in the port drop keel. Once on the surface the ship manoeuvred to bring the top of the moorings alongside the starboard waist so that a grapple could be thrown with the aim of capturing the floating line. floating line would then be connected to the recovery line that had previously been led from the double barrel winch, through the mooring sheave suspended from the starboard aft crane, round the starboard quarter and along the side deck.

Once successfully connected the ship would move slowly ahead allowing the mooring to stream clear astern before the winch began hauling in.

Most of the moorings came up tangled in some way, where necessary these were stoppered off using Tractel EC10 wire rope clamps so that the mooring could be split, untangled and recovered one section at a time.

IB3 was tangled with a large quantity of longline fishing gear. This was slowly and carefully recovered along with the mooring.

Figure 30: IB3 recovery with fishing line tangled along the mooring.

15.1.3 Deployments

Most of the moorings were wound onto steel storage drums via the double barrel winch ready for deployment. Each link in the mooring was wrapped in canvas to prevent the wire's outer jacket from damage. This wrap was removed during deployment to enable the mooring to be connected together fully.

The moorings were deployed from the steel storage drums via the double barrel winch, deck mounted counter sheave and 2 tonne mooring sheave suspended for the starboard pedestal crane. The heavier anchors were deployed using the Lebus 5 tonne deck winch via the aft gantry and released using a Sea Catch TR10 toggle release hook.

When required the port pedestal crane was used to lift and deploy syntactic spheres, the Darwin Mounds sediment trap and some of the lighter anchors.

15.2 Mooring Instrumentation

Dave Childs, Chris Crowe, Estelle Dumont, Helen Smith

15.2.1 SBE37

Recoveries

Fifty-six SBE37s Microcats SMP were recovered from the moorings (54 from the from the Ellett Array, 2 from DMLTM). All were still operational and collecting data at the time of recovery after being deployed for 24 months.

Figure 31: Obstructed exhaust of Microcat.

The instruments deployed in the top 100 to 200m and just above the bottom showed quite significant biofouling however none near the cell intake and exhaust, which were fitted with antifoulant devices. S/N 11139 (IB3 1500m) was recovered with an obstruction in the CT cell exhaust, thought to be antifoulant which had degraded (Figure 31). The data appeared to be unaffected.

Several instruments were recovered among tangles in the mooring wire (or fishing line on IB3) but no damage was observed.

Most of the microcats reported a clock of drift of less than 1 minute from UTC time, with some of the older instruments (serial numbers <5000) showing a larger offset of up to 3.75 minutes.

The raw data were converted to cnv in SBEDataProcessing (DatCnv module) for SBE37's v≥3.0, and in SeaTerm using the "Convert" tool for SBE37s v≤3.0.

All instruments recorded data for the full deployment period. No major issues were observed in the data.

They were all cal-dipped post-deployment (see cal-dip result table in the APPENDIX I). The pressure, temperature and conductivity data will be corrected for sensor drift and/or offsets in post-processing using the data from these calibration dips along with the pre-deployment ones carried out during JC238.

Deployments

Forty-seven SBE37s Microcats SMP were deployed across the moorings: 35 SBE37-SMP (inc. 2 on DMLTM) and 12 SBE37-IMP (inductive microcats, 10 deployed on RTEB1 and 2 on the Telemetry Test mooring).

They were all cal-dipped prior to deployment (see cal-dip result table in the APPENDIX I). Instruments were deployed at depths showing a pressure offset <5dbar. Temperature offsets were all <0.002°C. Instruments showing a conductivity offset >0.02 mS/cm were not deployed, and generally we tried to select those with an offset <0.015 mS/cm wherever possible.

They were fitted with new batteries (SAFT 3.6V Lithium AA cells), and their clocks were synchronised with GPS time. Sample intervals and endurance estimates are summarised in Table 11.

Table 11: Estimated endurances for the SBE37s deployed. As standard practice, a 20% safety margin is applied to the maximum battery endurances calculated. The IMP sampling rate was reduced to hourly as the base endurances calculated for a 30-minute interval were 729 days (aim: ~790 days or 26 months), and the endurances would have been further reduced by the power required for the (planned) inductive modem communications.

Model	Firmware version	Instrument s/n	Sample Interval	Navg	Endurance days (SBE calculator)	80% endurance
SBE37-IMP	2.3a	<5000	3600	4	1198	958
SBE37-SMP	3.x	6000<x<8000	1800	n/a	1243	994
SBE37-SMP	4.1	>9000	1800	n/a	4507	3605

15.2.2 SBE37-ODO

Recoveries

Eight SBE37-ODOs were recovered (4 from RTEB1 and 4 from IB4), including one (s/n 14149) paired with the SeaFET on EB1.
All ODOs were still recording at the time of recovery after being deployed for 24 months.
The instruments deployed at 50m showed quite significant biofouling however none near the cell intake and exhaust, which were fitted with antifoulant devices.
The ODOs reported a clock of drift of less than 1 minute from UTC time, except for s/n 12908 (deployed at 350m on IB4) which had drifted by -10 minutes 45s.
The raw data were converted to cnv in SBEDataProcessing (DatCnv module).
ODOs were cal-dipped post-deployment (see cal-dip result table in the APPENDIX I). The pressure, temperature and conductivity data will be corrected for sensor drift and/or offsets in post-processing using the data from these calibration dips along with the pre-deployment ones carried out during JC238. It is not possible to obtain accurate oxygen offsets during the caldips due to the long response time of the SBE63 oxygen sensor; oxygen data will be calibrated using in-situ samples taken from the CTD casts conducted just after the mooring deployment and just before recovery.

All instruments recorded data for the full deployment period. Notable data issues:

- S/N 21317 (500m on RTEB1): the temperature sensor inside the SBE63 oxygen sensor failed part-way through the deployment in February 2023 (after 7 months of deployment). The oxygen sensor itself failed completely in May 2024 (after 21.5 months of deployment) with the raw phase delay volt output reporting negative values, although it is uncertain how reliably it had been performing up to that point.
- Oxygen concentrations were recalculated using the modified Stern-Volmer equation described in the Sea-Bird SBE63 Optical Dissolved Oxygen Sensor manual (version 11, 29/03/2017), using the SBE37 temperature instead of the SBE63's (see Figure 32 and Figure 33). The difference between the SBE63 and SBE37 temperatures were typically less than 0.002°C at the start of deployment, and similar values were observed for other ODOs.
- However, without any in-situ sample data available for comparison prior to recovery it is difficult to assess the accuracy of the oxygen data. Further investigation will be carried out post-cruise.

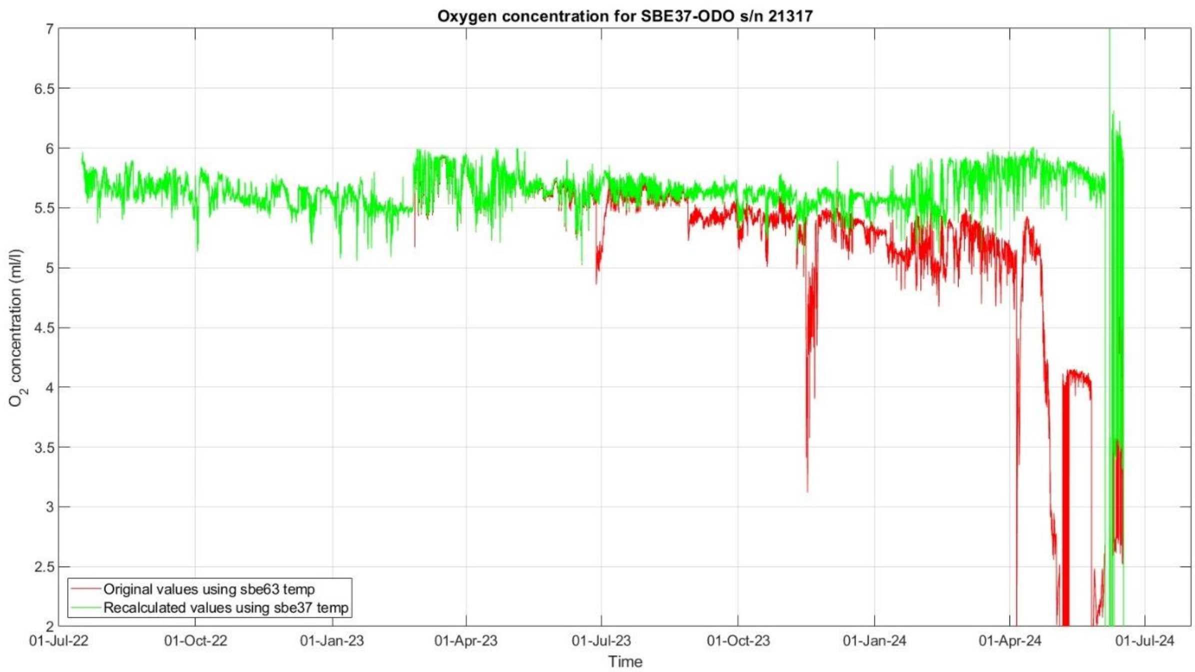


Figure 32: SBE37-ODO S/N 21317 original O_2 concentrations (red) calculated from SBE63's temperature sensor vs recalculated values (green) using SBE37's temperature.

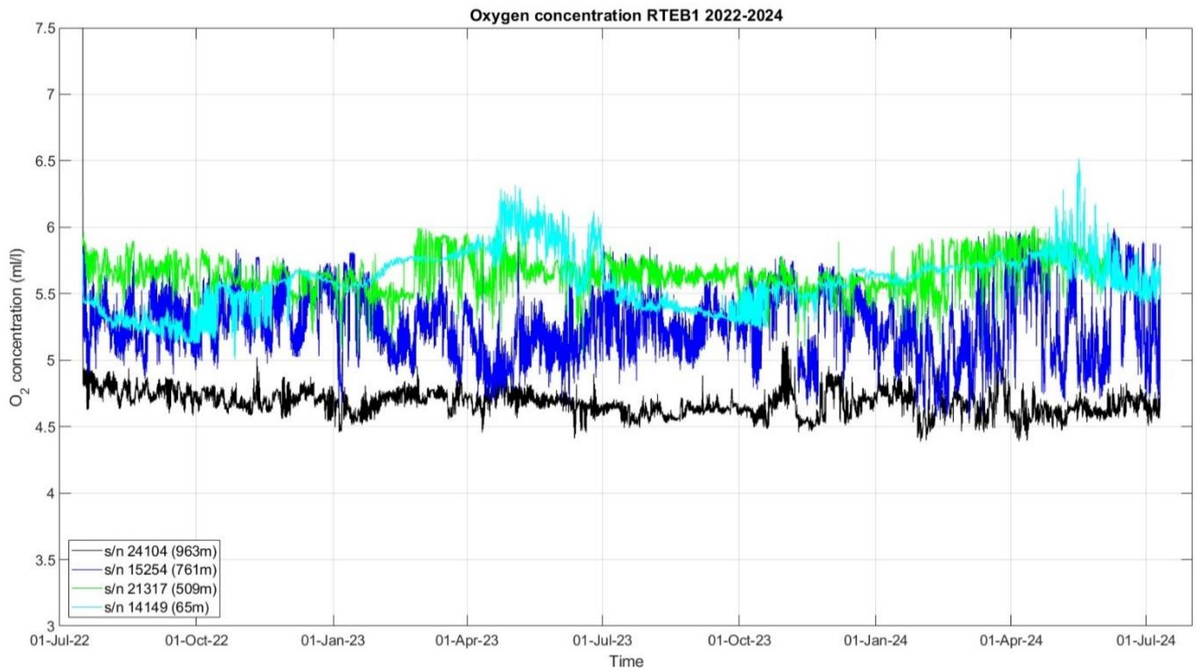


Figure 33: comparison plot of S/N 21317 recalculated O_2 values (green) against the other SBE-37 ODOs on mooring RTEB1

- S/N 12908 (350m on IB4): the oxygen sensor failed at the start of the cal-dip (5 minutes after the start time, while the CTD was still on deck). Temperature and conductivity data were unaffected.
- S/N 13000 (700m on IB4): a conductivity offset of ~0.045 mS/cm was calculated after the cal-dip. The oxygen data will be reprocessed using conductivity from adjacent SBE37 s/n 11334.

Deployments

Eight SBE37-ODOs were deployed on RTEB1 and IB4 (including one paired with the SeaFET on RTEB1); six recently serviced and two turned around from the recovered RTEB1 mooring.

Originally, S/N 21318 was planned to be paired with the SeaFET, but was found to have intermittent communication issues after the pre-deployment cal-dip. The same problem had happened during JC238 with this instrument, and it had been sent back to the manufacturer for servicing. The instrument was not deployed, and will be sent back to the manufacturer for further investigation.

All were cal-dipped prior to deployment (for pressure, temperature and conductivity). All produced acceptable results (see cal-dip result table in the APPENDIX I).

Deployment setup:
The SBE63 sensor (oxygen optode) requires a longer flushing time than the conductivity sensor for the readings to stabilise. SBE37-ODOs have the option of using Adaptive Sampling, described in the instrument manual as:
"If enabled (AdaptivePumpControl=Y), the Microcat calculates the pump time before each sample for best oxygen accuracy, as a function of the temperature and pressure of the previous sample (temperature and pressure influence the oxygen sensor time constant). Pump time increases with increasing pressure and decreasing temperature. The pump continues to run while sampling."
This option was activated for all SBE37-ODOs deployed stand-alone. As the pumping time is significantly higher than for a standard Microcat the energy usage is therefore increased. The sampling intervals were set as for the previous deployments (2018, 2020 and 2022), which had been calculated based on estimated pumping times using the minimum expected temperature at each depth.
New batteries were fitted prior to deployment (SAFT 3.6V Lithium AA cells), and the clocks synchronised to GPS time.

Table 12: Summary of SBE37-ODOs endurance estimates and sampling intervals.

Mooring	S/N	Depth (m)	Expected minimum temp (°C)	Expected max pumping time (sec)	Sampling interval (sec)	Estimated endurance (days)
RTEB1	15298	500	9.1	69	3600	923
RTEB1	15476	750	8.0	76	3600	858
RTEB1	14987	950	4.5	92	4500	890
IB4	15254	50	9.1	65	3600	973
IB4	21560	350	8.2	71	3600	907
IB4	21319	500	8.2	73	3600	891
IB4	24104	700	5.4	85	4500	949

15.2.3 DeepSeapHOx

Recovery

One DeepSeapHOx was recovered from RTEB1 (nominal deployment depth 50m), comprising of SeaFET V2 S/N 2002 and SBE37-ODO S/n 14149.
Both instruments were still recording at the time of recovery. The clock offset was negligible (+7s). The download of the data was troublesome, interrupting at various stages of the file. Several different baud rates were tried without success, and the data was eventually downloaded in several smaller blocks.
The pH sensor failed in August 2023 (after 13 months of deployment). It is suspected to be due to a failure of the ISFET chip, which SeaBird recommends replacing annually. The data before that point

appears fine, despite the accidental dip in freshwater prior to deployment (see JC238 cruise report). The SBE-37 ODO data was good throughout the deployment.
The OSBE37-ODO was cal-dipped separately from the SeaFET post-recovery (see section 15.2.2 SBE37-ODO) and produced good results. A CTD cast was conducted next to the mooring before recovery, and discrete water samples taken for dissolved oxygen, DIC/TA and nutrients, which will be used to calibrate the DeepSeapHOxsensors.

Deployments

One DeepSeapHOx, comprising of SeaFET V2 S/N 2061 and SBE37-ODO S/N 21320, was deployed on RTEB1. The SeaFET is the original SAMS V1 SeaFET S/N 117, which was upgraded to V2 last year.
The ODO was cal-dipped separately (for pressure, temperature and conductivity) and produced good results (see section 15.2.2 SBE37-ODO).
Both instruments were fitted with new batteries (Duracell Industrial D-cells – nominal capacity 15,476mAh – and SAFT AA Lithium AA cells), and their clocks synchronised to GPS time. The SeaFET was placed in seawater for 6 days before deployment, to allow for the sensor to recondition after the battery installation.

- The ODO baud rate was set to 9600 in SBE SeaTerm V2, before being connected to the SeaFET and the two paired together in the UCI software using the command 'Resync'. The same sampling parameters as in the last two deployments were used again (3600s sampling interval, 65s pump duration; see full setup log in APPENDIX HH).lab tests the UCI (v.2.0.4) deployment wizard proved somewhat unreliable resulting in the DeepSeapHOx not starting to sample at the set start time. In those cases the indicator led did confirm the instrument was not set to start sampling after programming (flashing red). An alternative way to start the deployment was used:the parameters via the SeaFET settings interface
- Download setup report via the Sensor menu
- Start the deployment via the Command Terminal:
  StartDateTime=07102024110000
  StartLater
- Check the instrument is set to start by running the magnet over the indicator LED (which should flash green).

The DeepSeapHOx was kept in seawater up to deployment time.

15.2.4 SUNA

Helen Smith, Andre Paloczy

The Submersible Ultraviolet Nitrate Analyzer (SUNA) V2 sensor measures dissolved nitrate and displays units in micromolar (µM). The sensor lights the water sample with its deuterium UV light source and measures this with its spectrometer. The difference between this measurement and a prior baseline measurement of pure water is the absorption spectrum. Nitrate processing uses the 217–240 nm wavelength range, which is approximately 35 spectrometer channels.

Pre deployment testing

The SUNA-SBE16+ system was tested in the lab prior to deployment. Samples with known nitrate concentrations in a seawater matrix were provided by the chemical oceanography group at SAMS, and used to calibrate the voltage response of the instrument, using the digital-to-analog converter (DAC) as given by the manufacturer:

C = DACmin + (DACmax - DACmin) / (Vmax - Vmin) * (V - Vmin)

Paragraph provided by Rich Abel – chemistry team lead. The sensor was calibrated using a primary nitrate stock solution prepared for the onboard measurement of dissolved inorganic nutrients (see section 13 of the cruise report). Prior to the cruise the primary stock solution was made from “trace metal” grade KNO_3 salt (>99.99% purity, Merck) dissolved in 1 litre (buoyancy corrected) of de-ionised water. The accuracy of the primary standard was confirmed with cross calibration of a secondary standard (OSIL, Havant, UK). To matrix match the calibration with deployment salinities the primary standard was diluted using OSIL low nutrient seawater (batch 31). The ‘zero’ calibrant was OSIL LNSW only.

The minimum and maximum (Vmin and Vmax) voltages for the SUNA/SBE16+/battery system were determined using standard low-nitrate (LNSW) and high-nitrate (HNSW) water samples. We used MilliQ water and two seawater matrix nitrate solutions, plus an intermediate-concentration solution, produced by diluting the HNSW with LNSW (Table 13). The instrument’s optical chamber was sealed with a layer of Parafilm® and a slit was cut through it. The water samples were then poured in for each test. The chamber was rinsed with MilliQ water, dried with a lint free tissue and fresh parafilm was applied for the measurement of each standard. Note, once standardised, the MilliQ water resulted in a higher reading from the SUNA than the LNSW. The LNSW’s concentration (0.13 µM) is below the instrument’s limit of detection reported by the manufacturer (1.0 µM).

Table 13: Reference solutions and resulting outputs from the SUNA and SBE16+ during testing and range finding on DY181

Reference Solution	SUNA reading (µM)	SBE16+ reading (V)
MilliQ (0 µM)	1	0.1271
LNSW (0.13 µM)	0	0.1264
HNSW (22.15 µM)	20	4.1175
SW dilution check	11	2.2035

The SUNA was programmed on the ship for the expected range of nitrate concentrations during the deployment. Based on historical *in situ* measurements of nitrate, it was determined that concentrations should range from about 5 µM to 15 µM (Figure 34 and Figure 35). The maximum expected value DACmax was thus set to 20 µM (DACmin = 0 µM), to leave some room for potential episodic large values.

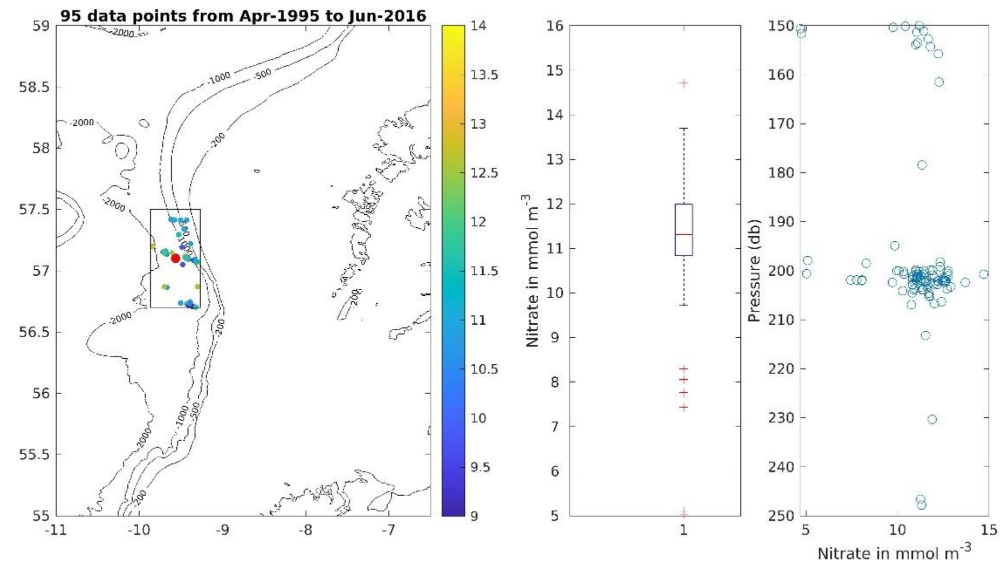


Figure 34: Nitrate concentration statistics around mooring EB1 (red dot on the map on the left panel), the planned deployment site for the SUNA system. The data are all in situ nitrate profiles available in the indicated box, retrieved from the BODC. (courtesy: Jo Hopkins, NOC).

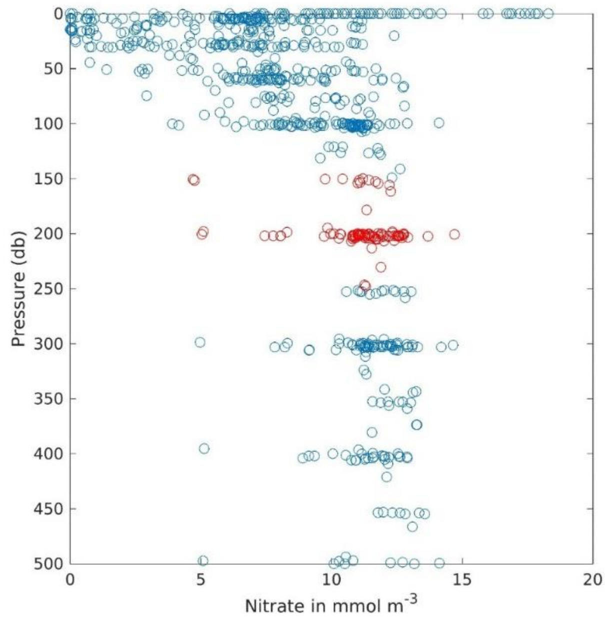


Figure 35: All nitrate concentration data points retrieved from BODC as a function of depth (Courtesy: Jo Hopkins, NOC).

Calibration castdips

The SUNA was attached to the rosette during the first calibration cast (caldip #1, ctd #2, 500 m). The pump intake for the SBE16+ was positioned to be as close to the SBE9+ as practicable to enable cross calibration of temperature and conductivity. The SUNA was clamped into a bracket with the sample chamber aligned with the middle of the Niskin bottles to enable a comparison with the nutrient bottle samples. Parafilm® was wrapped around the SUNA to protect the optical sensor area from contamination and was removed just before the cast deployment.

Figure 34 shows the time series comparison of the 30 s burst measurements of nitrate concentration logged by the SUNA, and the burst-averages logged by the SBE16+ overlaid. The nitrate concentrations determined from bottle samples fired at six depths in the upcast (500, 250, 120, 20, and 5 m) was provided by the SAMS chemical oceanography group and are plotted as green stars. These reveal a systematic positive bias of ~2.5 µM in the SUNA measurements. This bias highlights the importance of a similar calibration CTD on recovery to establish any drift or change in measurement offset from bottle samples. The overall range of observed values is consistent with the historical observations in the area surrounding mooring EB1 (Figure 34 and Figure 35). Figure 37 shows the SUNA nitrate burst-averages stored by the SBE16+ as a vertical profile. Once bottle salinity data from the entire cruise is available, calibration cast data from the SBE16+ will be compared with the rosette SBE 911+ CTD.

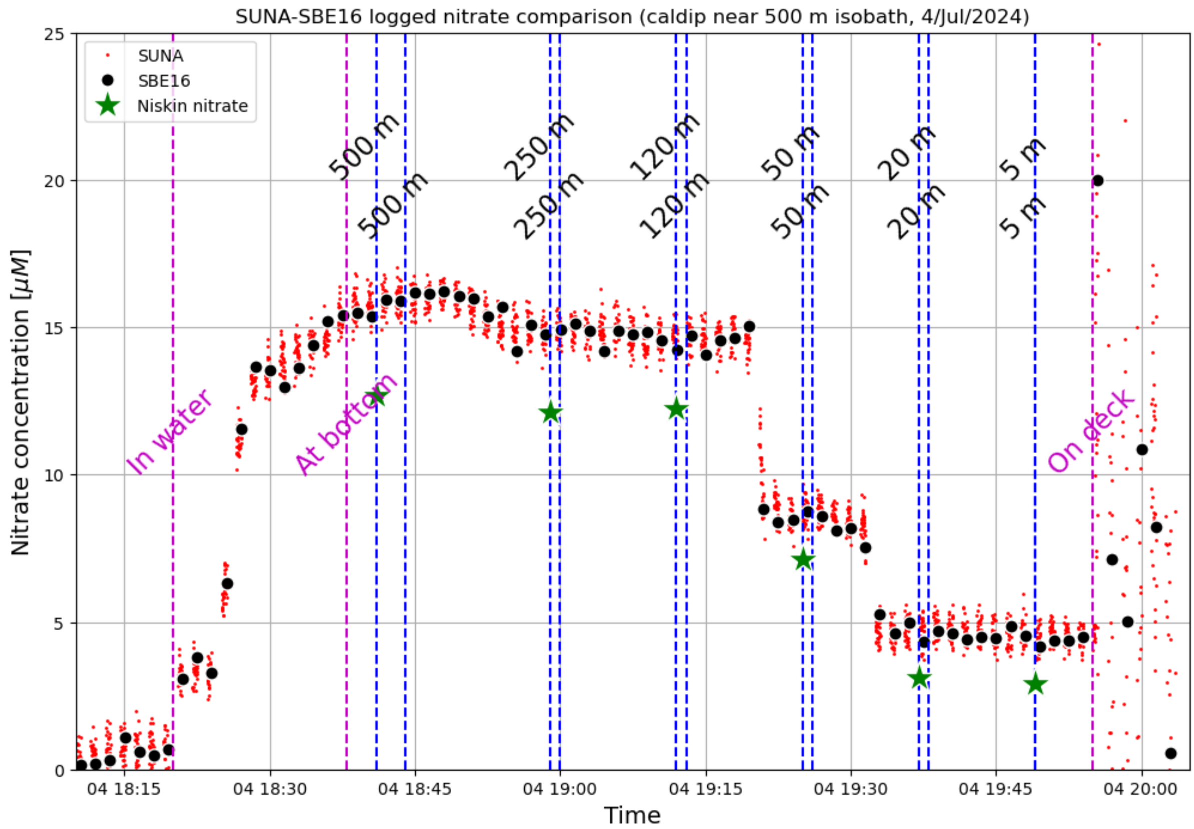


Figure 36: Time series of nitrate from the SUNA (red dots) and burst-averaged values logged by the SBE16+ (black) in the calibration cast near the 500 m isobath.

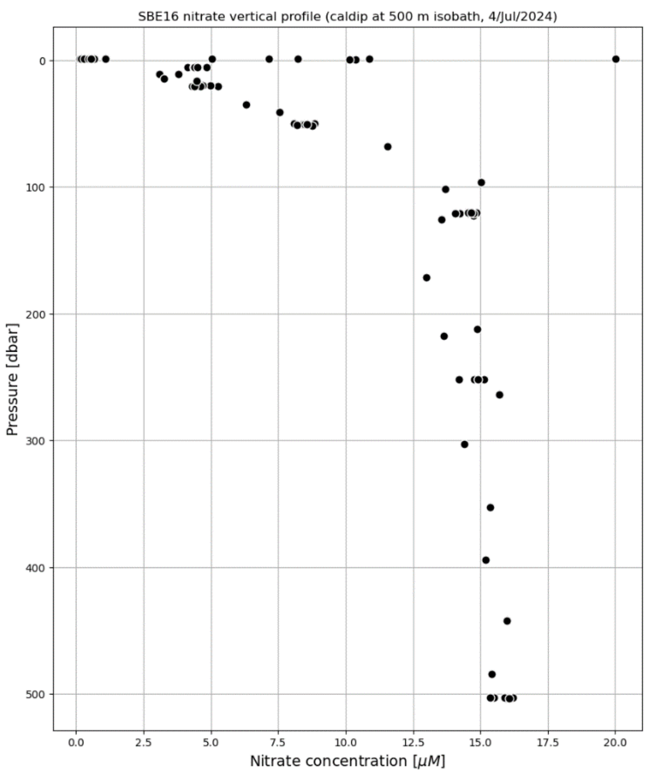


Figure 37: Vertical profile of nitrate burst-averages from the SUNA-SBE16+ system in the calibration cast near the 500 m isobath.

Deployment on EB1

A final reference validation was performed the day before deployment on 09/07/2024 – see APPENDIX O for UCI generated reports and SBE16+ set up.

The SUNA/SBE16+/battery pack system was deployed on RTEB1 at 200m on 10/07/2024. Sampling was set to start at 12:00 on 10/07/2024 at a rate of 7200 seconds. Figure 38 is a basic overview of the deployment set up along ~ 2.5 m of mooring wire.

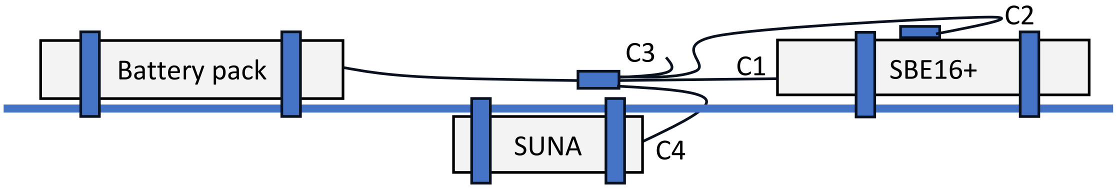


Figure 38: Alignment of instrumentation on RTEB1, left to right = bottom to top, cable numbers as labelled on the custom marine cable. Note – data cable C3 was capped, coiled up and cable tied to the SBE16+.

Concern was raised about potential of the instruments and battery pack knocking into each other and the connecting cables becoming under tension on deployment or recovery or during knockdowns. The power cables were taped together in loose coils to avoid snagging and cable pinching where possible. The components were offset on the wire to reduce the amount of contact between them.

Notes for recovery – **do not immediately clean the optical area of the SUNA** – download the data, do a 'dirty' measurement in the lab first, then a 'clean' measurement, then a reference update first as per the instructions. Then deploy on post recovery calibration dip. Be aware that the battery pack may be exhausted at the end of the deployment. Please check on recovery for any damage to the system components, particularly cable connections.

15.2.5 Nortek Aquadopp

Recoveries

Twenty-two Nortek Aquadopps were recovered across the moorings. After recovery the data were downloaded and the clock offsets checked (no significant drift found, maximum 179s). One instrument (S/N 11021 on IB4 at 1500m) was flooded (water ingress at bulkhead connector) and the data could not be retrieved.

Deployments

Nineteen Nortek Aquadopps were deployed. Their clocks were synchronised with GPS time, and new batteries fitted prior to deployment (alkaline dual packs, nominal capacity 100Wh). A functional check was performed. They were set to sample every 3600s, with an averaging period of 60s (same setup as the ones recovered; full setup parameters in the appendix).
The inductive Nortek Aquadopp meant to be use on the TeleTest mooring (S/N 8465) was found to be faulty and was not deployed.

15.2.6 RDI 300KHz ADCP

Recoveries

Six RDI WorkHorse ADCPs 300KHz were recovered from IB3, IB4 and IB5. Three of them were recovered flooded:

- S/N 20957 (IB5, upward-looking) – Figure 39: recovered with one transducer head missing and partially flooded. Suspected slow water ingress leak. As the instrument was only partially flooded and upward-looking (electronics at the top) data could be retrieved from the CF card. The last ensemble recorded was 24/07/2022 23:00 UTC, after 3.5 days in the water.
- S/N 24589 (IB4, downward-looking) – Figure 40: recovered flooded with pressure sensor missing. No data recovered.
- /N 24587 (IB3, upward-looking): recovered flooded. No external damage visible. No data recovered.

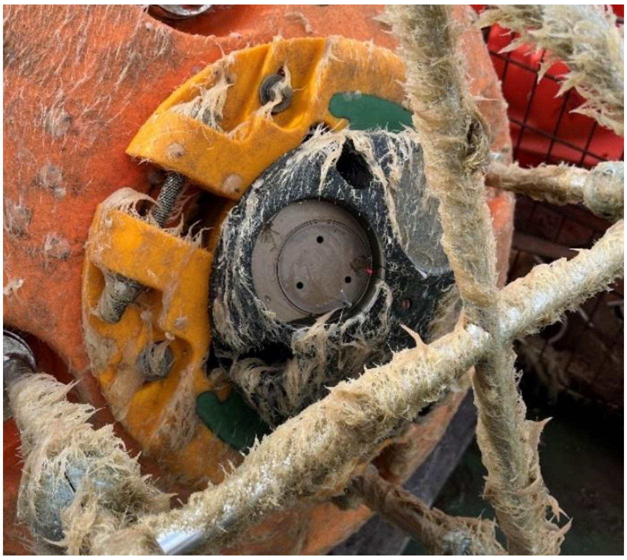


Figure 39: Missing transducer head on ADCP S/N 20957

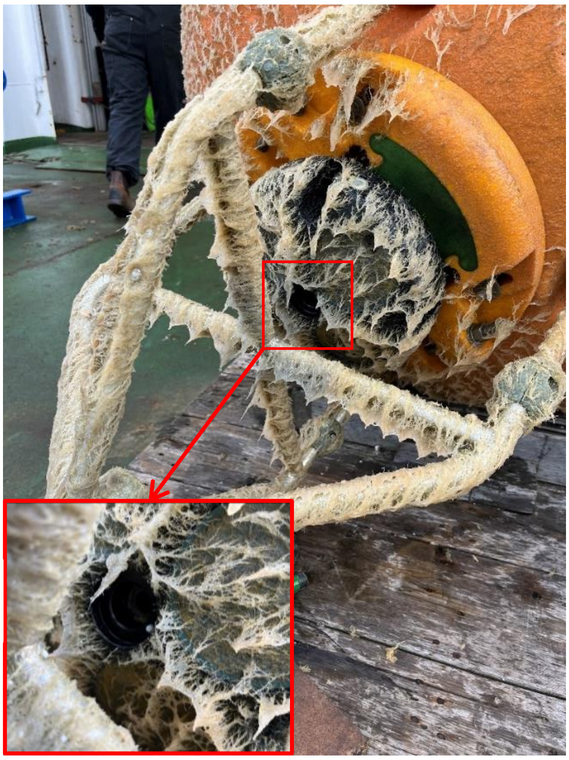


Figure 39: Missing pressure sensor on ADCP S/N 24589

Initial inspection of the instruments indicated that there were no issues with any of the o-ring seals and no signs of pinching or damage was found. This could point to a possible cause being a low-pressure leak past the o-rings which then self-seals at a higher pressure, once at depth.

Our routine maintenance procedures have remained constant and nothing has changed in the way these instruments are prepared for deployment. All seals are cleaned, and mating faces inspected prior to deployment when new battery packs are installed.

The flooding may indicate water ingress past the pressure port o-rings or the bulk head connector o-rings. These are generally not removed unless there is a problem with them, however this could be something that is added to our routine maintenance procedure in the future, however this in itself could introduce more potential flooding risks.

Data cards from each of the instruments were removed and dried out before being connected to a laptop to see if it was possible to retrieve any data, unfortunately no useful data was able to be recovered.

Figure 40 and Figure 41 below show flood damage to the pressure housing and the electronics assembly.

Figure 40: Pressure housing.

Figure 41: Electronics assembly

Deployments

Four ADCPs were deployed on IB4 and IB5. Before deployment new batteries were installed, clocks synchronised to GPS time, and functional tests performed. The setup parameters were:

- Ensemble interval = 1 hour
- Water pings = 42
- Ping interval = auto (00:01:25.7)
- Number of depth cells = 28
- Depth cell size = 4m

The full setup information is available in the APPENDIX HH.

15.2.7 Nortek Signature 55 ADCP

An upward looking Nortek Signature 55 ADCP was recovered and deployed on DY181 in 1000 m of water on the Rockall-Hatton Bank. The Signature55 is a long-range profiler that uses dual frequency, 55kHz and 75kHz, for both long, coarse resolution profiles and shorter, fine resolution. We only use the 55kHz coarse profile to get full water column data recovery over a two-year deployment period.

Recovery and data download

The instrument head, connected via subconn cable to an external battery pack, was released from its syntactic buoy frame and plugged in to mains power supply via the 24V DC power converter and LAN plug socket on the ADCP. Once connection was established and the ADCP was using mains power, the battery was then removed and serviced. The instrument head was cleaned with soft sponges and freshwater before testing and redeployment.

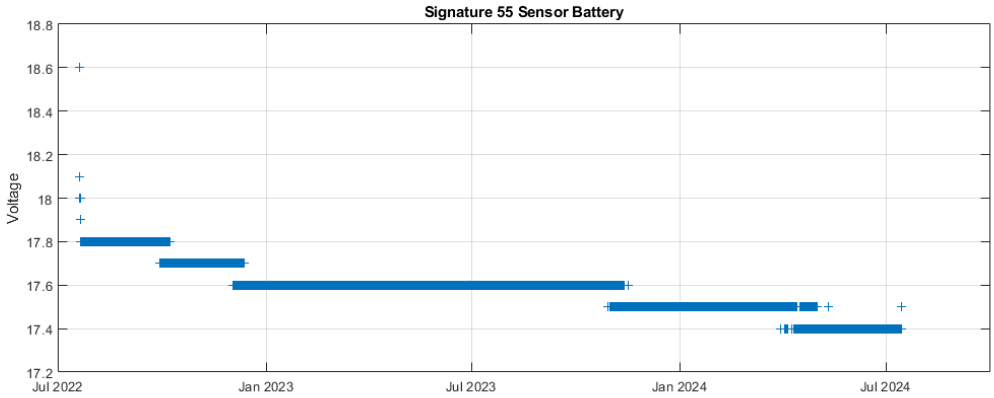


Figure 42: Battery voltage during deployment July 2022 – July 2024

Date download was done **Recorder Data Retrieval** tab in Nortek Signature Deployment software. Both the averaged (generated by the S55) and raw data were downloaded

S200044A012_RHAD2_JC238_avgd.ad2cp [28 MB]

S200044A012_RHAD2_JC238.ad2cp [251 MB]

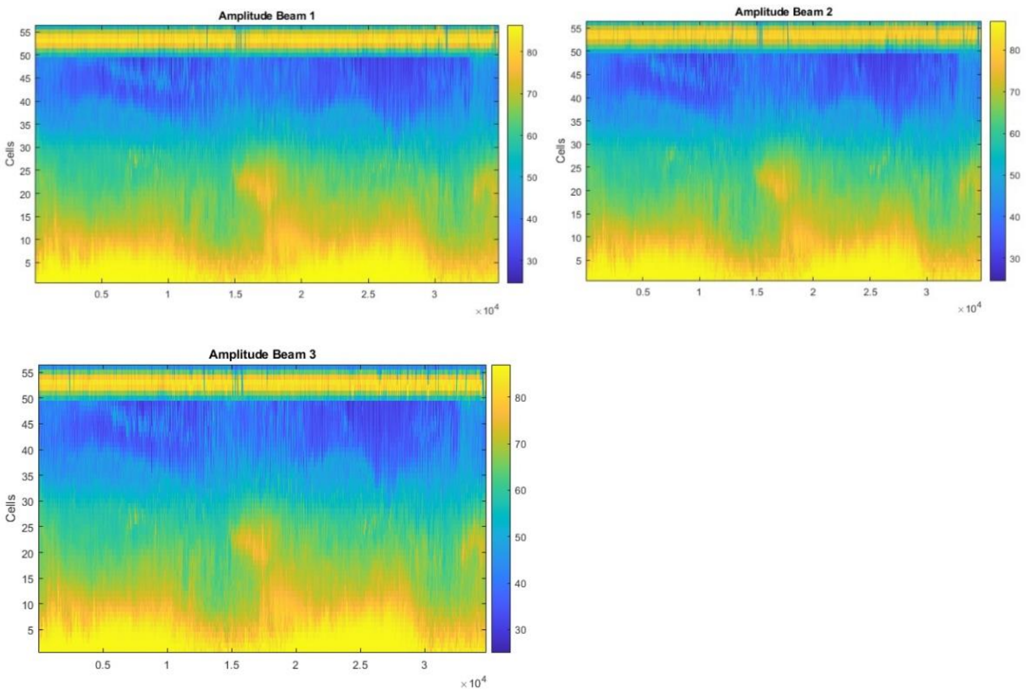


Figure 43: Beam amplitude of S55 deployed on RHADCP on JC238 and recovered on DY181

Redeployment

The S55 was redeployed with memory cleared and a replacement battery pack. The end cap connector was damaged on the replacement battery pack casing, discovered on deployment set up when selecting **Deployment > Start Recorder Deployment**, an error message appeared saying “No External or Internal Battery” – do not ignore this error message, it indicates battery issues. On the first deployment set up attempt, the external power cable was disconnected and the S55 failed to start logging, indicated by no flashing of the blue light (which blinks every time a ping is sent by the instrument), confirming the battery issue. The end cap was switched out with the end cap from the previously deployed battery pack. Once the battery cap was replaced, a test deployment was run to check the battery connection, the error message did not reappear, and the blue light flashed as expected. The deployment set up then proceeded as normal. The S55's firmware was not updated even though there was an update available. Note – firmware will need updating if turning around at next deployment. Current firmware = Signature55_SECV6056_BBPV2214_12.ad2

Power/cable Connection order established as follows

- Fit battery into buoy and run cable through to top
- Connect battery cable to S55
- Connect external power supply and LAN cable
- Plug ethernet port into laptop
- Connect to Signature Deployment Software and set up S55 for deployment
- When instrument is offline, disconnect LAN cable and wait for blue light at time given in deployment software.

Suggestion for any future deployments is to run a test deployment with the new battery and make sure the external power is disconnected when checking for the blue light at the expected sampling frequency.

There were issues syncing the S55 clock to the laptop used for deployment set up. Even when the laptop was reset to UTC, the S55 did not accept the new time when the sync to laptop box was checked. Restart of the software was required to push through the correct time setting to the S55. The clock settings were confirmed by accessing the web interface through **Windows Explorer > Networks**.

Functionality check

Pre-deployment checks followed those outlined in the Signature55 Operations Manual by using the help section accessed through the instrument software – Nortek Signature Deployment. While connected to mains power and using communication via ethernet cable, the instrument was loaded with test parameters from file AD2CP_55kHz_900001_test_RHADCP.deploy. This file was generated according to the instructions in the software, using a sampling frequency of 6 s. Parameters observed during the functionality check are summarised in the log sheet (APPENDIX GG). Compass calibration was not attempted due to the abundance of metals on the ship.

A new deployment file (AD2CP_55kHz_900001_DY181RHADCP.deploy) was created. Sampling was set to commence at 11:55 pm 14/07/2024. A blue LED light (which blinks every time a ping is sent by the instrument) was observed blinking for one minute at deployment start and 30 mins thereafter, confirming the S55 was set up with the required deployment parameters.

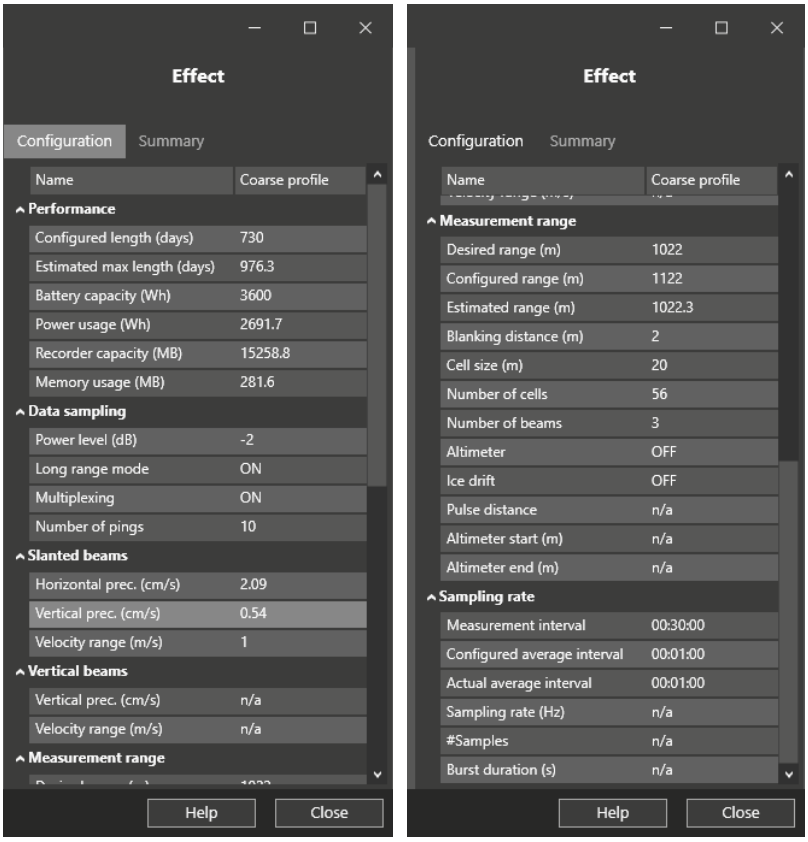


Figure 44: Configuration parameters for DY181 deployment of RHADCP, Nortek S55 sn J20268-002

15.3 Calibration dips

All SBE37s and SBE37-ODOs were attached to the CTD frame for direct comparison to CTD values at several depths. For full cal-dips the CTD was stopped for ten minutes at several bottle stops; for others (e.g. for shallow rated instruments having to go on a separate, shallow cast) only at the at the depths the instruments were recovered from and/or going to be deployed at.

As well as serving as instrument functional tests, the comparisons provide calibration points for the mooring instrumentation either pre or post-deployment, and are used to determine whether an instrument is suitable for (re)deployment. These calibration dips are a critical factor in tracing the instrument accuracy and stability back to a stable reference standard in the field. Final calibrations are obtained post final CTD calibration.

Notes:

- The data used for the caldip comparison were the last 5 minutes of each stop, after the sensor readings had time to stabilise.
- The microcat data were compared to the CTD Temp1 and Cond1 sensors, located beneath the rosette. Although noisier, Cond1 raw readings appeared to have less of an offset than Cond2. We suspect an offset of +0.001°C for the raw Temp1 readings (to be confirmed after final calibration of the CTD data).
- Data from stops shallower than 100m (in the thermocline area) were often noisy resulting in large sensor offsets being calculated. In those instances the data was reviewed and sensor performance estimated based on results from deeper stops.

- The temperature for caldip 4 / cast 46 appeared very noisy throughout the cast and the stops, for the microcats as well as the CTD sensors.
- The CTD appeared to move during some stops, resulting in noisy data and excessive offsets being calculated for the microcat sensors. For turnaround purposes, the data was visually inspected to confirm offsets were acceptable in the stable period of the CTD stops. For post-processing of the recovered instruments, the caldip dataset will need to be reviewed and periods of unstable readings removed.

These calibration casts are summarised in APPENDIX I. For details on the cal-dip data processing see section 16. For individual instruments cal-dip results see tables in APPENDIX K to APPENDIX M.

16 Mooring Data Processing

Tiago S. Dotto

The processing of the moored MicroCAT, MicroCAT-ODO, Aquadopps and ADCPs was performed based on the OSNAP-CLASS Mooring Processing Toolbox (https://github.com/ScotMarPhys/m_moorproc_toolbox). The steps for processing data are outlined in detail in the user guide provided with the toolbox, named "OSNAP_mooring_processing.docx", found /m_moorproc_toolbox/Documents/Processing_documents/. All scripts and functions were installed into subdirectories within the main folder */data/pstar/programs/m_moorproc_toolbox/*

The main steps are described in the next sections.

16.1.1 Set up Matlab scripts

The script *exampleofstartup.m*, provided with the toolbox, was updated to inform work directories used in DY181. The script was renamed to *startup.m* and saved in the home directory that contains Matlab directories.

a) The edits in the script *startup.m* were

```
% This is the Matlab startup file for processing hydro and/or RAPID and/or
OSNAP (etc.) mooring data at sea

%%% change the next lines to reflect your directory structure %%%
project = 'OSNAP';
basedir = '/data/pstar/projects/'; %contains osnap, or rpdmoc
progdir = '/data/pstar/programs/gitvcd/'; %contains m_moorproc_toolbox
use_mexec = 1;
cruise = 'dy181';

% setup for hydro data processing including running m_setup
addpath(fullfile(progdir,'ocp_hydro_matlab'))
global MOORPROC_G
if use_mexec
    if exist('MEXEC_G_user','var')
        path_choose = m_setup(MEXEC_G_user); %m_setup returns 1 if cruise
options/user selects to process LADCP rather than moored data
    else
        path_choose = m_setup;
    end
    m_common %global variables to workspace
    MOORPROC_G.cruise = cruise;
    MOORPROC_G.cruise_ctd = mcruise;
else
    path_choose = 2; %mooring data
    MOORPROC_G.cruise = cruise;
    MOORPROC_G.cruise_ctd = cruise;
end
```

```
if path_choose==2
    % setup for mooring processing
    % setup for using m_moorproc_toolbox since en705
    pathgit = fullfile(progdir,'m_moorproc_toolbox');
    addpath(pathgit)
    if isempty(which('moor_setup'))
        warning('add m_moorproc_toolbox containing moor_setup to path, enter
to continue',MEXEC_G.MSCRIPT_CRUISE_STRING)
        pause
    end
    MOORPROC_G.project = project;
    switch project
        case 'RAPID'
            MOORPROC_G.datadir = fullfile(basedir,'rpdmoc/rapid');
        case 'OSNAP'
            MOORPROC_G.datadir = fullfile(basedir,'osnap');
    end
    moor_setup(MOORPROC_G)
    expa = which('mc_call_caldip');
    global MOORPROC_G
    if contains(expa,MOORPROC_G.cruise) && ~contains(expa,'gitrepo')
        warning('is this where you intend your mooring processing tools to
come from? (%s)',fileparts(fileparts(expa)))
    end

end

s = settings;
s.matlab.editor.ReopenFilesOnRestart.PersonalValue = 0;
s.matlab.editor.ReloadFilesOnChange.PersonalValue = 1;
s.matlab.editor.SaveFilesOnClickAway.TemporaryValue = 1;
```

b) Once Matlab is opened, *startup.m* will ask which dataset will be processed. Type 2 for mooring/caldip data. This will call *moor_setup.m*, which contains the paths for the functions and work directories associated with m_moorproc_toolbox.

16.2 MicroCAT processing

16.2.1 Shipboard calibrations

Cruise CTD files (pre and post-deployment):

a) Create a directory for the cruise data within the main work path: /data/pstar/projects/osnap/cruise_data/dy181/mcruise/data/ctd/
b) Copy the cruise data from the archive directory of the cruise data.
    a. Look at the previous year cruise to copy the same type of CTD files for each caldip cast.
    b. The number of the caldip casts can be found in the cruise report or in /data/pstar/projects/osnap/data/moor/proc_calib/dy181/cal_dip/ (the files are named cast$Numinfo.dat, where $Num is the cast number).

16.2.2 Microcat caldip data

a) Create a cast$Numinfo.dat file in /data/pstar/projects/osnap/data/moor/proc_calib/dy181/cal_dip/ for each caldip that summarises information about each caldip CTD cast (e.g., geographic coordinates, time, water depth, start/end date and time), the serial numbers of the instruments and the deployment periods of the lowered MicroCAT. The deployment period number is used later to create a metadata file of the mooring deployed during the deployment period. See below an example for the sixth caldip cast number 66. The first column 'z' is the nominal depth that each MicroCAT will be allocated in the mooring.

```
Mooring             = caldip6
Latitude            = 57 58.868 N
Longitude           = 21 10.013 W
WaterDepth          = 2949
StartDate           = 2024/07/16
StartTime           = 03:48
EndDate             = 2024/07/16
EndTime             = 06:55
Columns             = z:instrument:serialnumber:deployment
   50   337  11321  1
  700   337  11324  1
  200   337  11325  1
 1900   337  11336  1
 2300   337  11340  1
 1200   337   9378  1
 2800   337   6115  1
  500   337   6123  1
 1000   337   3254  1
 1250   337   3256  1
 1500   337   3257  1
 1575   337   3276  1
   50   337   3212  1
  100   337   3213  1
  200   337   3219  1
  500   337   3207  1
  700   337   3264  1
```

b) Create the directories that will host the raw MicroCAT data files for each CTD cast in /data/pstar/projects/osnap/data/moor/raw/dy181/microcat_cal_dip/cast$Num/, and move in this directory the raw data file (.hex, .cnv, .xml, .xmlcon, and .asc). Note that the raw MicroCAT files have to be named as $SerialNumber_cal_dip_data.ext (where $SerialNumber is the serial number of each MicroCAT, and .ext is the file extension).
c) The script mc_call_caldip.m loads:
   a. the raw MicroCAT data that is located in /data/pstar/projects/osnap/data/moor/raw/dy181/microcat_cal_dip/cast$Num/.
   b. the shipboard CTD data files for the cast (in /data/pstar/projects/osnap/cruise_data/dy181/mcruise/data/ctd/). If new calibrated CTD files are available after the cruise, the *_raw.nc and *_psal.nc must be replaced.
   c. The caldip metadata file cast$Numinfo.dat that is located in /data/pstar/projects/osnap/data/moor/proc_calib/dy181/cal_dip/.
d) mc_call_caldip.m writes to a directory /data/pstar/projects/osnap/data/moor/proc_calib/dy181/cal_dip/microcat/cast$Num/ which is created manually. Plots are generated for all MicroCAT data for one CTD cast with the shipboard CTD data in the folder /data/pstar/projects/osnap/Documents/datareports/dy181/figs/caldip/.
e) The script mc_caldip_check.m provides a quick quantitative comparison of MicroCAT caldip data with the CTD data. Data obtained at the deepest bottle stops and at the nominal depth of each instrument are used. For each instrument, differences of conductivity, temperature and pressure between the MicroCAT and the CTD primary sensor were calculated. The mean and standard

deviation of the differences for each instrument are then presented in a table in /data/pstar/projects/osnap/Documents/datareports/dy181/stats/microcat_check$Num.log.

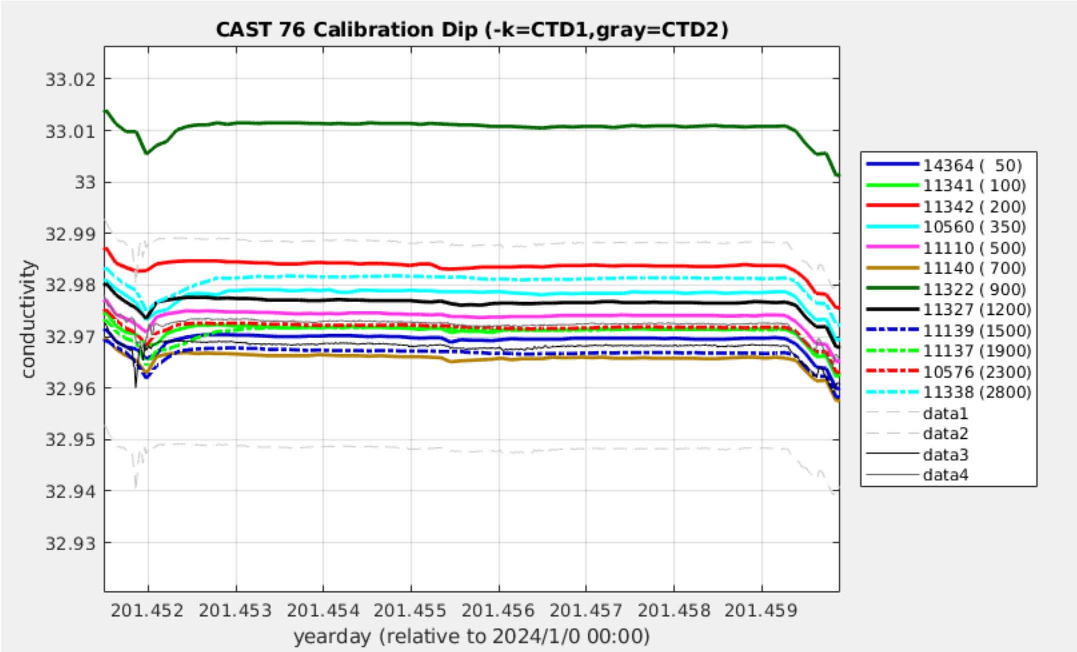


Figure 45: Example of a caldip plot for conductivity for CTD cast 76 at the depth of ~2000 m. The MicroCATs serial numbers are shown in the legend. This plot is generated by the function mc_call_caldip.m. The dashed lines depict the acceptable values, based on a 0.02 deviation from the primary sensor of the CTD. In this example, the MicroCAT SN 11322 did not perform well for the depth evaluated.

16.2.3 Microcat deployment data

a) Create a data processing control file *$Mooring_$DeplNum_$DeplYearinfo.dat*, where *$Mooring* is the mooring name, *$DeplNum* is the number of the deployment, and *$DeplYear* is the year when the mooring was deployed, for each mooring in the directory */data/pstar/projects/osnap/data/moor/proc/$Mooring_$DeplNum_$DeplYear*. The *$Mooring_$DeplNum_$DeplYearinfo.dat* file contains metadata for the mooring, such as longitude and latitude, water depth, mean magnetic deviation averaged between the start and end of the deployed period, deployment period (start and end date and time), nominal depths and serial numbers of each instrument. For example, the path */data/pstar/projects/osnap/data/moor/proc/ib5_03_2022/* contains the file *ib5_03_2022info.dat* shown below.

```
Mooring                     = ib5_03_2022
WaterDepth                  = 939
MagDeviation                = -8.84
Start_Date                  = 2022/07/21
Start_Time                  = 12:00
End_Date                    = 2024/07/15
End_Time                    = 8:00
Latitude                    = 57 48.057 N
Longitude                   = 19 10.170 W
Columns                     = z:instrument:serialnumber
48        337       3212
95        324       20957
96        324       20959
```

```
103     337     3213
199     337     3219
349     337     6115
494     337     3207
502     370     11990
700     337     3264
919     337     6123
925     370     11992
```

b) Copy the raw MicroCAT files in the directory */data/pstar/projects/osnap/data/moor/raw/dy181/microcat/*. Rename the raw .cnv files as *$SerialNumber_data.cnv*, where *$SerialNumber* is the serial number of each instrument.

c) Run the Stage 1 script *mc_call_2.m*. This function converts the raw data from /data/pstar/projects/osnap/data/moor/raw/dy181/microcat/ to rodb format file '.raw' for an entire mooring following the configuration previously set in *$Mooring_$DeplNum_$DeplYearinfo.dat*. The processed data are stored in */data/pstar/projects/osnap/data/moor/proc/$Mooring_$DeplNum_$DeplYear/microcat/*.

d) Check that the deployment time and recovery time are accurate in the corresponding */$Mooring_$DeplNum_$DeplYearinfo.dat* file. Then, run the Stage 2 script *microcat_raw2use_003_with_ODO.m*. This script generates '.use' files and saves them in */data/pstar/projects/osnap/data/moor/proc/$Mooring_$DeplNum_$DeplYear/microcat/*.
   The script also:
   a. Removes launching and recovery periods
   b. De-spike the data using the script *ddspike.m*
   c. Allows removing manually the data that are not picked up by the de-spike step. It uses the Matlab built-in function *brush.m* to select the data considered suspicious or bad.
      i. The **MicroCAT SN 4608** (nominal depth ~50 m) recovered from **RTEB1** seemed faulty between the end of September and mid-December 2023. The time series is noisy during that period, and difficult to remove suspicious data. The issues are visible in the 2-day low pass filtered salinity time series generated from the script *plot_stacked.m*. The data quality control and flag need to be revised.

e) Bad data flagged are replaced by the dummy values -9999

f) Plots and saves time series and 2-day low-pass filtered time series of each property for each sensor in */data/pstar/projects/osnap/Documents/datareports/dy181/figs/*

g) '.log' file with basic statistics, such as the mean and standard deviation of each sensor over time is saved in */data/pstar/projects/osnap/Documents/datareports/dy181/stats/*.

Below are examples of figures produced after Stage 2. A summary of basic statistics generated from Stage 2 is shown in APPENDIX U.

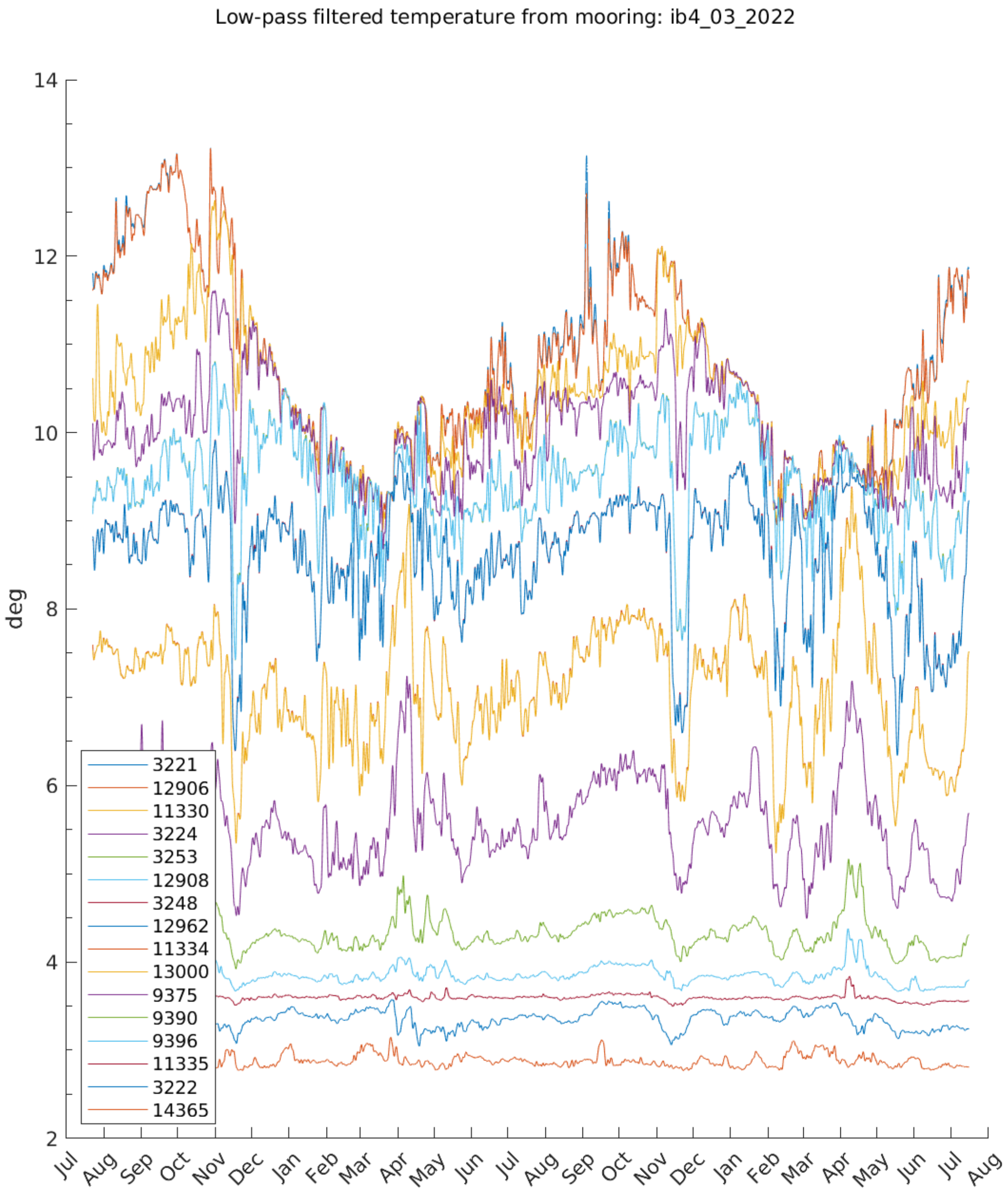


Figure 46: Example of a stacked plot for the 2-day low-pass filtered temperature for the mooring IB4 between July 2022 and July 2024. The MicroCATs serial numbers are shown in the legend. This plot is generated by the function plot_stacked.m.

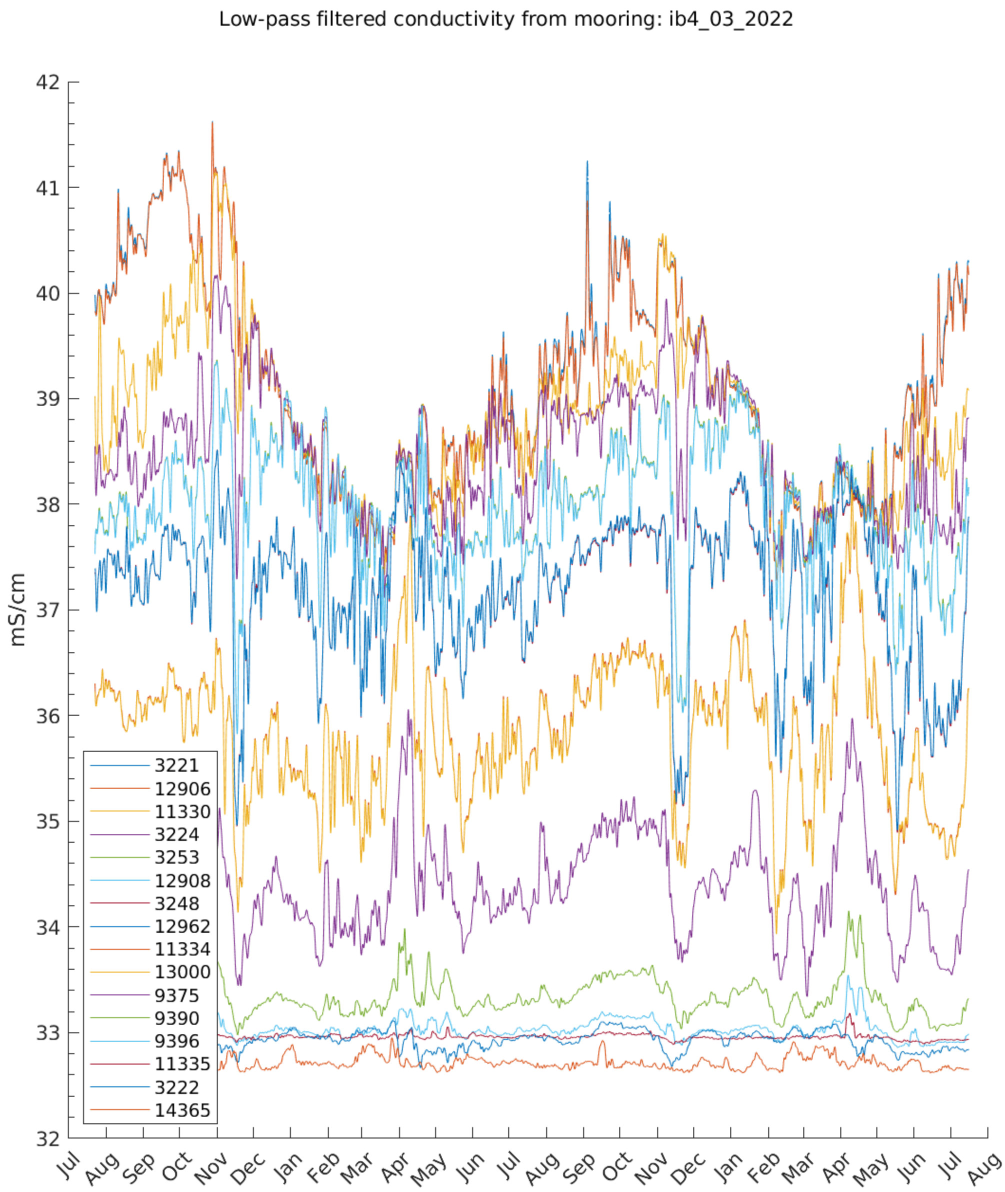


Figure 47: Example of a stacked plot for the 2-day low-pass filtered conductivity for the mooring IB4 between July 2022 and July 2024. The MicroCATs serial numbers are shown in the legend. This plot is generated by the function plot_stacked.m.

16.2.4 DeepSeapHOx Data Processing

SeapHOx data from the mooring RTEB1 were downloaded and transferred to the network drive, then copied onto the processing computer in the directory */data/pstar/projects/osnap/data/moor/raw/dy181/seaphox/*. The '.csv' data output was saved in blocks and merged into one single file called 'EB1_2022_SeapHOx_2002.csv'. The processing steps were:

1. Create a text file named 'rteb1_06_2020_filenames.txt' in the directory */data/pstar/projects/osnap/data/moor/raw/dy181/seaphox/* containing the serial number of the SeapHOx and the data filename created (i.e., EB1_2022_SeapHOx_2002.csv'). This was a single line txt:
   ```
   2002 EB1_2022_SeapHOx_2002.csv
   ```

2. Run *process_seaphox.m*, which calls:
    a. Stage 1 function *seaphox2rodb_01.m*: converts the .csv data into a rodb file .raw.
    b. Stage 2 function *seaphox_raw2use_01.m*: converts the .raw file into '.use'. Similarly to Stage 2 of MicroCAT, it removes the launching and recovery period, produces basic statistics, and plot initial figures for evaluation. The '.log' file is saved at */data/pstar/projects/osnap/data/moor/proc/rteb1_07_2022/seaphox/*.

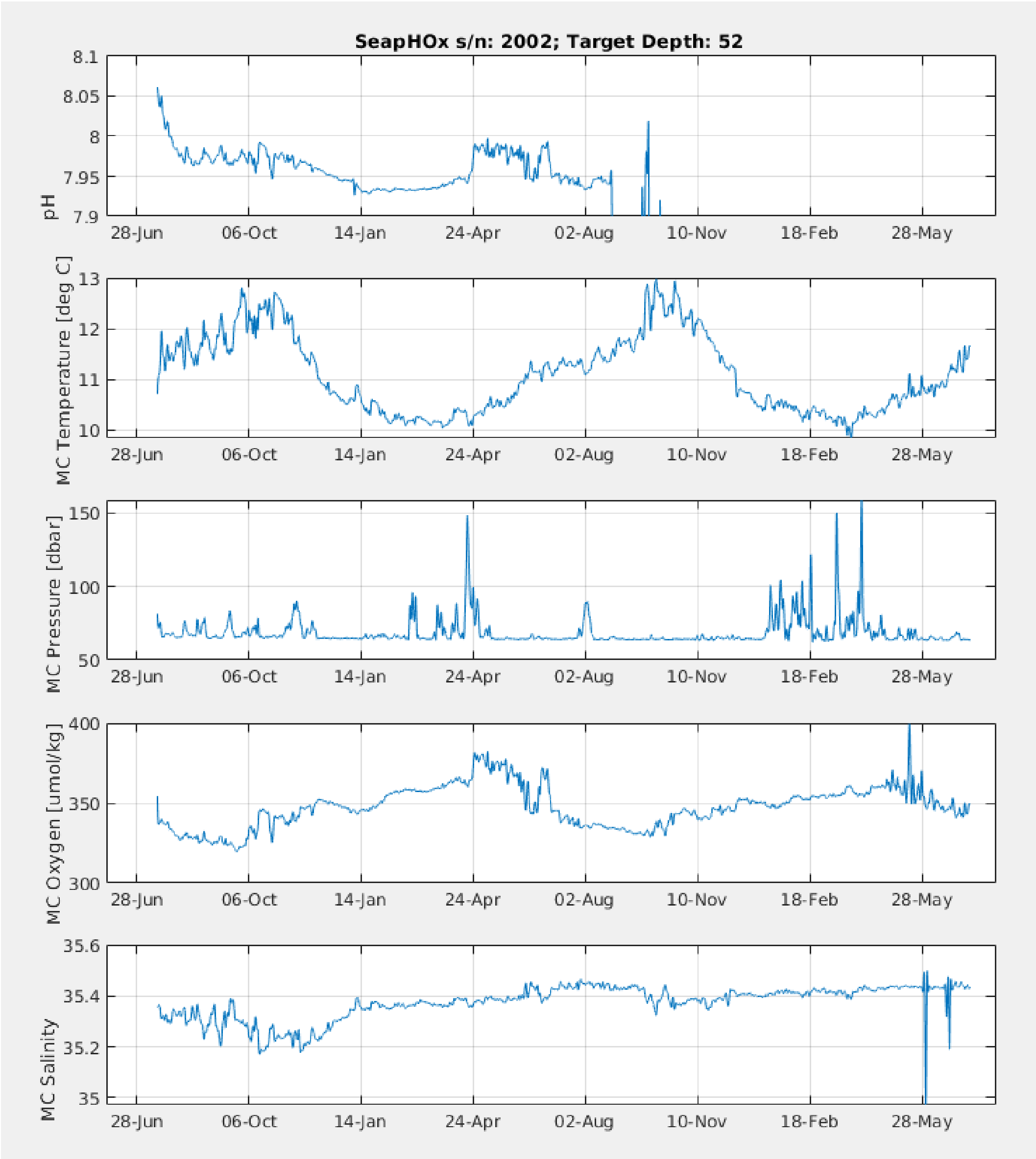


Figure 48: 2-day low-pass filtered data outputs for the SeaPHOx instrument from mooring RTEB1 between July 2022 and July 2024. This plot is generated by the function process_seaphox.m. pH sensor was faulty after August 2023. Note that the data are not calibrated.

16.2.5 Moored current-meter data processing (ADCP & single-point)

All OSNAP moorings possess hydroacoustic instruments measuring oceanic currents. They are of two kinds, namely (1) Acoustic Doppler Current Profilers (ADCPs), which measure currents over a depth range; and (2) single-point current-meters, which more simply measure the currents at their deployment depth. The single-point current-meter deployed on the OSNAP mooring recovered during

DY181 were all Nortek Aquadopp, while the ADCPs are all Teledyne-RI 300 kHz, except for the Nortek S55 ADCP installed at the RHADCP mooring.

After each recovery, the data were downloaded by the NMF technicians and transferred to the processing computer via USB stick and saved in the respective Nortek Aquadopp folder (*/data/pstar/projects/osnap/data/moor/raw/dy181/nortek*) and the ADCPs folder (*/data/pstar/projects/osnap/data/moor/raw/dy181/adcp*). Processing was performed to succinctly check instrument operation and data quality. The processing scripts include editing, initial quality control, filtering, gridding into 12-hour intervals, and eventually visualisation. Data processing is made up of three stages – in addition to the initial download – summarized in Figure 49, where the top and bottom rows feature the workflow for single-point current-meters and ADCPs, respectively.

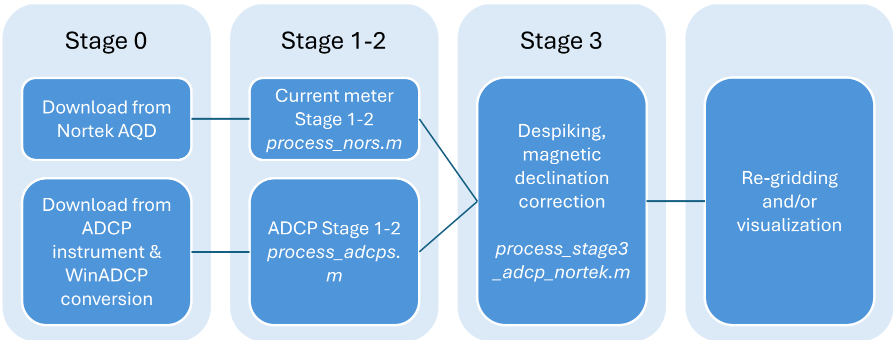


Figure 49: Current meter/profiler workflow.

16.2.6 Nortek Aquadopp single-point current-meter Stage2 1 and 2 processing

The precise processing steps are given in the OSNAP-CLASS Mooring Processing Toolbox user guide, section "*Processing of moored current meter and ADCP data*". Here we present a summary of the processing completed during DY181.

Filenames and directory trees were arranged following the general functioning of the OSNAP-CLASS Processing Toolbox. For each moored instrument, five Aquadopps data files (.aqd, .dat, .dia, .hdr and .ssl) were copied to the moored raw data folder */data/pstar/projects/osnap/data/moor/raw/dy181/nortek/*. The files were renamed as *$SerialNumber_data.ext*, where *$SerialNumber* is the serial number of each instrument and *.ext* are the respective five extensions. The text files, named *$Mooring_$DeplNum_$DeplYear_filenames.txt*, where *$Mooring* is the mooring name, *$DeplNum* is the number of the deployment, and *$DeplYear* is the year when the mooring was deployed, contained the list of all Aquadopps per moorings and the name of the associated '.dat' files. An example is shown below for ib5_03_2022_filenames.txt:

```
11990 11990_data.dat
11992 11992_data.dat
```

The Aquadopp serial number 11021 installed at 1496 m on the IB4 mooring line was flooded, and its data could not be downloaded by the NMF technicians. Its entry in ib4_03_2022info.dat was hence removed and no processing was performed for this instrument.

Stages 1 and 2 were performed by running the script *process_nors.m*. It removes launching and recovery periods, converts data to '.raw' and '.use', generates an informative sheet containing mooring position, instrument serial numbers, etc, and saves it as *$Mooring_$DeplNum_$DeplYear_Nortek_stage1.log*. For each single-point current-meter, *process_nors.m* also produces plots of the u, v and w velocity components against time, which can be used for diagnostics. The data, logs and plots are saved in */data/pstar/projects/osnap/data/moor/proc/$Mooring_$DeplNum_$DeplYear/nor/*. Logs of Stage 2 are saved in */data/pstar/projects/osnap/Documents/datareports/dy181/stats/*.

A summary of basic statistics generated from Stage 2 is shown in APPENDIX U.

16.2.7 ADCP Stages 1 and 2 processing

ADCP data files (*.000) were converted to '.mat' files using WinADCP, and subsequently copied to the processing computer via USB stick and stored in */data/pstar/projects/osnap/data/moor/raw/dy181/adcp/*. The naming of the files was set up to match instructions (*$SerialNumber_data.mat*). The script *process_adcps.m* was run, performing Stage 1 and Stage 2 of the processing.

During Stage 1, the data is read and the mask of the range of bins and acceptable values is manually selected. It also converts the '.mat' data into rodb files '.raw'. The files '.log' created display basic statistics for each bin. Data and logs are saved in */data/pstar/projects/osnap/data/moor/proc/$Mooring_$DeplNum_$DeplYear/adcp/*. For example, below is shown part of the .log file for ib5_03_2022_ADCP_stage1.log:

```
Instrument Target Depth[m]  : 94
Start date and time         : 20-Jul-2022 08:00:00
End date and time           : 16-Jul-2024 10:00:00
Sampling Frequency [per day]: 24
Number of samples           : 17451; expected: 17451
Median heading / pitch / roll [deg]                 : 209.0  -3.2  -0.7
Median temperature [deg C]             20959         : 10.33

Bin 1 : nominally 4.20 m - 8.20 m from sensor head

Median velocity u / v / w [cm/s]                                  : -4.3  -5.8  -0.6
Median signal strength Beam1 / Beam2 / Beam3 / Beam4 [counts]     : 116  115  116  120
Median correlation Beam1 / Beam2 / Beam3 / Beam4 [counts]         : 122  121  119  121
Median percent good pings Beam1 / Beam2 / Beam3 / Beam4 [counts] :   0    0    0  100
Median velocity error [cm/s]                                      :  0.0
Median speed [cm/s]                                               : 15.1
Median direction [cm/s]                                           : 204.60
```

During Stage 2, process_adcps.m removes launching and recovery periods, and converts '.raw' to '.use'. For each ADCP bin, process_adcps.m also produces plots of the u, v and w velocity components against time, which can be used for diagnostics. The data, log and plots are saved in /data/pstar*/projects/osnap/data/moor/proc/$Mooring_$DeplNum_$DeplYear/adcp/*.

16.2.8 Stage 3 processing of single-point current-meter and ADCP data

Rockall Trough moorings do not feature ADCP, while Icelandic Basin moorings do. The Iceland Basin moorings were set up with one upward-looking ADCP and one downward-looking ADCP, however in DY181 one ADCP of each mooring was flooded and the data could not be retrieved by NMF technicians. Processing Stage 3 can only be done if processing Stages 1 and 2 have been completed on the Nortek Aquadopp data first. For the Icelandic Basin moorings, the ADCP Stages 1 and 2 must be completed in addition. In that case, the ADCP nominal depths, instrument numbers and serial numbers must be manually indicated in the informative sheet generated during the Stage 1 single-point current meter processing. This text file, named *$Mooring_$DeplNum_$DeplYearinfo.dat*, is found in the mooring processed data folder */data/pstar/projects/osnap/data/moor/proc/$Mooring_$DeplNum_$DeplYear/*. One example is shown below:

```
Mooring                = ib5_03_2022
WaterDepth             = 939
MagDeviation           = -8.84
Start_Date             = 2022/07/21
Start_Time             = 12:00
End_Date               = 2024/07/15
End_Time               = 8:00
Latitude               = 57 48.057 N
Longitude              = 19 10.170 W
Columns                = z:instrument:serialnumber
48       337      3212
95       324      20957
96       324      20959
103      337      3213
199      337      3219
349      337      6115
494      337      3207
502      370      11990
700      337      3264
919      337      6123
925      370      11992
```

Stage 3 was done by running *proc_stage3_adcp_nortek.m* which performs the following:

1. Removal of the data with ‘percentage good’ below 75% (ADCP only).
2. Correction for magnetic declination.
3. Correction for sound speed deviations from 1500 m/s.
4. De-spiking using the default spike/mean ratio of 10, and no additional manual de-spiking was performed.
5. Low-pass filtering of the de-spiked data using a 40-hour Butterworth filter, and interpolation onto 12-hour timesteps.

While the two last steps are automatically performed by *proc_stage3_adcp_nortek.m*, some information must be indicated by the operator to perform magnetic declination and sound speed corrections. Prior to the execution of *proc_stage3_adcp_nortek.m* and for each mooring, the magnetic declination at the median deployment date was indicated in the information sheet. The magnetic declination was calculated from the Python script *pyIGRF_compute_magdev.py*, which computes the average magnetic declination of the start and end dates. The Python script comes within the toolbox. (Alternatively, the user can obtain the magnetic declination from the NOAA Magnetic Field Calculators, https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml, using the IGRF 1590-2024 model). The magnetic declinations used in DY181 were: RTEB1= -3.802˚, RTWB1= -5.302˚, RTWB2= -5.123˚, IB5= -8.84˚, IB4= -11.21˚, and IB3= -11.73˚. For the ADCPs, the instrument was set up with a salinity of 35 pre-deployment. During the execution of *proc_stage3_adcp_nortek.m*, a fixed salinity value of 35.1 was indicated in the Matlab prompt when asked for “Fixed salinity value for speed of sound correction”. This information and the temperature recorded by the instruments allow *proc_stage3_adcp_nortek.m* to compute density and eventually sound velocity.

16.2.9 Visualisation of ADCP and single-point current-meter data after Stage 3

Examples of visualisation plots are shown below. These plots were generated from *stick_plot.m* for Aquadopp, *proc_stage3_adcp_nortek.m* for Aquadopp and ADCP, and *plot_ADCP_data_IB.m* for ADCP.

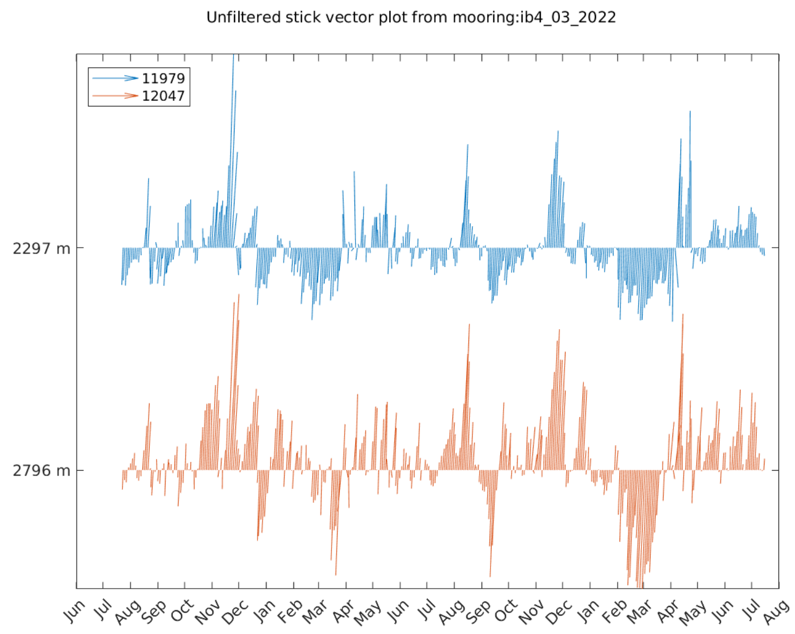


Figure 50: Example of stick plot of current velocities at IB4. 2-day low-pass filtering additional to the other processing steps mentioned in the text. The stick plot is set to plot two data per day. This can be changed in the script stick_plot.m.

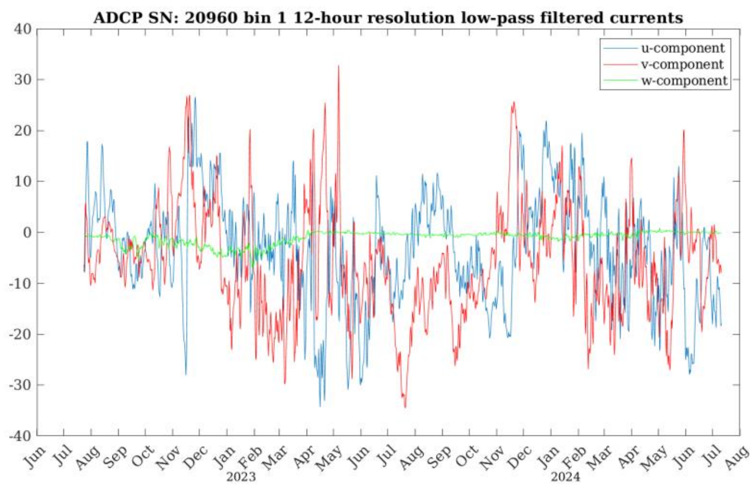


Figure 51: Example of a 40-hour low-pass filtered and 12-h mean binned for the first bin of ADCP serial number 20960 (upward looking) for IB4. Velocity components u, v and w are plotted between July 2022 and July 2024. These plots are generated from proc_stage3_adcp_nortek.m for each bin.

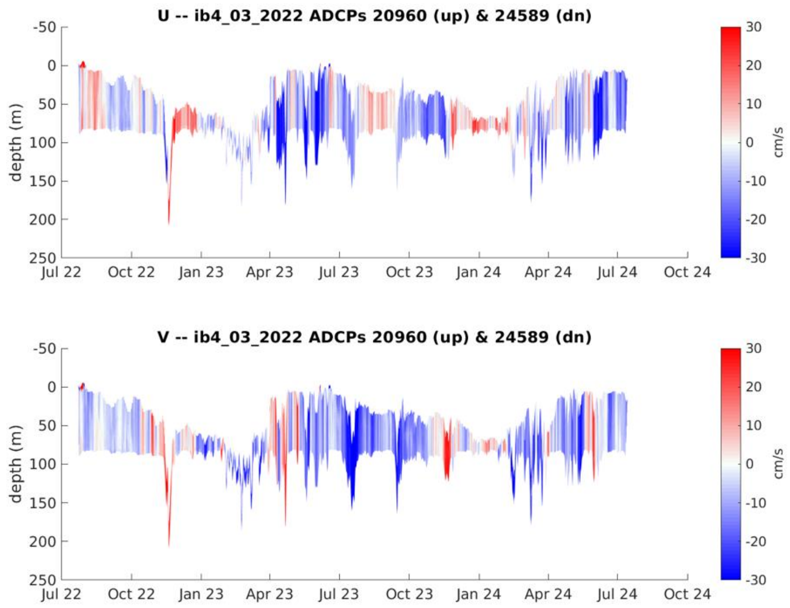


Figure 52: Example of a 40-hour low-pass filtered and 12-h mean binned for all bins of IB4 ADCP. Velocity components u (top) and v (bottom) are plotted between July 2022 and July 2024. These plots are generated from plot_ADCP_data_IB.m combining all bins. ADCP serial number 24589 was flooded and the NMF technicians could not retrieve data from this instrument.

17 Lander (Fetch-AZA)

Sam Jones

17.1 EB1L data download

We downloaded approximately 10 months of data from the AZA-Fetch at EB1 (EB1L) on 06/07/24. This instrument (ID 2501) was deployed on JC238 in 2022, and a download had last been performed via an Autonaut autonomous surface vehicle on 05/09/2023. The job file set up to download the data was from the AZA-MF template as recommended by Sonardyne.

We established communications using the ship's starboard USBL at 1451 and retrieved the data bookmarks (1563-2609). We set telemetry to maximum bandwidth (9000 bps) and requested data retrieval at 1455. For about 5 minutes, we received intermittent 'no data' responses from the Fetch, possibly due to poor communications, but after the data transfer commenced it continued smoothly and was completed ~20 minutes later at 1516. For the avoidance of doubt, we then also downloaded the data from the time interval when the Autonaut was on-site in 2023 (bookmarks 1522-1563).

As on previous data downloads, the SAM software was able to generate data plots from the binary file, but the job file was not able to export correctly to csv. This was probably because the job type we used for the download, while correct for the instrument, was not the one used for the original configuration (PMT). The data and log files were packaged and set to Sonardyne who successfully decoded the data and confirmed that the instrument was still working correctly.

17.2 IB4L1 Deployment

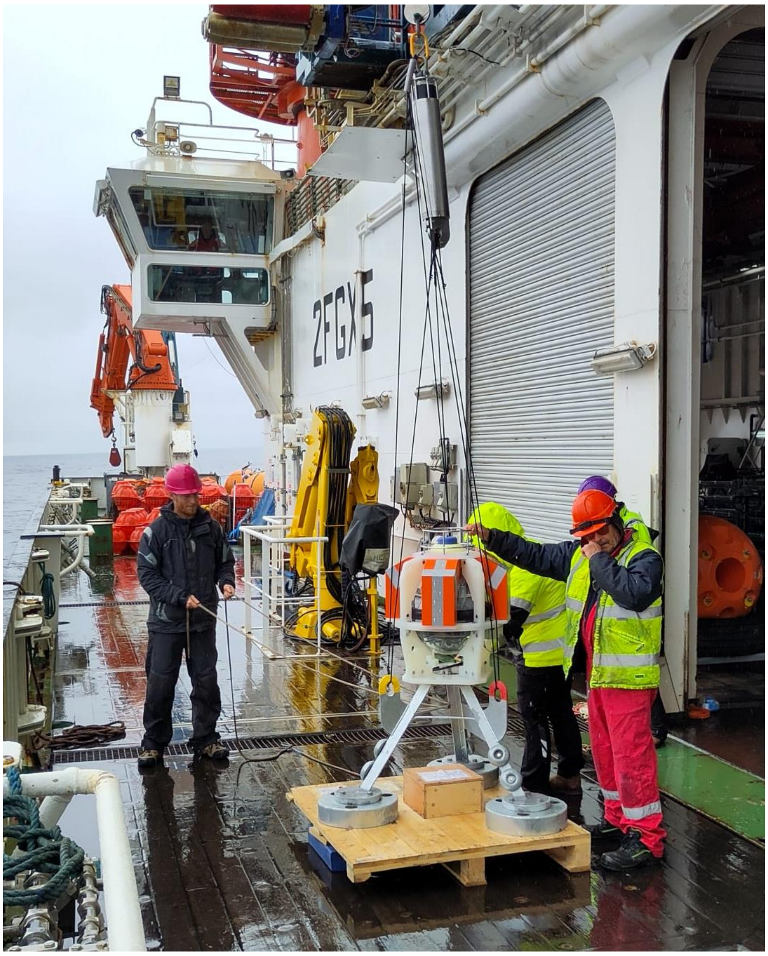


Figure 53: Fetch-AZA prior to being deployed at IB4L1.

17.2.1 Connecting Fetch to lander frame

Before departure from Aberdeen, the Fetch (transponder ID: 2311) was connected to the lander frame using a gantry crane. The plastic insert on the lander frame was initially tightened by hand onto the release screw due to comms issues with the Fetch, and the package secured for transit. The release screw was later fully torqued using the ARM and SCREW commands in the Subsea Array Manager (SAM) software.

17.2.2 Communications tests

Communications using the iWand on-deck were a bit patchy and required the iWand to remain perpendicular to the Fetch transponder, and for the interface to be wetted with seawater.

A lower test was performed on 14/07/24. We aimed to establish communications between the ship's integrated USBL systems and the Fetch, ideally both through the SAM software (programming, data download), and Ranger 2 (ranging and tracking). Note that as of DY181, the starboard USBL computer has the SAM software licence on RRS Discovery but the port computer does not.

The package was lifted on the CTD winch using 3 lifting stops connected to the lander frame. We lowered the Fetch to 70 m and established good comms using the SAM software after turning the power and gain settings to minimum on the ship's transducer. We couldn't establish communications using Ranger 2, probably because we had less control over the power settings.

17.2.3 Deployment timeline (16th July 2024)

Nominal deployment location was 58.0 °N, 21.132 °W, approximately 0.8 km north-east of the IB4 mooring location.

1030: Connect to Fetch via iWand on deck. Successful communication with unit. The pre-configured job (IB4L1_deployment_160724_Fetch_MF_job) was sent to the unit (see Figure 54). This job file was also copied to the ship's starboard USBL machine so it could be used for final communication and configuration once the Fetch was in the water. The first AZA cycle was set to start at 2300 on the evening of deployment so there was no risk of it commencing during descent. Get AZA status, set to Seabed mode, HP valve open, LP valve closed. In the AZA tab > "Advanced" button menu set the "Max deployment depth" and "Run single AZA operation" (took ~20 min). Start AZA logging, under Check tab "check time and logging" to confirm that the expected AZA cycle was scheduled at 2300. We packaged up the job folder containing the log files and emailed to Stephen Andre at Sonardyne for checking.

1230: Assemble lifting bridle to acoustic release. The custom-made deployment bridle was made up of three lengths of braided rope with spliced loops at each end. Having established that this bridle was effective but quite long on previous cruises, this version was re-spliced to reduce the total package length (including acoustic release and Fetch) to ~4 m.

Each end of rope was spliced on to a master link attached to the topside shackle of an acoustic release. The tail end of each rope length was passed through each leg of the lander frame and looped on to the release hook. As on M184, we thought there was a slight risk of snagging if the bridle was shackled to the lander frame, so we padded the eyes of the lander frame with sections of hosepipe and electrical tape and threaded the bridle directly through the eyes.

1247: The Fetch AZA and lander were lifted over the starboard rail using the CTD winch and lowered to approximately 70 m depth. Note the shortened bridle allows just enough space to lift the Fetch lander over the rail using the CTD winch. Communication via the ship's USBL to both SAM and Ranger 2 software were established without modifying the power and gain settings on this occasion.

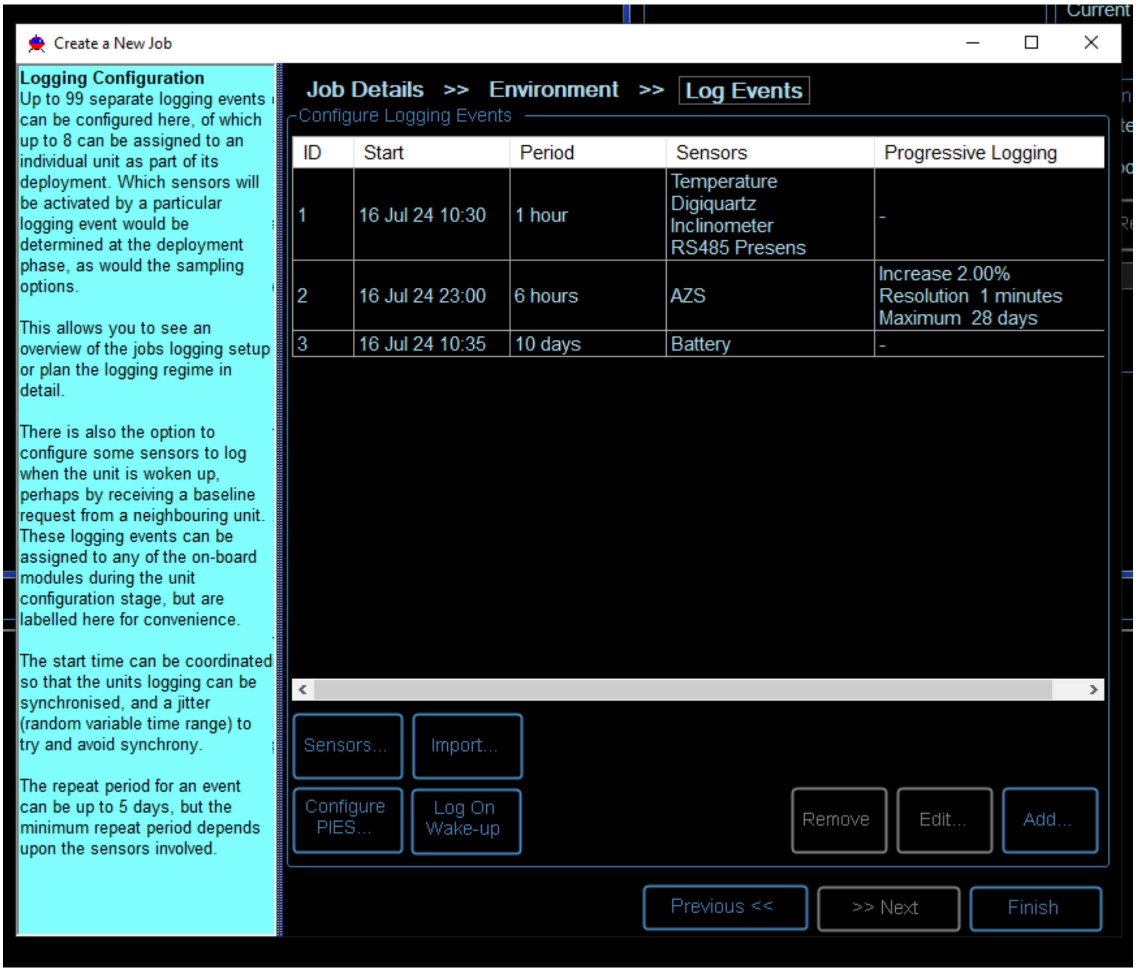


Figure 54: Configuration screenshot for deployment job.

1330: Release was delayed so that we could investigate a potential problem highlighted by Stephen Andre at Sonardyne via email. In short, the job log seemed to suggest that the deployment depth in the AZA settings was set to zero. This would be a problem as it informs the pump's range and may impair AZA cycles. We suspected that this might have happened because the software's auto-filled values were appropriate for our intended deployment depth, so we didn't change the values before clicking 'set depth', which may have resulted in a command not being sent. Consequently, we stopped the logging, re-set the AZA depth value and started the logging again. As it transpired, Stephen could still only see the deployment depth as zero after this change, so it is probably a problem with the log rather than the job itself. We received confirmation via email that it was ok to proceed with the deployment. As described below, we later returned and downloaded data to demonstrate that the AZA was functioning correctly.

1421: Release command sent to acoustic release. Descent tracked using Ranger 2 (Figure 55).

1454: Lander at seabed (at 57 58.496 N, 21 7.949 W). Depth from Ranger 2: 2910.6 m. Successful communication with the lander was only possible up to 150 m horizonal displacement from the final seabed location.

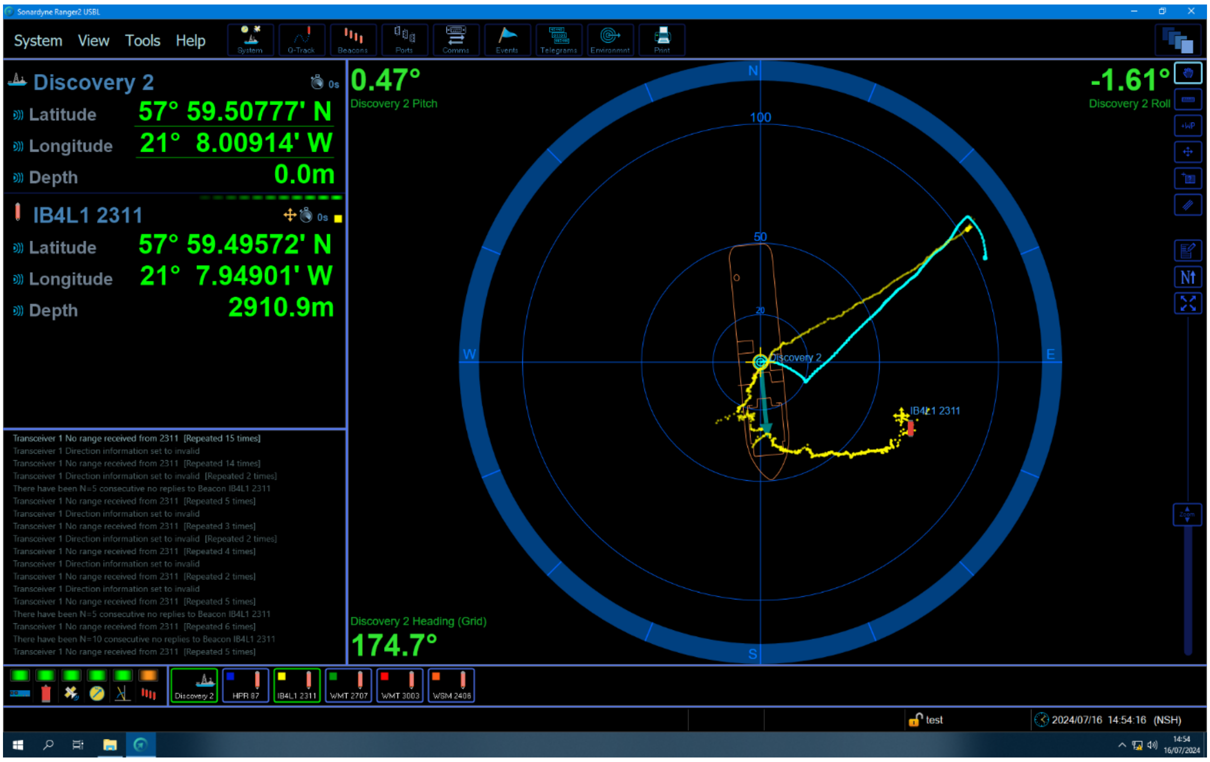


Figure 55: Ranger 2 screenshot showing descent profile and seabed location of the Fetch lander. Yellow track shows the Fetch horizontal displacement during descent, pale blue track shows the position of the ship, which had to move during the descent to maintain good communication.

17.2.4 Test data download

On 17/07/24 we returned to the EB4L1 deployment site to download the ~24 hours of data that had been recorded by the Fetch. This was to confirm that the AZA cycles were being performed and that the instrument was configured correctly. As before, the ship was configured with Ranger 2 running on the port USBL and SAM running on the starboard USBL. We used the same job file as for the deployment (IB4L1_deployment_160724_Fetch_MF_job).

At 1239 we contacted the Fetch using Ranger 2. To establish reliable communication in SAM we increased the gain to 46 dB and the power to 190 dB. Clicking the 'Get bookmarks' button returned pages 35-43 to download. At 1244 we retrieved these data (~20 seconds).

The downloaded data were correctly decoded to csv and Sonardyne confirmed that the instrument was performing as expected.

18 Test Telemetry Moorings

Chris Cardwell and John Walk

18.1 Aim

Four days of DY181 were dedicated to acoustic telemetry testing for WP3 Task B of the RAPID-Evolution project, part of the CCROC program. The aim of WP3 is to develop a robust, automated data download system for the RAPID array using surface autonomous vehicles to telemeter sample data from the instruments on the mooring to shore via satellite. We have done this in occasional RAPID trials before during 2015 and 2018 but the weakest link in the communication path has always been the acoustic telemetry between the surface autonomous vehicle and the subsea telemetry buoy on the mooring. The purpose of this cruise was to assess the equipment we propose to use, to explore different techniques for accessing the data on the mooring acoustically and to develop best practice for acoustic downloads that we can turn into robust automated scripts for the surface vehicles. The first long-term test deployment will be on the RAPID WB2 mooring in December 2024.

18.2 Test telemetry system overview

The test telemetry system consisted of two telemetry buoys, one deployed free-floating as a substitute for an autonomous surface vehicle and the other fitted to a 100m sub-sea test mooring as shown in the picture below.

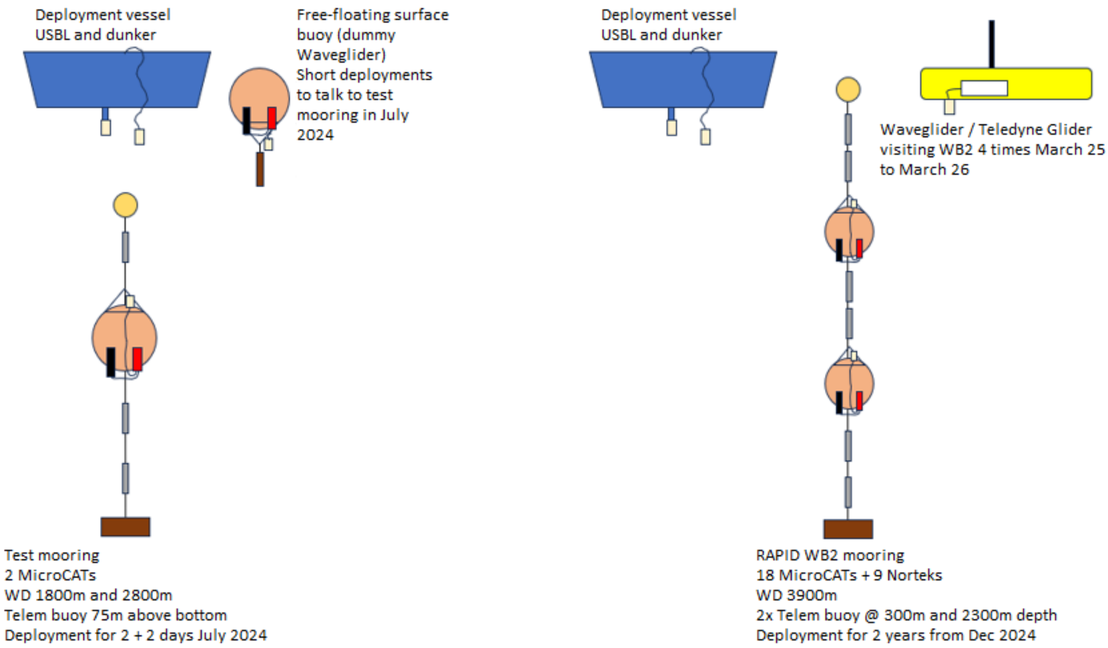


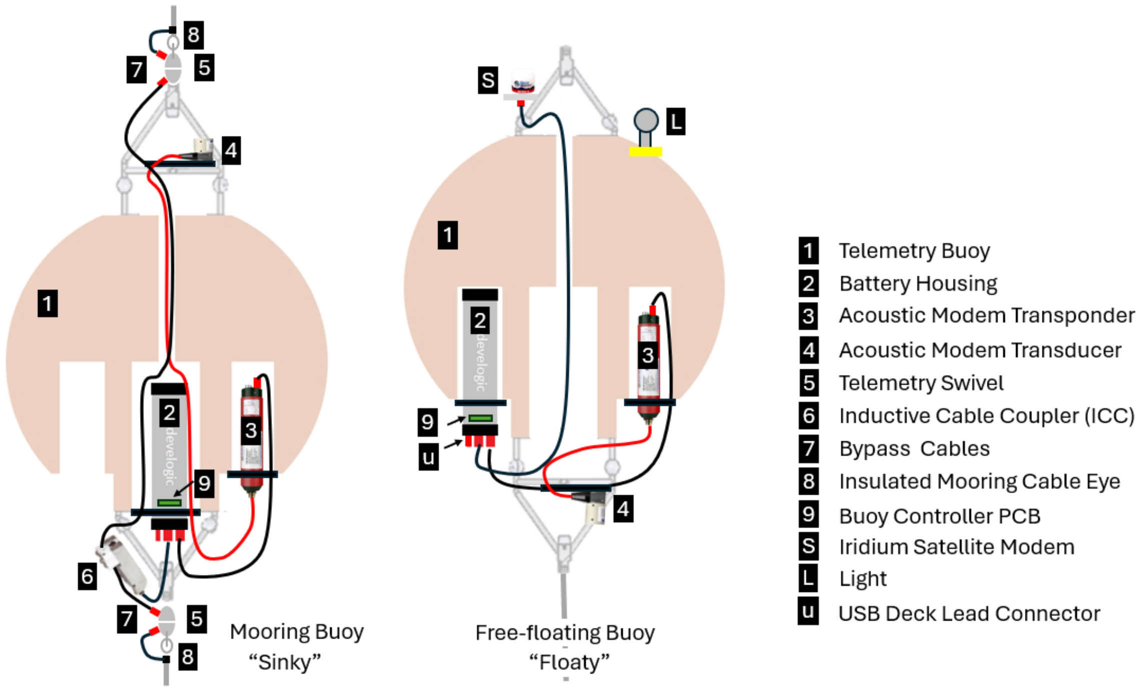
Figure 56: Telemetry Test Systems (Darren Rayner, modified)

The two buoys which came to be known as “floaty” and “sinky” were fitted with Sonardyne acoustic modems. Sonardyne claim compatibility between all of the modems in their “6G” family that are in the same frequency band as our MF modems and that includes the USBL modems fitted to the Discovery and the James Cook so we also tested using the ship’s USBL and a hand-deployed “dunker” modem that could be deployed on any ship as alternative ways to communicate with a mooring if a ship is on site.

The free-floating buoy was controlled remotely via Iridium satellite SBD messages sent by e-mail from the ship and from shore. The test mooring buoy was controlled acoustically by the free-floating buoy, the dunker and the USBL – in a real deployment it runs its sampling autonomously and the acoustic control is only used for data downloads and remote configuration. The dunker was attached to our own electronics and controlled via a USB deck lead (in the lab we also used a direct serial connection to the modem). The USBL modem was controlled by Windows applications on the USBL computer.

18.3 Equipment

As outlined above, two Mk3 49” telemetry buoys (**1** below) were fitted out with telemetry equipment, one deployed on the test mooring and one deployed free floating. A third buoy identical to the one on the test mooring was provisioned for in case we decided to add telemetry to the OSNAP EB1 mooring but in the end the buoy was deployed without telemetry equipment.



The battery housings (**2**) were Develogic DW.TH units (6000m-rated, titanium) fitted with SAFT LSH20 Lithium Primary cells. They are capable of holding a 7s7p (about 70Ah at 0°C, 91Ah at 22°C) arrangement of cells but we reduced that using in-series blanks to give a 4s4p (40Ah) arrangement on the mooring buoy and a 4s7p (70Ah) arrangement in the free-floating buoy giving 14.4V output in both cases. Both housings were fitted internally with a CCROC A7398 v1.0b buoy controller printed circuit board (PCB, **9**) designed by us to control the inductive instruments and the acoustic and satellite telemetry. A third identical battery housing (not shown) with a 4s3p (30Ah) arrangement of cells was used for the dunker modem tests. The acoustic modems (**3**) were brand new Sonardyne WMT 8190-3162 units (3000m rated) fitted with Sonardyne 641-0107 remote transducers (**4,** directional MF) with right-angled connectors. The transducers were mounted to plastic plates fitted to the horizontal bars of the longer lifting frames on the buoys so they could be offset from the mooring cable to provide a clearer acoustic path – the mooring buoy's transducer was mounted at the top of the buoy pointing vertically upwards and the free-floating buoy's transducer was mounted at the bottom of the buoy pointing vertically downwards. The test mooring was specified to have inductive instruments above and below the telemetry buoy so the upper and lower insulated mooring cables were secured to the telemetry buoy via insulated mooring eyes (**8**) and Develogic telemetry swivels (**5**) which allowed them to be connected electrically to each other by an arrangement of bypass cables (**7**). The inductive connection from our electronics to the mooring cable was made using a Sea-bird 100-turn Inductive Cable Coupler (ICC, **6**) clamped around the bypass cable and fastened to the buoy lifting frame. The ICC's coil was connected by a cable to the battery housing and from there to a Sea-bird inductive modem (IMM) mounted directly on our PCB. The free-floating buoy was fitted with a Xeos Nemo-S Iridium satellite modem (**S**, rated for 100m) mounted on a metal plate fixed to one of the diagonals on the lifting frame and we purchased a 3 month subscription from Xeos that allowed us to send and receive Iridium SBD messages via e-mail to communicate with the free-floating buoy. The satellite modem included a GPS receiver that periodically broadcast GPS location messages but we also fitted the buoy with a light (**L**) to assist with locating the buoy if we lost sight of it. Finally the battery housings were all fitted with a connector (**u**) for a deck lead allowing us to configure and upgrade the firmware in our electronics by attaching to a laptop via a USB cable.

The test mooring diagram is presented elsewhere in this cruise report. It was fitted with two Sea-bird SBE-37 Microcat instruments (the intended Nortek Aquadopp ADCP was found by the Sensors and Moorings team to be broken and was not deployed). On the second deployment we moved the Microcat (IMM id 12) from the upper section of the mooring cable (i.e. above the telemetry buoy) to 10m below the other Microcat (IMM id 16) on the lower section of the cable to work around a fault in the mooring cable insulation.

On advice from the crew and the moorings team the free-floating buoy was fitted with a small chain weight on the end of 50m of line tied to the bottom lifting frame to stabilize the buoy without fouling the acoustics. To assist with recovery it was also fitted with a line shackled to the top lifting frame with a single glass sphere, along with a bridle joining the two lifting frames. The buoy was deployed and recovered four times without any significant problems.

In addition to the equipment shown we used two further modems, firstly the ship's starboard USBL which had a temporary licence to be used as a modem (i.e. for communications) and which we accessed from the computer displays in the main lab, and secondly an Avtrak 6 type 8220-9910 modem (MF, directional) used as a dunker. The dunker was simply lowered on a rope over the starboard side of the ship (with permission from the Bridge and assistance from the deck crew) near to the CTD position to a depth approximately 7m below the waterline - which is about 0.5m below the ship - and tied off to a cleat. The electrical cable was also tied off separately and then extended (to about 15m total) to reach the hangar where we connected it to one of our Develogic battery housings and a laptop. We ran the RS232 serial connection over that cable at 115200 baud rate which is faster than would normally recommended for that distance (Sea-bird recommend 57600 for 16m) but it worked fine. Both the USBL and Avtrak modems are Sonardyne MF devices supporting the same "6G" language as the WMT modems in the buoys and can therefore freely interoperate with them.

Finally we borrowed from the OSNAP scientists a Sonardyne iWand that had been purchased for use with the Sonardyne Fetch AZA lander deployed on the cruise. It is a small hand-held modem with a transducer that's held directly against the transducer of another modem allowing you to test and configure the larger device (especially helpful in breezy conditions on deck). It has a USB option for connecting to a laptop and presents itself as a virtual COM port to which we were able to connect our own GUI application and successfully download status and data records via the iWand from our own buoy controller electronics attached to one of the WMT modems.

18.4 Software

All three systems (mooring buoy, free-floating buoy and dunker) ran identical firmware written by us on their buoy controller PCBs. We used versions CCROC_1_0_6 (test mooring, first deployment), CCROC_1_0_11 (test mooring, second deployment, free-floating buoy first, second and third deployments) and CCROC_1_0_12 (dunker and free-floating buoy, fourth deployment). The final software version CCROC_1_0_13 (adding modem reset) was tested in the lab only. All versions of the software are available in the NOC OTEG subversion repositories at NOC.

The buoy controllers interact with the modems over a serial RS232 connection using text commands from Sonardyne Command Language that's common to all their 6G modems. Commands are sent either to the local modem or through the local modem to the remote modem. A specific command (MDFT) can send data beyond the remote modem (over its RS232 serial link) to any attached device. We used text commands sent using MDFT to our remote buoy controller for system status, data downloads and to interact with the inductive instruments on the mooring. For testing purposes our firmware on the test mooring buoy controller was able to return fake data records with any number of instruments (e.g. 18 SBE + 9 NTK for a RAPID WB2 mooring simulator or 10 SBE for an OSNAP EB1 mooring simulation) but commands sent through to the actual instruments on the test mooring returned real data.

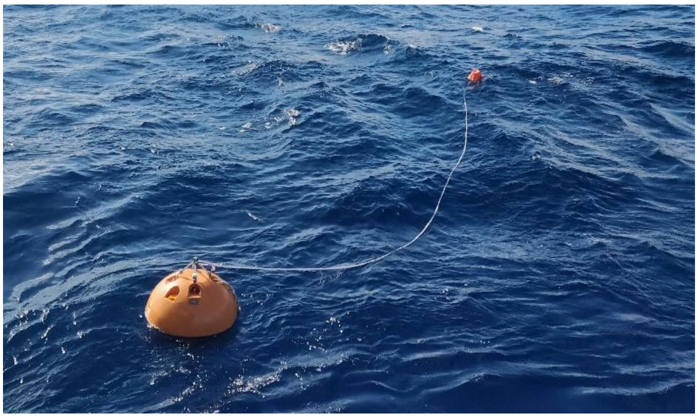
All three systems were controlled with a single Windows Graphical User Interface (GUI) application written by us running on a laptop connected via a USB deck lead to a port on the battery housings. We also ran it standalone on a laptop to generate and decode the Iridium messages for sending over the satellite to control the free-floating buoy. The GUI versions matched the firmware versions throughout except that we created an additional version CCROC_1_0_14 to demonstrate controlling the USBL modem (and the iWand) with our own software as described later. The only other software we used was Sonardyne's 6G Terminal Lite program (v2.00.04.361) to do most of the testing with the USBL.

18.5 Deployments

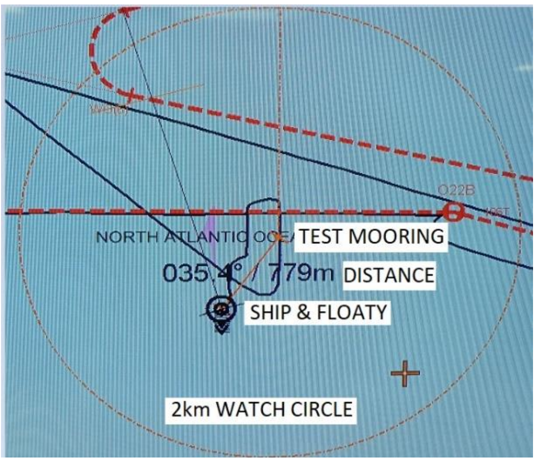
We deployed the test mooring twice and the free-floating buoy four times over three days. The weather was exceptionally calm on all three days. Full test logs and test data are in the DY181/Science/Telemetry folder on the ship's science_public drive.

8 July 2024: test mooring deployed exactly as any other OSNAP mooring at 57° 8.31' N 9° 35.63' W, depth 1821.0m (trilaterated), tested using the starboard USBL modem and 6G Terminal Lite software only; mooring recovered on 9 July 2024. Ship positioned 100m off the mooring position for the initial tests, then 900m, then finally steamed slowly out to where the signal started to be unviable (at about 2000m) with the USBL pole down the whole time (limiting the ship to 4 knots). The inductive communications did not work on this deployment due (we suspect) to water ingress to the mooring cable terminations.

20 July 2024: test mooring re-deployed after a visual inspection of the cable by the moorings team at 57° 57.49' N 21° 4.52' W, 2685.0m depth, briefly tested using the USBL modem then free-floating buoy deployed above the test mooring. It sat fairly low in the water but was stable and we had no problems with the satellite telemetry.



The ship was allowed to drift with the buoy and the Bridge very helpfully provided us with a display (below) of the ship position and distance from the mooring with a 2km watch circle to allow us to keep half an eye on the buoy's progress.



On its first outing the buoy drifted in a roughly straight line covering about 1600m in just over an hour and a quarter with the ship drifting with it while we ran telemetry tests to check buoy controller status and acoustic signal quality and download reliability, timings and power usage, all done remotely by e-mails sent from the ship and from shore. We also tested the inductive communications following modifications since the 8 July deployment and they worked perfectly. We then recovered and re-deployed the free-floating buoy approximately 2000m the other side of the mooring on the same track where it stubbornly drifted round in circles at about 1600-1800m from the mooring until we recovered it again for the night. We had configured the modem to return GPS positions periodically in case we lost sight of it but in the event we did not do so and recovery by the deck crew was straightforward using a grappling hook to catch the buoy's recovery line over the starboard side of the ship and then lifting the buoy over the stern as normal.

21 July 2024: free-floating buoy once again above the mooring. The buoy hardly drifted at all (never more than 200m from the mooring) and acoustic conditions were good but the long downloads we attempted terminated early leading us to suspect a software issue. We therefore recovered the buoy early to check the detailed logs. That investigation led us to change a timeout in the buoy controller firmware and we decided to test the fix using the dunker modem that we'd intended to deploy at the same location (about 200m from the mooring) anyway. All of the tests with the dunker were successful (the Bridge confirmed that the ship's DP was running throughout those tests) so we upgraded the free-floating buoy to the same version of the firmware and redeployed it. Whilst we had some successful transfers we also saw the same error as before on a simulation of a longer (OSNAP 12-month) transfer. We recovered the free-floating buoy for the final time after that and recovered the test mooring the next day. The mooring tangled a little on recovery but nothing was damaged apart from the mooring cable.

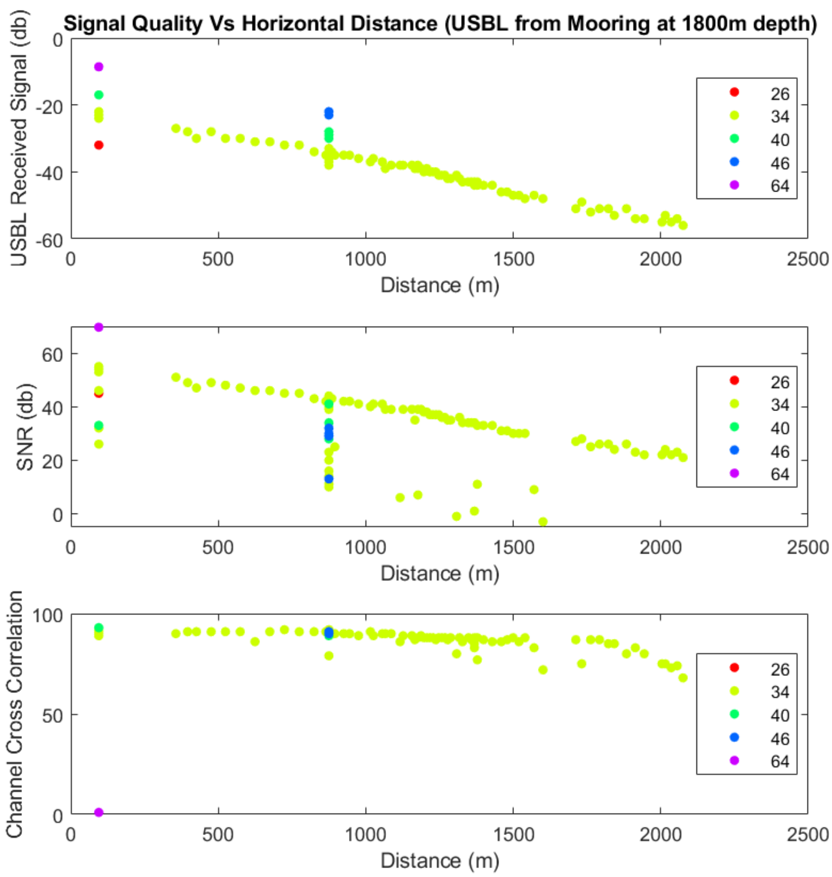
23-25 July: we did not deploy the buoys again but after some discussions with Sonardyne about the failures we'd seen, we implemented a workaround recommended by them to reset the modems if our software ever timed out waiting for the modem to complete a transfer. Tests in the lab using the dunker and a WMT modem over 10cm of air suggest the workaround is effective. We also discussed with Sonardyne the possibility of running our own software on the USBL PC to control the USBL modem for long downloads (something their 6G Terminal Lite program is not well suited to) and they offered several solutions. The one we tried (described later) was successful.

18.6 Acoustic signal tuning

The key to successful acoustic transfers is to ensure the modems are tuned to the prevailing acoustic conditions. The 6G modems can be configured (with the DIAG command to the local modem) to return statistics with every acoustic transfer that describe the incoming signal quality (the ALS command sent to the remote modem can get the same statistic for the other end). The key statistics to observe are signal strength (DVB) and signal-to-noise ratio (SNR). A third statistic called cross correlation (XC) can be used as a summary of signal quality. In their documentation Sonardyne provide the following as a guide to what range those statistics need to be in for successful acoustic communications:

	good	okay	difficult
XC	>60	>50	<50
DBV	-3 to -26	-36 to -3	otherwise
SNR	>12	>6	<6

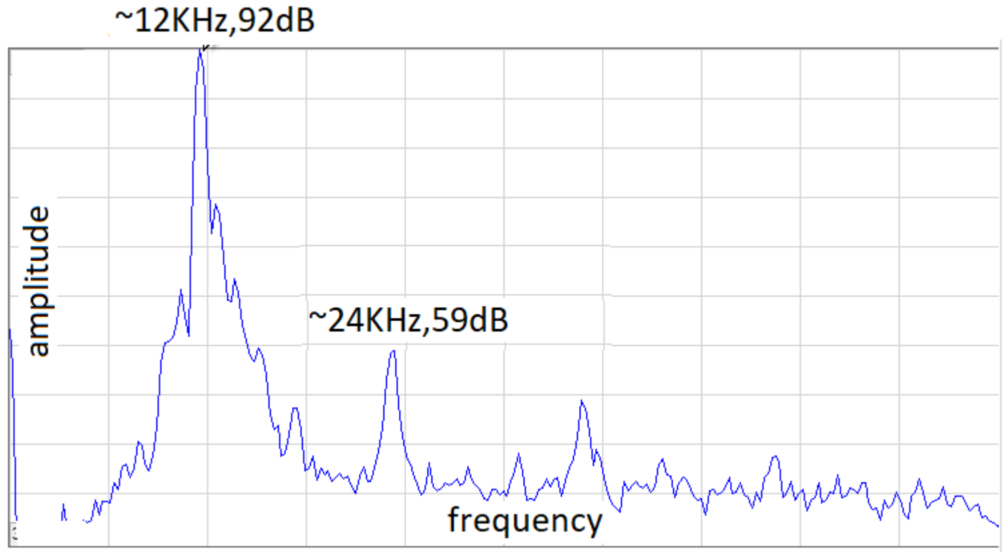
The modem allows you to adjust several parameters to alter the transmission and reception of the signal. The principle ones are transmission power (NPL/TPL) which controls how loudly the modem speaks and linear gain (LG) which controls how hard the modem listens. The are adjusted with the CS command and may need to be increased or decreased to get a good signal. A good example was our very first attempt to communicate with the test mooring using the USBL where initially we could get no contact with the test mooring but after an examination of the DBV and SNR parameters and a realisation that the linear gain was extremely high we guessed that the signal was saturating the receiver (USBL) and after we turned LG down we got an immediate response from the test mooring and near-perfect acoustic communications. As described earlier we obtained a sequence of signal quality measurements from about 100m to 2000m from the mooring on that first deployment and the results are shown below:



As would be expected the signal strength (when shown in dB) drops off almost linearly with distance and in the absence of any other noise sources, the signal-to-noise ratio declines with it. The numbers in the boxes are linear gains and whilst it would appear from the top graph that we could have extended the range beyond 2000m (the point at which we started to see unrecoverable errors) by increasing the linear gain it looks from the one result near 800m that the signal quality would have declined possibly enough to make the change ineffective. Perhaps most notable is that the cross-correlation (which we tended to ignore) does show a marked decline from beyond about 1700m which is almost exactly where we saw the tests having to try harder with error correction and retries (although still succeeding). The gap in the plot around 1400m was where we tried a short bulk download while the ship was still moving away from the mooring at 4 knots and it worked perfectly. The directional transducers we deployed on the buoys have a 60° cone (i.e. 30 either side of vertical) so we would have expected the signal to decline after about 1000m with the modem deployed at 1746m (75m above the sea-bed at this site) but in fact it held up longer. The USBL modems on the Discovery have omnidirectional modems (160° or 180°) but the modem in the free-floating buoy was directional and showed a similar range in the same conditions.

In general we left the test mooring's modem's transmit power at 187 (the maximum the WMT modems allow). The free-floating buoy's modem was set the same. The dunker and the USBL modems could be set higher if necessary because power consumption isn't an issue but as we found the acoustic conditions were better at the test mooring end there may be little to gain from it.

Another consideration with acoustic telemetry is interference from other sources (e.g. echo sounders, DP) but at no point in the deployments did we have to request anything to be turned off. Sonardyne's 6G Terminal Lite program can display a Fast Fourier Transform (FFT) plot using data obtained from the modem by running its FFT command to analyse the incoming signal.



An example is show above where there's a very large spike at about 12KHz with a smaller one (almost certainly a harmonic) at 24KHz which is close to the 26KHz operating frequency of our MF modems but while these spikes may have caused the occasional retry their impact on successful downloads to the USBL was slight. One good piece of advice from Sonardyne to reduce the impact of reflections from the sea-bed and ship noise is, when doing downloads from the ship, always to set the ship off a little from the mooring point (they suggested at least a 50m horizontal offset from a mooring that has its modem at 1000m depth)

It was worth noting that on the tests conducted on the cruise between the USBL and the AZA Fetch suspended 50m below the ship, better acoustic communications required the linear gain and transmission power to be *reduced* to avoid problems with echoes and saturation.

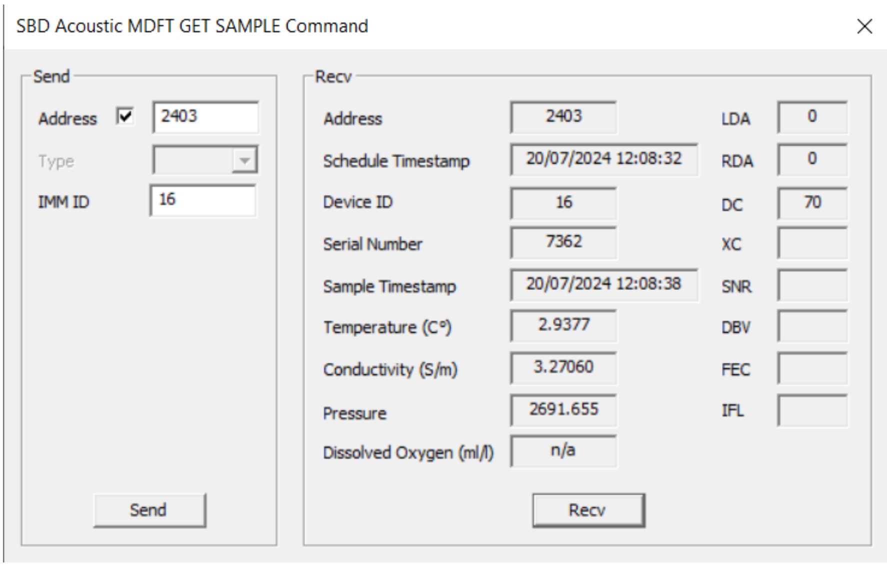
One possible resort to deal with a noisy signal is to reduce the bit rate of the acoustic transmissions. We found 3500 bps (TS6 set by the MS command) to be effective in the conditions we had although in noisier conditions 900 bps (TS3) is recommended. Of course longer transmissions consume more power. We briefly tried 9000 bps (TS7) with no success even under near-ideal conditions.

Transfer times and power consumption for all test data transfers are all available in the test logs on the science drive as detailed above and we have not yet summarized them but they will form the basis of the power consumption calculations for the RAPID deployments. Note however that for the RAPID deployments the power draw of a sleeping modem on the mooring is of much greater concern than its transmission power requirements for a handful of downloads. Sleep power is not an issue for the surface vehicle because it can turn the modem off entirely when it is not required.

18.7 Remote control

It is not a primary goal of this project to provide remote control of the instruments on a mooring but it's worth remarking that our experience of the test infrastructure we set-up to run the tests on the free-floating-buoy was very positive. It was remarkably robust and useable and so the approach of combining off-the-shelf solutions for all of the communications channels with our own electronics at the junctions between them may be a design worth replicating, particularly as it would transfer very easily from the free-floating surface buoy to other vehicles with which we have integrated our electronics in the past.

As a bit of a stunt we asked for an Iridium SBD message to be sent by e-mail from Southampton that requested a specific instrument on the mooring (at 2700m depth) to take an on-demand sample and 6 minutes later they had the response (below), the request having travelled via the Iridium service provider, the satellite modem, our surface electronics, the surface acoustic modem, the sub-sea acoustic modem, our sub-sea electronics, the local inductive modem, the remote inductive modem (in SBE #16) and the instrument itself, and the response having travelled the whole path in reverse. And we did this several times without issue.



Of course this requires a ship or autonomous vehicle (or free-floating buoy!) to be in the vicinity of the mooring but on the occasions that you have that capability it is already feasible to offer full access to the instruments on the mooring (with appropriate access control if that access includes modifying their settings).

18.8 Conclusion

Very little of what we have done here is new but what's encouraging is the reliability and interoperability of the acoustic equipment that gives us an effective and complete communication path from a sub-surface mooring to shore. Notwithstanding the fact that all tests were undertaken in near-perfect weather conditions, we now have high confidence that we can build a reliable data retrieval solution for RAPID using acoustic communications to a sub-sea telemetry buoy. We have found that Sonardyne's claims for interoperability between their different modem products is matched by our experience of them so that we have several alterative options for acoustic communications with a telemetry buoy equipped with a modem from this family of equipment if a ship happens to be in the vicinity. Finally we have found that remote configuration of instruments on an inductive mooring via simple Iridium SBD communications with any surface vehicle equipped with a suitable modem and in reasonable proximity (<1500m) of the mooring is not only viable but straightforward, including reading and adjusting the acoustic parameters of the modems remotely as necessary to achieve the best signal.

18.9 Issues/Improvements

18.9.1 Inductive Communications Failure

We believe the failure in the inductive communications during the first deployment was caused by water ingress to the insulated terminals of the mooring cables that attach to the swivels on the mooring buoy. On the first recovery of the test mooring one of the PEEK (plastic) washers that protect the terminal (a potted eyelet) from damage by the steel swivel fell off and revealed what looked like a rusty exposed metal surface below it. Tests on deck where we dunked it in a bucket of seawater proved inconclusive as we still got successful communications with an instrument on the mooring cable but we decided to modify the mooring on the second deployment to move both instruments to the lower section of the mooring cable and reverse the ICC so it was clamped directly to the mooring cable (as it's designed to) and sent its coil signals back to our electronics via the swivel. In that configuration the inductive telemetry worked perfectly, albeit with the loss of the ability to communicate with the mooring cable above the buoy.

18.9.2 Download failures – workaround from Sonardyne

Discussions with Sonardyne about the download failures using the free-floating buoy suggested that our timeout should have been adequate and the success of the dunker (which has older firmware than the WMT on the buoys) backs up the suggestion that there might be a bug in the present WMT firmware. However Sonardyne suggested a workaround to reset the modem following a timeout by our software of an ongoing MDFT command and while it seems heavy-handed we tested it in the lab using the dunker and a WMT over air and it consistently worked.

18.9.3 Central battery housing placement

The central placement of the battery housing on the test mooring buoys is a nuisance requiring the removal of the lifting frame to install or remove the housing and fouling the cables when it is refitted. It is better located in one of the offset recesses as we did on the free-floating buoy.

18.9.4 Modem sleep current

The WMT modem sold to us by Sonardyne have performed very well during these trials but they have a very significant flaw in that their sleep power draw of 650mW is enormous. By contrast the AZA Fetch also deployed on this cruise (and from the same manufacturer) must sleep with a power draw of something less than 18mW (5.7mA@3.6V) to achieve the 10 year claimed operational deployment period on a 500Ah battery. The company's Avtrak6 Nano modems also have a sleep power draw of about 5mW (but not the range or depth rating that we require). We will continue discussions with Sonardyne to try solve this problem otherwise will need to turn the modems off with our own electronics and wake them up on a calendar when we hope a vehicle will be around to collect the data. This problem is the primary reason we did not deploy the current solution on the OSNAP EB1 mooring as we'd hoped to.

18.9.5 Modem resets

Both the USBL and dunker modems reset themselves while we were using them losing changes to MS and CS parameters that hadn't been saved to non-volatile memory using the SC command and turning off diagnostics. Sonardyne have confirmed that this behaviour is due to a watchdog timer and will happen after 17.5 minutes.

18.9.6 Greasing clamp bolts

A couple of the stainless steel clamp bolts on one of the battery housing clamps galled so tightly that we had to resort to hacksawing them off. It is a well-known problem with stainless steel and we may need to apply some sort of lubrication or protection to the bolts before they are deployed.

18.9.7 Controlling the USBL modems with our own software

One final test we wanted to make was to prove the possibility of using the USBL modem to download bulk data. To achieve that we ideally wanted to run our own software on the USBL computer (a Windows PC) to manage the downloads. The difficulty with that is getting a serial data connection from our software to the modem because it is connected to the USBL computer indirectly via a Sonardyne Navigation Sensor Hub (NSH), not directly to a COM port. One of Sonardyne's suggestions was to use of a capability of their 6G Terminal Lite program to pair the NSH port (NSH\3A) with a loopback Windows COM port (you need to connect their program to both ports then double-right-click on the COM port to get to the pairing option). It may be possible to create a virtual loopback port but we created a physical one using a null modem cable between the unused COM1 and COM2 ports on the rear of the USBL computer. We were then able to pair NSH\3A with COM1 and connect our GUI application to COM2 and communicate directly with the USBL modem. Full details are in our Cruise Log in the DY181/Science/Telemetry folder.

19 Coccolithophore data collection and analysis

Pablo N. Trucco-Pignata

All Samples were drawn from the non-toxic surface water supply in the Discovery underway lab.

19.1 Particulate Inorganic carbon (PIC)

For PIC, 0.5 L was filtered onto 0.4 µm polycarbonate filters, rinsed with pH-adjusted MilliQ (trace ammonia solution), placed in 15-mL Falcon tubes and oven dried (50ºC) overnight. PIC measurements will be carried out by ICP-OES at the University of Maine (Poulton, Mitchell) or at the University of Ghent (Neukermans, Poulton).

19.2 High Performance Liquid Chromatography (HPLC)

For HPLC, 1 L was filtered onto Whatman GF/F filters, placed in 2 mL Cryotubes, and stored at -80°C before analysis by NASA (Moore, Bouman).

19.3 Chlorophyll-*a*

For chlorophyll-*a*, 200 mL was filtered onto Whatman GF/F filters placed in 2 mL Cryotubes and stored at -80°C before analysis by NASA (Moore, Bouman).

19.4 Scanning Electron Microscopy (SEM)

For SEM, 500 mL was filtered onto 0.4 µm Whatman polycarbonate filters, rinsed with pH-adjusted MilliQ (trace ammonia solution) to remove saltwater and prevent salt crystals, placed in Petri-slides and dried overnight at 50°C before being stored at room temperature for later analysis at Heriot-Watt (Poulton). Filters will be analysed for coccolithophore and diatom abundance and species identification.

19.5 Sterivex filtration for DNA/RNA

For analysis of DNA/RNA, 2L of water were filtered through 0.2 µm Sterivex cartridge filters using a peristaltic pump set to 70 rpm. Filters were sealed with caps or Parafilm and stored at -80°C. The current planned activity with these filters is metabarcoding for eukaryotic communities using the 18s V9 rDNA marker.

19.6 TA DIC and pH

Daily water samples for the determination of DIC, TA and pH were drawn from the surface water supply in the underway lab. Parallel sampling was undertaken for nutrients. The DIC and TA samples were collected in 250 mL glass bottles with ample rinsing and overflowing to avoid gas exchange with the air. The samples were always poisoned with a saturated mercuric chloride solution (50 µL per 250 mL sample).

Also, 5 CTD casts were sampled during the cruise following the same procedure as for the underway system.

19.6.1 LoC Sensors for pH, TA, and DIC

We connected Lab-on-Chip (LoC) sensors from NOC for continuous monitoring of pH, TA, and DIC in the underway lab. These advanced microfluidic devices are designed to perform precise and automated chemical analyses on small volumes of water samples, allowing for high-resolution, real-time data collection. The LoC sensors integrate microfluidic channels with chemical reagents to measure carbonate parameters accurately, thus providing valuable insights into the ocean's carbonate chemistry and its spatial and temporal variability during the cruise.

19.6.2 pCO2 General Oceanic Sensor

A pCO2 General Oceanic sensor was operational starting from the 17th of July, providing continuous measurements of pCO2 levels in the surface water. This sensor system utilises a non-dispersive infrared (NDIR) gas analyser to detect carbon dioxide levels coupled with an equilibration chamber. By continuously monitoring pCO2, we can assess the air-sea CO2 flux and better understand the carbon cycle dynamics in the ocean, contributing to our knowledge of oceanic carbon sequestration and its response to climate change.

Pablo Trucco-Pignata will analyse and quality control all the carbonate chemistry samples and measurements in the NOC facilities.

20 Gas-tight carbonate seawater sampler

Samual T. Castle

20.1 Summary

The work undertaken on DY181 was twofold: to perform functional and performance testing of two prototype gas tight samplers (S/Ns: GTS1, GTS2) against a range of key parameters, and to collect DIC water samples at a series of depths for comparison with the water samples captured by the Niskin bottles. The sampler was deployed opportunistically on the NMF Stainless Steel CTD frame 21 times over the course of the cruise and utilised the RS232 Niskin bottle firing codes to take a co sample alongside a specific bottle position and depth. The sampler was powered directly from the 15V CTD power supply. Extensive testing on the bench was also performed with in the region of 150 test deployments.

20.2 Preparation for deployment at Sea

Following a failed external pressure test in the pressure pot in Southampton both sensors needed the mineral oil from the pressure compensating housing draining. After replacing the compressible powder filled 3D printed volume reductors for PVC blocks I successfully oil filled both housings, using a syringe to remove any air bubbles. In order to pressure test the modified devices I sent both GTS1 and GTS2 down to 2100m (CTD casts 4 & 5). On each cast the device was mounted on two parallel bars, and a nylon block, across the bottom of the CTD frame with two jubilee clamps cinching it down securely (as seen in Figure 57). They were left disconnected electrically, with the bulkhead connectors plugged, in case of water ingress. Both devices passed the test with no obvious leakage.

Figure 57: (left) GTS mounted to bottom of CTD frame, (right) First dip in the sea

A custom Y-shaped cable manufactured by MacArtney (UK 15481 Rev A) was used to connect power, ground, and RS232 comms from the CTD to the GTS sampler. The cable was inserted in line between the SBE 9plus and SBE 32 for each deployment and cable tied neatly along the frame. Before any deployments at depth were attempted the cables and serial firing codes were tested whilst the CTD frame was in the hangar. All RS232 codes were received as expected and matched the expected codes as per the Seabird datasheet.

20.3 Characterising sampling performance

In order to gain an understanding of the sampling performance of the devices, so that appropriate pumping durations could be chosen for the deployments, bench testing was carried out. The device was powered using a bench top power supply (various voltages, current limit: 2 A), and 500 ml blood bags containing Milli-Q water were attached via pneumatic hoses to the sample chamber inlet and the exhaust. Average flow rates were calculated by measuring the captured volume of water over a given pumping duration.

The tests showed that the inlet 187 Zero Leak Check valve from the Lee Company significantly restricts flow into the device despite the device possessing the ability to generate a much greater pressure differential (up to 10x) than the valves cracking pressure. As a result, flow rate was significantly lower than expected, by at least a factor of 10. A basic test with the spare valve hooked up to an air compressor showed that drawing 0.65 bar of negative pressure (the pumps maximum at atmospheric pressure) through the valve, failed to crack the valve. This is despite the cracking pressure being declared on the data sheet as 0.138-0.552 bar. More stringent testing is required back in Southampton, but if the valves are shown to not exhibit the performance claimed by the Lee Company, then a conversation with the supplier will be necessary, as this is unacceptable at the price point that these were sold to us.

By optimising the motor duty cycle used to pump, and the input voltage, consistent flowrates of 35-40 ml/min were able to be achieved. Armed with this knowledge samples could now be taken, albeit slower than anticipated.

20.4 Seawater sampling

GTS1 was successfully deployed on 21 CTD casts as described in Table 14. Of these the first 6 deployments were used to assess the device's performance in the sea environment, with elevated ambient pressure. These deployments were shown to match the performance exhibited in the bench testing so appropriate motor duty cycle and pump durations could be input for the following deployments. These initial deployments were not loaded with mercuric chloride. Following these trials 15 seawater samples were captured at various depths (of which 5 were compromised, indicated in **red**).

Table 14: GTS deployments aboard Discovery (DY181)

cast ID	**CTD cast #**	**GTS #**	**sample depth (m)**	**bottle #**	**duty cycle (%)**	**flow rate (ml/min)**	**max depth (m)**	**DIC co sample**	**sample #**
S	34	1	50	7	35	5.33	170	-	-
R	35	1	30	11	35	5.33	133	-	-
Q	36	1	50	11	60	25.00	314	-	-
EB1 post	40	1	50	21	80	37.50	1790	-	-
F	49	1	50	19	90	39.36	1800	-	-
E	50	1	600	9	70	33.25	1640	-	-
RAG158	57	1	50	11	90	38.54	1055	SAMS	SC01
RAG155	60	1	150	9	90	38.95	1223	SAMS	SC02
O18	63	1	500	3	90	38.71	910	SAMS	**SC03**
O20	65	1	10	21	90	34.35	1567	SAMS+NOC	**SC04**
O23	67	1	2920	1	90	0.35	3001	NOC	**-**
O22	68	1	1000	7	90	30.26	1997	NOC	SC05
IB4 post	70	1	750	11	90	29.01	2945	NOC	SC06
O24	71	1	300	15	90	34.81	3018	SAMS+NOC	SC07
O30	73	1	1550	7	90	15.75	2725	NOC	**SC08**
O26	77	1	15	21	90	25.28	2935	SAMS	**SC09**
O21b	80	1	570	7	90	39.36	2400	NOC	SC10
Eddy1	88	1	25	23	90	40.19	2890	NOC	SC11
Eddy5	92	1	1400	11	90	24.69	2986	NOC	SC12
Eddy11	98	1	5	24	90	38.12	3020	NOC	SC13
Eddy12	100	1	100	20	90	38.12	2953	NOC	SC14

The device was prepared for deployment using the following steps:

- The backside of floating piston was filled with Milli-Q water from a blood bag.
- The biocide cavity was primed with 0.15 ml mercuric chloride using a pipette under the chemistry lab fume hood (a convenient place to clean in case of spills).
- The bottle number, alongside which the device was intended to fire, and the firing delay (5 seconds) were input into the GUI.
- The device was clamped to the frame and the CTD cable connected up at all three ends. Periodically, when connecting the cables, Molekote grease was used liberally on the SubConn connectors and silicone grease was used on the Impulse connectors.
- The CTD was moved out onto the deck by the S&M team and made ready for the cast.
- The CTD was powered up.
- Connecting to the device with the USB cable, 'Deploy' was hit in the GUI on a laptop.
- The USB cable was disconnected, and the bulkhead connector plugged.
- The CTD cast proceeded as usual. When the rosette reached the appropriate firing depth, the CTD stop was extended to give the GTS time to take its sample (usually approx. 13 mins).

Upon recovery, before the Niskin bottle sampling started, the device and connecting cable were quickly removed from the CTD frame and taken into the chemistry lab. The GTS samples were decanted into bottles after a range of time periods to assess if the quality of the sample is affected by a delay before decantation. The samples were retrieved using the following steps:

- The device was connected up to a laptop and the benchtop power supply with the two appropriate cables.
- The metering valve was cracked using a large flat head screwdriver.
- A 250 mm length of blue nylon pneumatic hose, which had been soaked in clean seawater, was attached to the sample outlet.
- Approximately 50 ml was slowly (35% duty cycle) decanted into a measuring jug to flush the air from the hose.
- The tube was inserted to the bottom of the borosilicate bottle and 250 ml of sample was slowly decanted, stopping once the sample reached the bottom of the bottle neck.
- The bottle was sealed with a greased stopper.
- The remaining sample in the GTS was decanted into the same measuring jug.
- When all the sample had been expelled, the volume in the jug was measured and used to estimate the average flowrate achieved in the deployment.
- The excess sample was poured out into a sealed waste container.
- The GTS was flushed with a full sample volume of clean Milli-Q water, in through the check valve and out through the metering valve, to ensure all surfaces were washed of the previous sample and biocide mixture.

Alongside the GTS samples DIC samples from the Niskin bottles were collected as a control. Where the appropriate sample was already being taken by the chemistry team the cruise results will be used. However, in the cases where there were no DIC samples being taken I co sampled the corresponding Niskin bottle using the standing operating procedure defined in "Guide to Best Practices for Ocean CO2 measurements". These samples will be analysed at NOC. In addition, two repeat DIC samples were taken, so that the results from SAMS and NOC can be verified for consistency.

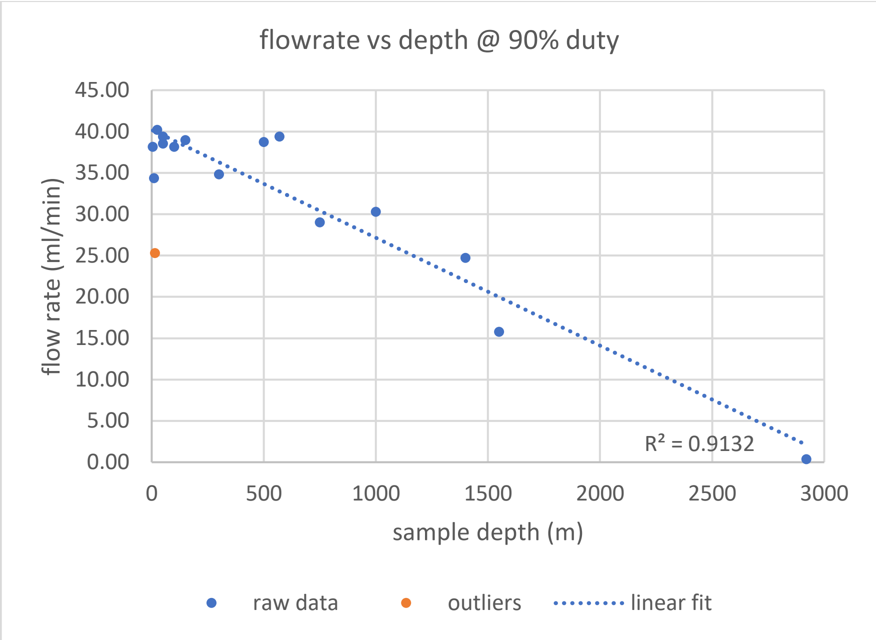


Figure 58: Flow rate vs depth at 90% duty cycle

20.5 Sampler performance at depth

I observed a linear (R^2 = 0.9132) reduction in performance (flow rate) with sample depth as can be seen in Figure 58. I have several potential theories for the cause of this which will be tested thoroughly using the pressure pot at NOC.

APPENDIX

APPENDIX A SERIAL NUMBERS OF CTD UNDERWATER SENSORS AND HARDWARE

Table 15: Stainless Steel CTD Instrument Package

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Casts Used
Stainless steel 24-way CTD frame	NOCS	SBE CTD6	n/a	All stainless steel casts
Primary CTD deck unit	SBE 11plus	11P-24680-0588	n/a	All stainless steel casts
CTD Underwater Unit	SBE 9plus	09P-34173-0758	n/a	All stainless steel casts
24-way Carousel	SBE 32	32-60380-0805	n/a	All stainless steel casts
Primary Temperature Sensor	SBE 3P	03P-4116	F0	All stainless steel casts
Primary Conductivity Sensor	SBE 4C	04C-2580	F1	All stainless steel casts
Digiquartz Pressure sensor	Paroscientific	90074	F2	All stainless steel casts
Secondary Temperature Sensor	SBE 3P	03P-5838	F3	All stainless steel casts
Secondary Conductivity Sensor	SBE 4C	04C-3258	F4	All stainless steel casts
Primary Pump	SBE 5T	05T-3086	n/a	All stainless steel casts
Secondary Pump	SBE 5T	05T-3088	n/a	All stainless steel casts
Primary Dissolved Oxygen Sensor	SBE 43	43-2061	V0	All stainless steel casts
Secondary Dissolved Oxygen Sensor	SBE 43	43-2068	V1	All stainless steel casts
Fluorometer	CTG Aquatracka MKIII	088244	V2	All stainless steel casts
Transmissometer	WETLabs C-Star	CST-1837TR	V3	Stainless steel casts 011S -
Altimeter	Valeport VA500	81629	V4	All stainless steel casts
BBRTD	WETLabs	758R	V5	All stainless steel casts
PAR Down-looking UWIRR	Satlantic Cosine Log	2348	V6	All stainless steel casts
PAR Up-looking DWIRR	Satlantic Cosine Log	2349	V7	All stainless steel casts
LADCP Down-looking (Master)	TRDI WHM 300KHz	24465	n/a	All stainless steel casts
DOST	SBE 35	0048	n/a	All stainless steel casts
LADCP Up-looking (Slave)	TRDI WHM 300KHz	24466	n/a	All stainless steel casts
LADCP battery pack	NOCS	WH008T	n/a	All stainless steel casts
10L Water Samplers	Ocean Test Equipment	Set B	n/a	All stainless steel casts
Titanium EM CTD Swivel	MDS ST6003-2E2-Ti	1246-2	n/a	All stainless steel casts

APPENDIX B SBE 9PLUS CONFIGURATIONS

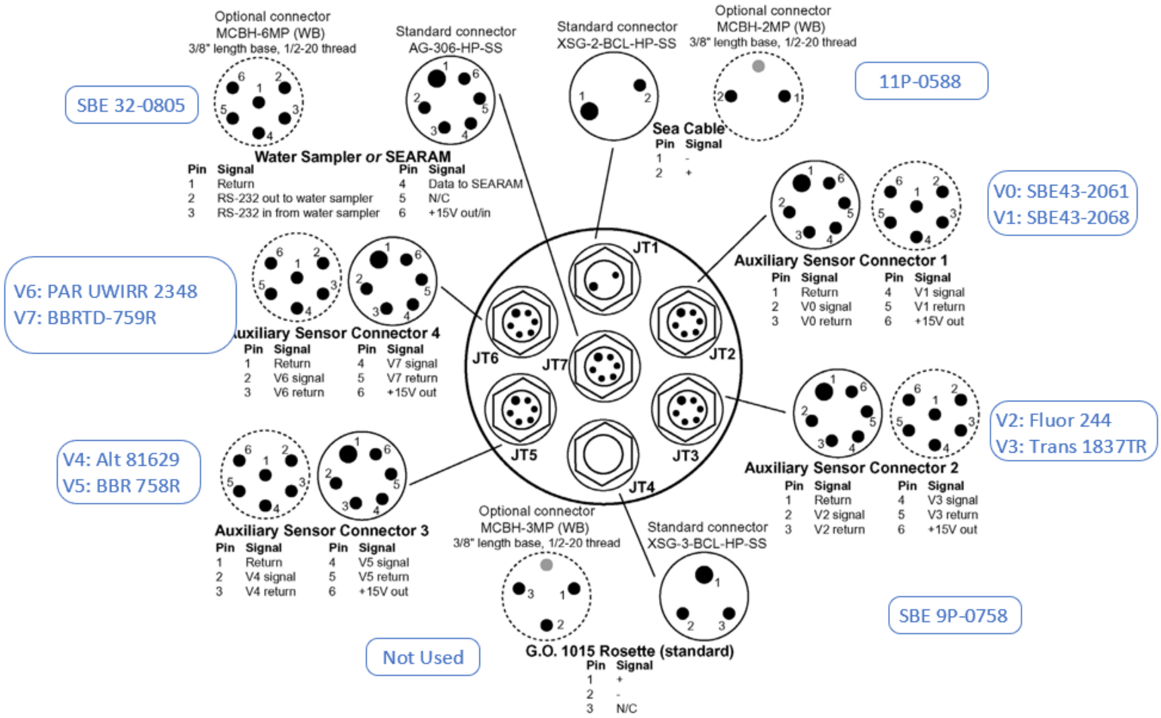


Figure 59: SBE 9plus CTD Top End Cap Configuration

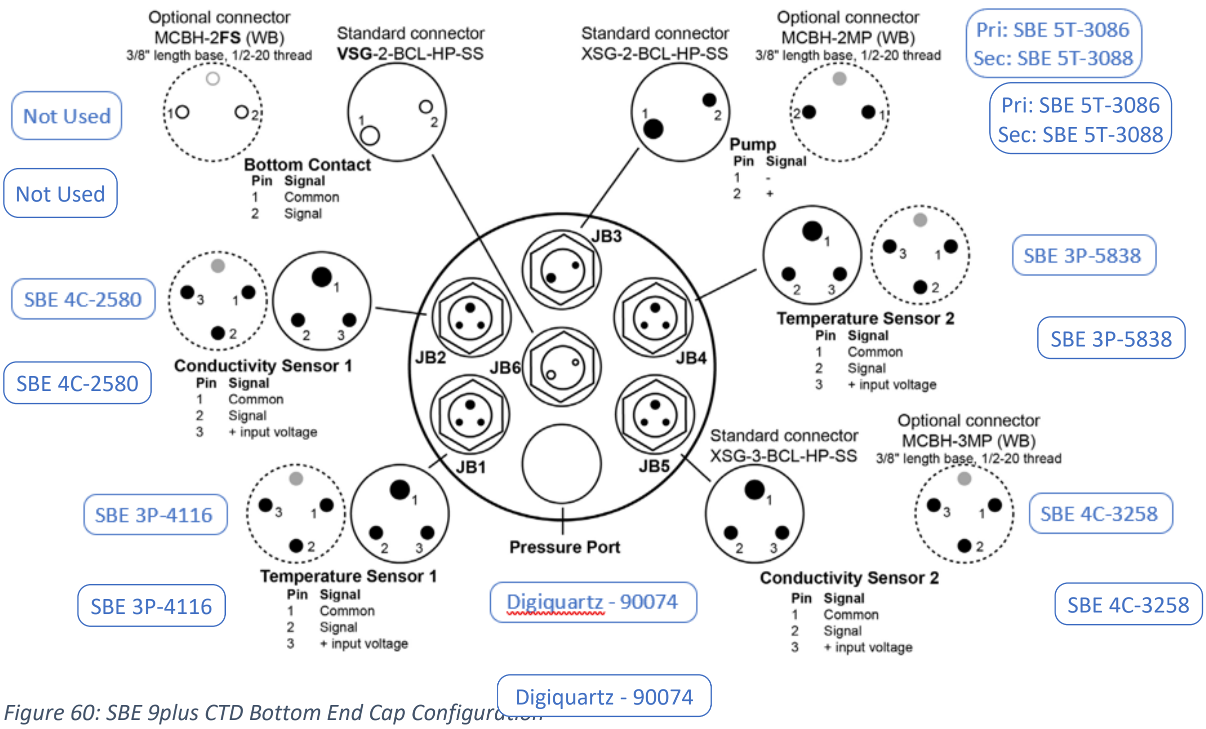


Figure 60: SBE 9plus CTD Bottom End Cap Configuration

APPENDIX C SEASAVE CONFIGURATIONS & INSTRUMENT CALIBRATIONS

PSA file: C:\Users\sandm\Documents\Cruises\DY181\Data\Seasave Setup Files\DY181_SS_0758_nmea.psa

Date: 07/25/2024

Instrument configuration file: C:\Users\sandm\Documents\Cruises\DY181\Data\Seasave Setup Files\DY181_SS_0758_nmea.xmlcon

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Deck unit : SBE11plus Firmware Version >= 5.0
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : Yes
NMEA device connected to : PC
Surface PAR voltage added : No
Scan time added : Yes

1) Frequency 0, Temperature

Serial number : 03P-4116
Calibrated on : 10-Nov-23
G : 4.41800037e-003
H : 6.82970854e-004
I : 2.40107068e-005
J : 1.99418176e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-2580
Calibrated on : 21-Dec-23
G : -1.01222373e+001
H : 1.48806714e+000
I : 3.47485859e-004
J : 4.87682430e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 90074
Calibrated on : 23 September 2022
C1 : -6.571123e+004
C2 : 2.050504e-001
C3 : 1.612220e-002
D1 : 2.883800e-002
D2 : 0.000000e+000
T1 : 2.986693e+001
T2 : -2.678465e-004
T3 : 3.986390e-006
T4 : 7.472100e-010
T5 : 0.000000e+000
Slope : 1.00012000
Offset : 0.01710
AD590M : 1.283700e-002
AD590B : -8.642460e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-5838
Calibrated on : 19-Oct-23
G : 4.34193231e-003
H : 6.69245002e-004
I : 2.67802756e-005
J : 2.14684330e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-3258
Calibrated on : 24-Oct-23
G : -1.06586042e+001
H : 1.36042880e+000
I : 2.59308293e-004
J : 5.30189949e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

Serial number : 43-2061
Calibrated on : 21-May-24
Equation : Sea-Bird
Soc : 4.83800e-001
Offset : -4.91100e-001
A : -2.74330e-003

B : 9.29140e-005
C : -1.73580e-006
E : 3.60000e-002
Tau20 : 9.70000e-001
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Oxygen, SBE 43, 2

Serial number : 43-2068
Calibrated on : 21-May-24
Equation : Sea-Bird
Soc : 4.79700e-001
Offset : -5.31100e-001
A : -3.13370e-003
B : 1.42330e-004
C : -2.42060e-006
E : 3.60000e-002
Tau20 : 1.12000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

8) A/D voltage 2, Fluorometer, Chelsea Aqua 3

Serial number : 088244
Calibrated on : 29 November 2022
VB : 0.358220
V1 : 2.123120
Vacetone : 0.550570
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

9) A/D voltage 3, Transmissometer, WET Labs C-Star

Serial number : CST-1837TR
Calibrated on : 17 October 2022
M : 22.0357
B : -0.1873
Path length : 0.250

10) A/D voltage 4, Altimeter

Serial number : 81629
Calibrated on : N/A

Scale factor : 15.000
Offset : 0.000

11) A/D voltage 5, OBS, WET Labs, ECO-BB

Serial number : 758R
Calibrated on : 21 September 2023
ScaleFactor : 0.003461
Dark output : 0.073000

12) A/D voltage 6, PAR/Irradiance, Biospherical/Licor

Serial number : 2349
Calibrated on : 19 February
M : 0.80861200
B : 1.05340900
Calibration constant : 735889322.20000005
Conversion units : umol photons/m^2/sec
Multiplier : 1.00000000
Offset : 0.00000000

13) A/D voltage 7, PAR/Irradiance, Biospherical/Licor, 2

Serial number : 2348
Calibrated on : 19 February 2023
M : 0.80753400
B : 1.05899300
Calibration constant : 735889322.20000005
Conversion units : umol photons/m^2/sec
Multiplier : 1.00000000
Offset : 0.00000000

Scan length : 45

Pump Control
This setting is only applicable to a custom build of the SBE 9plus.
Enable pump on / pump off commands: NO

Data Acquisition:
Archive data: YES
Delay archiving: NO
Data archive: C:\Users\sandm\Documents\Cruises\DY181\Data\CTD Raw Data\DY181_CTD095.hex
Timeout (seconds) at startup: 60
Timeout (seconds) between scans: 10

Instrument port configuration:
Port = COM1
Baud rate = 19200
Parity = N
Data bits = 8

```
  Stop bits = 1
--------------------------------------------
Water Sampler Data:
  Water Sampler Type:   SBE Carousel
  Number of bottles:    32
  Port:                 COM5
  Enable remote firing: NO
  Firing sequence:      User input
  Tone for bottle fire confirmation uses PC sound card.
--------------------------------------------
Header information:
  Header Choice = Prompt for Header Information
    prompt 0 = Ship / Cruise: RRS DISCOVERY / DY181
    prompt 1 = Event:
    prompt 2 = Cast:
    prompt 3 = Station:
    prompt 4 = Julian Day:
    prompt 5 = Date:
    prompt 6 = Time (UTC):
    prompt 7 = Latitude:
    prompt 8 = Longitude:
    prompt 9 = Depth (uncorrected m)
    prompt 10 = Principal Scientist: Kristin Burmeister/ Yvonne Firing
    prompt 11 = Operator:
--------------------------------------------
TCP/IP - port numbers:
  Data acquisition:
    Data port:          49163
    Status port:        49165
    Command port:       49164
  Remote bottle firing:
    Command port:       49167
    Status port:        49168
  Remote data publishing:
    Converted data port:  49161
    Raw data port:      49160
--------------------------------------------
Miscellaneous data for calculations
  Depth, Average Sound Velocity, and TEOS-10
    Latitude when NMEA is not available:  57.00000000
    Longitude when NMEA is not available: 0.00000000
  Average Sound Velocity
    Minimum pressure [db]:          20.00000000
    Minimum salinity [psu]:         20.00000000
    Pressure window size [db]:      20.00000000
    Time window size [s]:           60.00000000
  Descent and Acceleration
    Window size [s]:                2.00000000
  Plume Anomaly
    Theta-B:                        0.00000000
    Salinity-B                      0.00000000
```

```
    Theta-Z / Salinity-Z              0.00000000
    Reference pressure [db]           0.00000000
  Oxygen
    Window size [s]:                  2.00000000
    Apply hysteresis correction:      1
    Apply Tau correction:             1
  Potential Temperature Anomaly
    A0:                               0.00000000
    A1:                               0.00000000
    A1 Multiplier:                    Salinity
-------------------------------------------
Serial Data Output:
  Output data to serial port: NO
-------------------------------------------
Mark Variables:
  Variables:
  Digits   Variable Name [units]
  ------   ---------------------
  0        Scan Count
  4        Depth [salt water, m]
  7        Conductivity [S/m]
  5        Salinity, Practical [PSU]
-------------------------------------------
Shared File Output:
  Output data to shared file: NO
-------------------------------------------
TCP/IP Output:
  Raw data:
    Output raw data to socket:            NO
    XML wrapper and settings:             NO
    Seconds between raw data updates:     0.00000000
  Converted data:
    Output converted data to socket:      NO
    XML format:                           NO
-------------------------------------------
SBE 11plus Deck Unit Alarms
  Enable minimum pressure alarm:   NO
  Enable maximum pressure alarm:   NO
  Enable altimeter alarm:          NO
-------------------------------------------
SBE 14 Remote Display
  Enable SBE 14 Remote Display:    NO
-------------------------------------------
PC Alarms
  Enable minimum pressure alarm:   NO
  Enable maximum pressure alarm:   NO
  Enable altimeter alarm:          NO
  Enable bottom contact alarm:     NO
  Alarm uses PC sound card.
-------------------------------------------
Options:
```

Prompt to save program setup changes: YES
Automatically save program setup changes on exit: NO
Confirm instrument configuration change: YES
Confirm display setup changes: YES
Confirm output file overwrite: YES
Check scan length: NO
Compare serial numbers: NO
Maximized plot may cover Seasave: NO

APPENDIX D SEA-BIRD SBE35 DOST CONFIGURATION

The SBE35 was connected to the SBE9plus underwater unit and the SBD32 carousel using its 'y' – cable.

It was configured to take 8 temperature samples each time that a bottle was fired.

* SBE35 V 2.0a SERIAL NO. 0048

* number of measurement cycles to average = 8

* number of data points stored in memory = 0

* bottle confirm interface = SBE 911plus

* 19-may-24

* A0 = 4.077370000e-03

* A1 = -1.087021000e-03

* A2 = 1.692063000e-04

* A3 = -9.481479000e-06

* A4 = 2.042044000e-07

* SLOPE = 0.999991

* OFFSET = 0.000193

APPENDIX E LADCP COMMAND SCRIPTS

Down-Looking Master	**Up-Looking Slave**
CR1 ; factory defaults RN MAST_ ; file name prefix WM15 ; water mode 15 (LADCP) TC2 ; ensembles per burst LP1 ; pings per ensemble TB 00:00:02.80 ; time per burst TE 00:00:01.30 ; time per ensemble TP 00:00.00 ; time between pings "staggered pinging with alternating sampling intervals of 1.5 and 2.0 s works well" LN25 ; number of depth cells LS0800 ; bin size [cm]	CR1 ; factory defaults RN DY180S ; file name prefix WM15 ; water mode 15 (LADCP) LP1 ; pings per ensemble TP 00:00.00 ; time between pings TE 00:00:00.00 ; time per ensemble LN25 ; number of depth cells LS0800 ; bin size [cm] LF0 ; blank after transmit [cm] WB1 ; narrow bandwidth mode 1 (not sure if required)

LF0 ; blank after transmit [cm] -- recommendation for WH300 is to set 0 and discard first bin, as traditional half-bin-length blank is insufficient LW1 ; narrow bandwidth LADCP mode LV400 ; ambiguity velocity [cm/s] -- set to just over maximum along-beam velocity (e.g. 1 m/s with heave compensation) ... ??? SM1 ; send sync pulses SA011 ; send pulse before each ensemble SB0 ; disable hardware-break detection on Channel B (ICN118) SW5500 ; wait .5500 s after sending sync pulse SI0 ; # of ensembles to wait before sending sync pulse EZ0011101 ; Sensor source: ; - manual speed of sound (EC) ; - manual depth of transducer (ED = 0 [dm]) ; - measured heading (EH) ; - measured pitch (EP) ; - measured roll (ER) ; - manual salinity (ES = 35 [psu]) ; - measured temperature (ET) EX00100 ; coordinate transformation: ; - radial beam coordinates (2 bits) ; - use pitch/roll (not used for beam coords?) ; - no 3-beam solutions ; - no bin mapping CF11111 ; Flow control: ; - automatic ensemble cycling (next ens when ready) ; - automatic ping cycling (ping when ready) ; - binary data output ; - enable serial output	LW1 ; narrow bandwidth LADCP mode LV400 ; ambiguity velocity [cm/s] SM2 ; receive sync pulses SA011 ; wait for pulse before ensemble SB0 ; disable hardware-break detection on Channel B (ICN118) EZ0011101 ; Sensor source: ; - manual speed of sound (EC) ; - manual depth of transducer (ED = 0 [dm]) ; - measured heading (EH) ; - measured pitch (EP) ; - measured roll (ER) ; - manual salinity (ES = 35 [psu]) ; - measured temperature (ET) EX00100 ; coordinate transformation: ; - radial beam coordinates (2 bits) ; - use pitch/roll (not used for beam coords?) ; - no 3-beam solutions ; - no bin mapping CF11111 ; Flow control: ; - automatic ensemble cycling (next ens when ready) ; - automatic ping cycling (ping when ready) ; - binary data output ; - enable serial output ; - enable data recorder CD001000000 ; - disable velocity serial output ; - disable correlation serial output ; - enable echo intensity serial output ; - disable percent good serial output

; - enable data recorder CD001000000 ; - disable velocity serial output ; - disable correlation serial output ; - enable echo intensity serial output ; - disable percent good serial output ; - disable status serial output ; - reserved ; - reserved ; - reserved ; - reserved CK ; keep params as user defaults (across power failures) CS ; start pinging	; - disable status serial output ; - reserved ; - reserved ; - reserved ; - reserved CK ; keep params as user defaults (across power failures) CS ; start pinging

APPENDIX F SBE PROCESSING

The Table 16 below lists the Sea-Bird processing routines run by Sensors and Moorings Technicians. Note this is only the modules that were run by NMF, not by scientific staff.

Table 16: Sea-Bird processing routines.

Module	**Run?**	**Comments**
Configure	N	
Data Conversion	Y	**As per BODC guidelines Version1.0 October 2010 (Oxygen Concentration umol/l and umol/kg, Latitude and Longitude (degrees), Scan Count, Time and Pressure Temperature)**
Bottle Summary	N	**As per BODC guidelines Version1.0 October 2010, with above variables added (except not averaging Scan Count and Time)**
Mark Scan	N	
Align CTD	N	As per BODC guidelines Version1.0 October 2010 **(dissolved oxygen advanced 6 seconds)** (appended file name)
Buoyancy	N	
Cell Thermal Mass	N	As per BODC guidelines Version1.0 October 2010 (appended file name)
Derive	N	As per BODC guidelines Version1.0 October 2010 (appended file name)
Bin Average	N	As per BODC guidelines Version1.0 October 2010 **(1 metre depth bins)** (appended file name)
Filter	N	As per BODC guidelines Version1.0 October 2010 (appended file name)
Loop Edit	N	As per BODC guidelines Version1.0 October 2010 (appended file name)

Wild Edit	N	**Not applicable.**
Window Filter	N	
ASCII In	N	
ASCII Out	N	
Section	N	
Split	N	
Strip	N	As per BODC guidelines Version1.0 October 2010 (appended file name)
Translate	N	
Sea Plot	N	
SeaCalc II	N	

Software Used:

- SeaBird SeaTerm 1.59
- SeaBird SeaSave 7.26.7.121
- SeaBird SBE Data Processing 7.26.6.28
- NMF Labview Autosal program

APPENDIX G VMADCP SECTIONS PLOTS

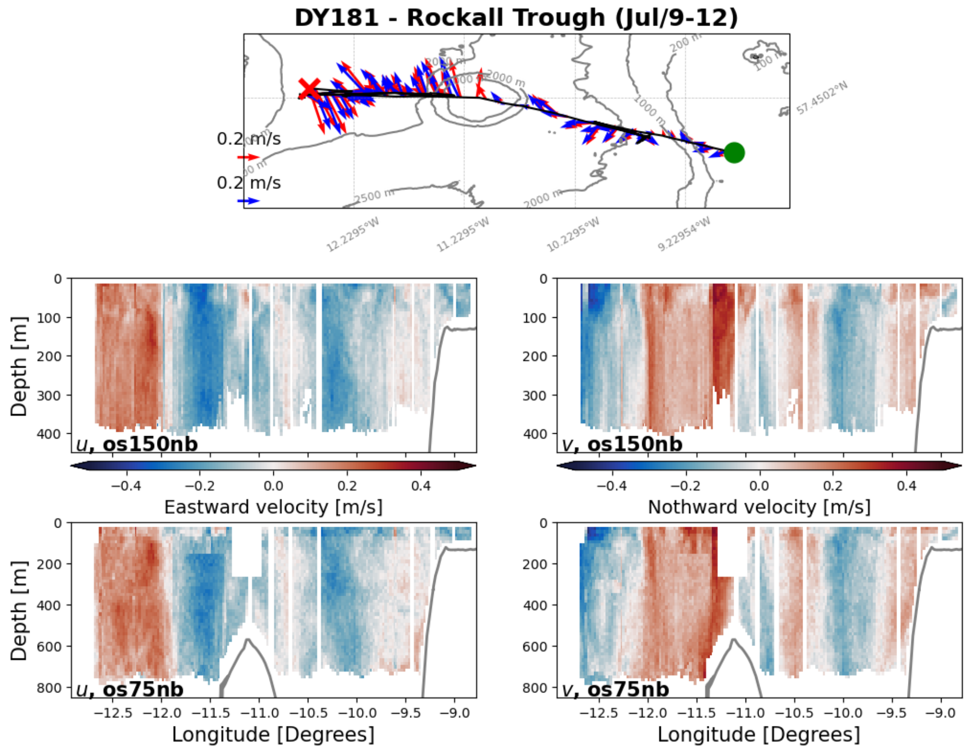


Figure 61: ADCP section across Rockall Trough. Left panels: Eastward velocity. Right panels: Northward velocity. Upper and lower panels show the 150 and 75 kHz data, respectively. Data during CTD casts, telemetry mooring tests or other times when the ship speed was low are masked. The grey lines show the bottom depth interpolated from the SRTM15+ dataset. Blue and red vectors are from the 150 and 75 kHz ADCPs, respectively.

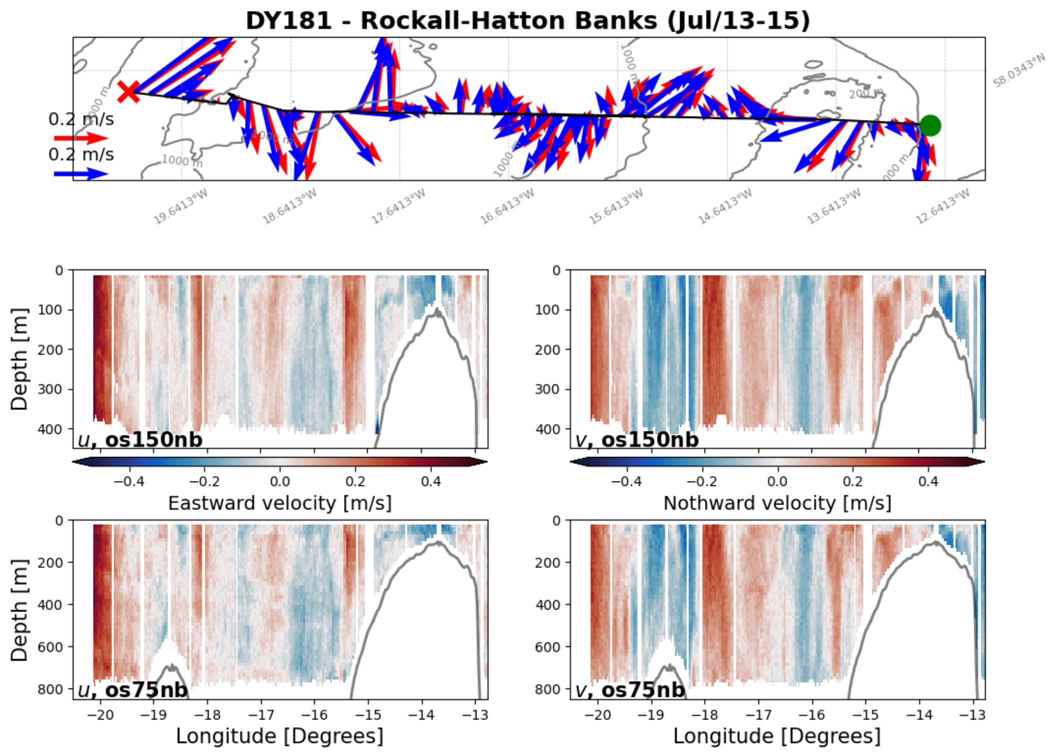


Figure 62: Same as Figure 61, but for the Rockall Plateau and the Rockall/Hatton Banks.

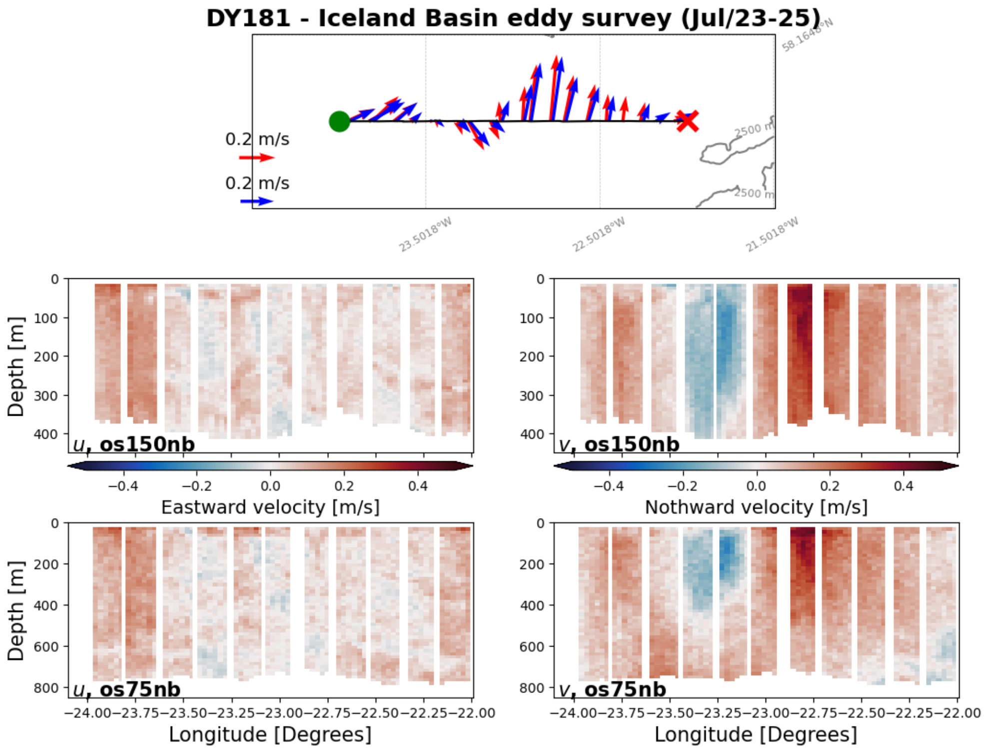


Figure 63: Same as Figure 61, but for the Rockall Plateau and the Eddy survey in the Iceland Basin.

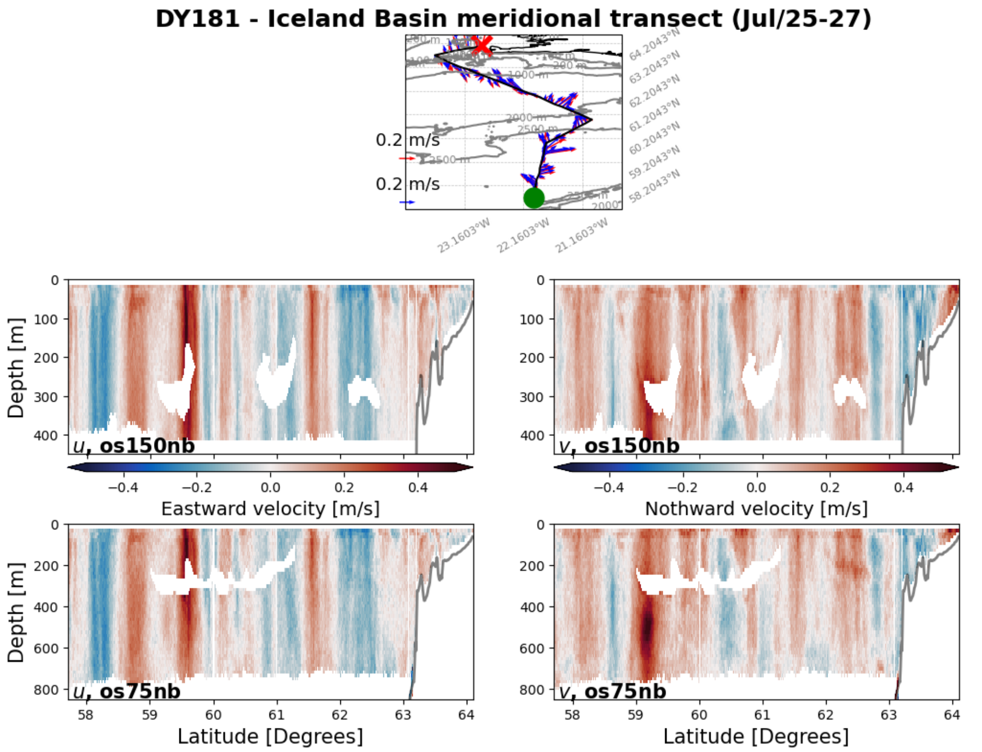


Figure 64: Same as Figure 61, but for the meridional transit segment in the Iceland Basin

APPENDIX H SUMMARY OF CTD STATION NUMBERS, DATES, POSITIONS, DEPTH

	Time Start	Latitude	Longitude	Water	Niskins	Salts	Oxygens	Nutrients	Carbon
CTD cas	Time Bottom	deg min	deg min	Depth (m)					
	Time End								
	24/07/03 1912								
1	24/07/03 1917	57 23.888 N	001 20.569 W	117	2	12	4	0	0
	24/07/03 1928								
	24/07/04 1823								
2	24/07/04 1837	59 42.772 N	006 38.107 W	614	6	6	0	0	0
	24/07/04 1955								
	24/07/04 2153								
3	24/07/04 2213	59 48.188 N	006 55.939 W	1037	11	0	0	0	0
	24/07/04 2254								
	24/07/06 0655								
4	24/07/06 0738	57 13.907 N	010 02.938 W	2102	0	0	0	0	0
	24/07/06 0915								
	24/07/06 0951								
5	24/07/06 1032	57 13.907 N	010 02.938 W	2101	12	11	12	12	9
	24/07/06 1231								
	24/07/07 1611								
6	24/07/07 1618	56 48.509 N	008 09.937 W	129	7	6	4	6	0
	24/07/07 1631								
	24/07/07 1728								
7	24/07/07 1734	56 50.246 N	008 19.818 W	134	5	5	5	5	0
	24/07/07 1743								
	24/07/07 1844								
8	24/07/07 1849	56 52.999 N	008 29.862 W	129	6	6	6	5	0
	24/07/07 1900								
	24/07/07 2030								
9	24/07/07 2035	56 57.053 N	008 47.030 W	128	7	7	6	7	0
	24/07/07 2046								
	24/07/08 2000								
10	24/07/08 2011	57 06.013 N	009 16.736 W	415	0	0	0	0	0

CTD cas	Time Start Time Bottom Time End	Latitude deg min	Longitude deg min	Water Depth (m)	Niskins	Salts	Oxygens	Nutrients	Carbon
	24/07/08 2020								
	24/07/08 2024								
11	24/07/08 2036	57 06.013 N	009 16.736 W	415	0	0	0	0	0
	24/07/08 2044								
	24/07/08 2047								
12	24/07/08 2100	57 06.013 N	009 16.736 W	415	0	0	0	0	0
	24/07/08 2111								
	24/07/08 2114								
13	24/07/08 2127	57 06.010 N	009 16.740 W	415	0	0	0	0	0
	24/07/08 2136								
	24/07/08 2138								
14	24/07/08 2151	57 06.013 N	009 16.736 W	414	0	0	0	0	0
	24/07/08 2200								
	24/07/08 2201								
15	24/07/08 2212	57 06.010 N	009 16.740 W	415	0	0	0	0	0
	24/07/08 2221								
	24/07/08 2223								
16	24/07/08 2233	57 06.012 N	009 16.736 W	414	0	0	0	0	0
	24/07/08 2242								
	24/07/08 2243								
17	24/07/08 2254	57 06.013 N	009 16.736 W	414	0	0	0	0	0
	24/07/08 2304								
	24/07/08 2307								
18	24/07/08 2319	57 06.010 N	009 16.740 W	414	0	0	0	0	0
	24/07/08 2330								
	24/07/08 2332								
19	24/07/08 2344	57 06.010 N	009 16.740 W	414	0	0	0	0	0
	24/07/08 2353								
	24/07/08 2355								
20	24/07/09 0008	57 06.012 N	009 16.735 W	413	0	0	0	0	0

CTD cas	Time Start Time Bottom Time End	Latitude deg min	Longitude deg min	Water Depth (m)	Niskins	Salts	Oxygens	Nutrients	Carbon
	24/07/09 0018								
	24/07/09 0020								
21	24/07/09 0032	57 06.013 N	009 16.736 W	413	0	0	0	0	0
	24/07/09 0043								
	24/07/09 0044								
22	24/07/09 0056	57 06.013 N	009 16.735 W	413	0	0	0	0	0
	24/07/09 0106								
	24/07/09 0108								
23	24/07/09 0119	57 06.013 N	009 16.736 W	413	0	0	0	0	0
	24/07/09 0129								
	24/07/09 0130								
24	24/07/09 0142	57 06.012 N	009 16.735 W	413	0	0	0	0	0
	24/07/09 0153								
	24/07/09 0210								
25	24/07/09 0223	57 06.012 N	009 16.736 W	412	0	0	0	0	0
	24/07/09 0233								
	24/07/09 0234								
26	24/07/09 0246	57 06.012 N	009 16.736 W	413	0	0	0	0	0
	24/07/09 0255								
	24/07/09 0256								
27	24/07/09 0308	57 06.012 N	009 16.736 W	412	0	0	0	0	0
	24/07/09 0318								
	24/07/09 0319								
28	24/07/09 0330	57 06.013 N	009 16.735 W	412	0	0	0	0	0
	24/07/09 0340								
	24/07/09 0341								
29	24/07/09 0353	57 06.012 N	009 16.735 W	412	0	0	0	0	0
	24/07/09 0403								
	24/07/09 0405								
30	24/07/09 0416	57 06.012 N	009 16.735 W	412	0	0	0	0	0

CTD cas	Time Start / Time Bottom / Time End	Latitude deg min	Longitude deg min	Water Depth (m)	Niskins	Salts	Oxygens	Nutrients	Carbon
	24/07/09 0426								
	24/07/09 0427								
31	24/07/09 0438	57 06.012 N	009 16.735 W	413	0	0	0	0	0
	24/07/09 0447								
	24/07/09 0449								
32	24/07/09 0500	57 06.012 N	009 16.735 W	413	0	0	0	0	0
	24/07/09 0509								
	24/07/09 0513								
33	24/07/09 0524	57 06.012 N	009 16.735 W	413	0	0	0	0	0
	24/07/09 0535								
	24/07/09 1150								
34	24/07/09 1156	56 57.007 N	008 47.005 W	126	7	7	6	7	0
	24/07/09 1210								
	24/07/09 1332								
35	24/07/09 1342	56 59.960 N	008 59.800 W	133	8	8	4	8	0
	24/07/09 1400								
	24/07/09 1507								
36	24/07/09 1519	57 03.078 N	009 13.133 W	316	9	8	6	8	0
	24/07/09 1538								
	24/07/09 1702								
37	24/07/09 1733	57 06.055 N	009 25.116 W	1422	11	11	10	11	7
	24/07/09 1812								
	24/07/09 1944								
38	24/07/09 2021	57 08.993 N	009 42.023 W	1927	12	12	12	12	0
	24/07/09 2106								
	24/07/09 2302								
39	24/07/09 2347	57 13.894 N	010 02.857 W	2101	12	12	12	10	0
	24/07/10 0047								
	24/07/10 0337								
40	24/07/10 0413	57 05.248 N	009 32.887 W	1794	6	6	6	3	3

	Time Start	Latitude	Longitude	Water	Niskins	Salts	Oxygens	Nutrients	Carbon
CTD cas	Time Bottom	deg min	deg min	Depth (m)					
	Time End								
	24/07/10 0503								
	24/07/10 1744								
41	24/07/10 1820	57 06.239 N	009 35.521 W	1829	12	12	6	12	3
	24/07/10 1908								
	24/07/10 2220								
42	24/07/10 2306	57 18.073 N	010 22.894 W	2209	12	12	11	12	7
	24/07/11 0002								
	24/07/11 0136								
43	24/07/11 0217	57 22.021 N	010 39.985 W	2113	12	12	12	12	9
	24/07/11 0318								
	24/07/11 0439								
44	24/07/11 0456	57 23.941 N	010 51.989 W	786	8	7	5	7	0
	24/07/11 0527								
	24/07/11 0647								
45	24/07/11 0702	57 26.880 N	011 05.130 W	586	7	7	6	0	0
	24/07/11 0730								
	24/07/11 2112								
46	24/07/11 2154	57 29.000 N	011 31.910 W	2015	12	12	12	12	9
	24/07/11 2347								
	24/07/12 0107								
47	24/07/12 0126	57 28.102 N	011 19.039 W	746	7	7	7	7	0
	24/07/12 0154								
	24/07/12 0416								
48	24/07/12 0451	57 29.544 N	011 50.928 W	1789	12	10	12	12	1
	24/07/12 0549								
	24/07/12 1819								
49	24/07/12 1854	57 30.433 N	012 14.720 W	1801	12	12	11	12	8
	24/07/12 1955								
	24/07/12 2142								
50	24/07/12 2217	57 31.711 N	012 37.736 W	1646	11	11	10	11	0

CTD cas	Time Start / Time Bottom / Time End	Latitude deg min	Longitude deg min	Water Depth (m)	Niskins	Salts	Oxygens	Nutrients	Carbon
	24/07/12 2317								
	24/07/13 0038								
51	24/07/13 0102	57 32.533 N	012 51.962 W	1099	8	7	7	7	6
	24/07/13 0136								
	24/07/13 0231								
52	24/07/13 0242	57 32.927 N	012 59.726 W	297	7	7	5	7	0
	24/07/13 0303								
	24/07/13 0433								
53	24/07/13 0439	57 34.028 N	013 19.889 W	176	6	6	6	6	0
	24/07/13 0455								
	24/07/13 0622								
54	24/07/13 0628	57 34.990 N	013 37.900 W	112	0	0	0	0	0
	24/07/13 0633								
	24/07/13 0926								
55	24/07/13 0933	57 35.581 N	014 16.181 W	197	6	6	6	6	0
	24/07/13 0949								
	24/07/13 1220								
56	24/07/13 1234	57 36.293 N	014 53.858 W	476	7	7	6	7	0
	24/07/13 1253								
	24/07/13 1532								
57	24/07/13 1554	57 36.860 N	015 31.730 W	1055	8	6	8	8	7
	24/07/13 1637								
	24/07/13 1919								
58	24/07/13 1945	57 37.468 N	016 09.968 W	1171	8	5	8	0	0
	24/07/13 2018								
	24/07/13 2245								
59	24/07/13 2309	57 38.190 N	016 47.910 W	1195	8	8	8	8	0
	24/07/13 2348								
	24/07/14 2151								
60	24/07/14 2220	57 38.860 N	017 25.940 W	1223	8	8	8	8	8

CTD cas	Time Start Time Bottom Time End	Latitude deg min	Longitude deg min	Water Depth (m)	Niskins	Salts	Oxygens	Nutrients	Carbon
	24/07/14 2305								
	24/07/15 0142								
61	24/07/15 0207	57 39.443 N	018 03.679 W	1060	8	8	8	7	0
	24/07/15 0249								
	24/07/15 0533								
62	24/07/15 0551	57 39.930 N	018 41.876 W	711	7	7	7	6	0
	24/07/15 0620								
	24/07/15 1543								
63	24/07/15 1604	57 43.771 N	019 13.657 W	910	8	8	8	7	5
	24/07/15 1644								
	24/07/15 1851								
64	24/07/15 1917	57 47.521 N	019 44.758 W	1304	10	10	10	7	0
	24/07/15 1952								
	24/07/15 2149								
65	24/07/15 2222	57 50.426 N	020 08.097 W	1542	9	11	10	10	8
	24/07/15 2330								
	24/07/16 0350								
66	24/07/16 0445	57 58.867 N	021 10.014 W	2949	12	12	3	11	9
	24/07/16 0655								
	24/07/16 1607								
67	24/07/16 1701	57 57.258 N	021 11.830 W	2944	12	12	12	12	1
	24/07/16 1933								
	24/07/16 2118								
68	24/07/16 2158	57 54.679 N	020 51.107 W	1991	12	12	12	12	1
	24/07/16 2303								
	24/07/17 0054								
69	24/07/17 0138	57 52.703 N	020 29.825 W	2245	12	12	12	12	9
	24/07/17 0245								
	24/07/17 1340								
70	24/07/17 1433	57 58.890 N	021 07.724 W	2857	12	11	3	11	1

CTD cas	Time Start Time Bottom Time End	Latitude deg min	Longitude deg min	Water Depth (m)	Nisk ins	Salt s	Oxyg ens	Nutrie nts	Carbon
	24/07/17 1547								
	24/07/17 1826								
71	24/07/17 1921	57 57.473 N	021 51.402 W	3017	12	12	12	11	11
	24/07/17 2101								
	24/07/17 2344								
72	24/07/18 0045	57 57.449 N	022 30.784 W	2983	12	12	11	12	0
	24/07/18 0219								
	24/07/18 1931								
73	24/07/18 2024	57 58.832 N	025 40.484 W	2714	12	12	12	12	1
	24/07/18 2137								
	24/07/19 0009								
74	24/07/19 0102	57 58.424 N	025 00.763 W	2750	12	12	11	12	0
	24/07/19 0224								
	24/07/19 0435								
75	24/07/19 0528	57 57.680 N	024 29.230 W	2827	12	12	12	12	9
	24/07/19 0645								
	24/07/19 0916								
76	24/07/19 1009	57 57.536 N	023 50.058 W	2936	12	12	11	12	0
	24/07/19 1249								
	24/07/19 1539								
77	24/07/19 1634	57 58.034 N	023 11.327 W	2989	12	12	10	12	11
	24/07/19 1759								
	24/07/20 0105								
78	24/07/20 0156	57 57.680 N	021 03.239 W	2658	0	0	0	0	0
	24/07/20 0359								
	24/07/20 0451								
79	24/07/20 0537	57 56.570 N	020 56.100 W	2247	0	0	0	0	0
	24/07/20 0622								
	24/07/20 2040								
80	24/07/20 2123	57 54.238 N	020 42.032 W	2112	4	0	4	0	0

CTD cas	Time Start / Time Bottom / Time End	Latitude deg min	Longitude deg min	Water Depth (m)	Niskins	Salts	Oxygens	Nutrients	Carbon
	24/07/20 2312								
	24/07/21 0009								
81	24/07/21 0143	57 53.657 N	020 34.938 W	2372	0	0	0	0	0
	24/07/21 0230								
	24/07/21 0336								
82	24/07/21 0418	57 52.188 N	020 20.717 W	2134	0	0	0	0	0
	24/07/21 0500								
	24/07/21 2012								
83	24/07/21 2050	57 51.073 N	020 14.765 W	1797	2	12	12	0	0
	24/07/21 2129								
	24/07/22 0043								
85	24/07/22 0112	57 48.602 N	019 55.709 W	1395	0	0	0	0	0
	24/07/22 0140								
	24/07/22 0300								
86	24/07/22 0326	57 46.730 N	019 38.384 W	1199	0	0	0	0	0
	24/07/22 0350								
	24/07/22 0442								
87	24/07/22 0506	57 45.580 N	019 29.990 W	995	0	0	0	0	0
	24/07/22 0527								
	24/07/23 1956								
88	24/07/23 2052	57 40.018 N	024 00.011 W	2883	19	19	20	0	0
	24/07/23 2216								
	24/07/23 2359								
89	24/07/24 0053	57 40.020 N	023 49.060 W	2906	19	19	16	0	0
	24/07/24 0219								
	24/07/24 0355								
90	24/07/24 0450	57 40.003 N	023 37.955 W	2943	19	18	8	0	0
	24/07/24 0622								
	24/07/24 0759								
91	24/07/24 0857	57 40.024 N	023 27.162 W	2981	19	17	20	0	0

	Time Start	Latitude	Longitude	Water	Nisk ins	Salt s	Oxyg ens	Nutrie nts	Carbon
CTD cas	Time Bottom	deg min	deg min	Depth (m)					
	Time End								
	24/07/24 1034								
	24/07/24 1158								
92	24/07/24 1254	57 39.997 N	023 16.387 W	3000	19	19	23	0	0
	24/07/24 1427								
	24/07/24 1618								
93	24/07/24 1711	57 40.026 N	023 05.402 W	3000	19	19	23	0	0
	24/07/24 1829								
	24/07/24 2019								
94	24/07/24 2114	57 39.990 N	022 54.510 W	2998	19	8	12	0	0
	24/07/24 2231								
	24/07/24 2351								
95	24/07/25 0047	57 40.000 N	022 43.570 W	3012	19	7	11	0	0
	24/07/25 0224								
	24/07/25 0338								
96	24/07/25 0433	57 40.000 N	022 32.710 W	3012	23	9	12	0	0
	24/07/25 0611								
	24/07/25 0737								
97	24/07/25 0833	57 40.000 N	022 21.800 W	3009	19	10	10	0	0
	24/07/25 1008								
	24/07/25 1141								
98	24/07/25 1238	57 40.008 N	022 10.870 W	3014	22	10	12	0	0
	24/07/25 1432								
	24/07/25 1619								
99	24/07/25 1732	57 40.006 N	021 59.947 W	NaN	0	0	0	0	0
	24/07/25 1814								
	24/07/25 1837								
100	24/07/25 1935	57 39.935 N	021 59.946 W	3065	19	10	9	0	0
	24/07/25 2112								
	24/07/26 1137								
101	24/07/26 1227	60 00.014 N	021 46.542 W	2722	0	0	0	0	0

	Time Start	Latitude	Longitude	Water	Nisk ins	Salt s	Oxyg ens	Nutrie nts	Carbon
CTD cas	Time Bottom	deg min	deg min	Depth (m)					
	Time End								
	24/07/26 1317								

APPENDIX I SUMMARY OF CALIBRATION DIPS

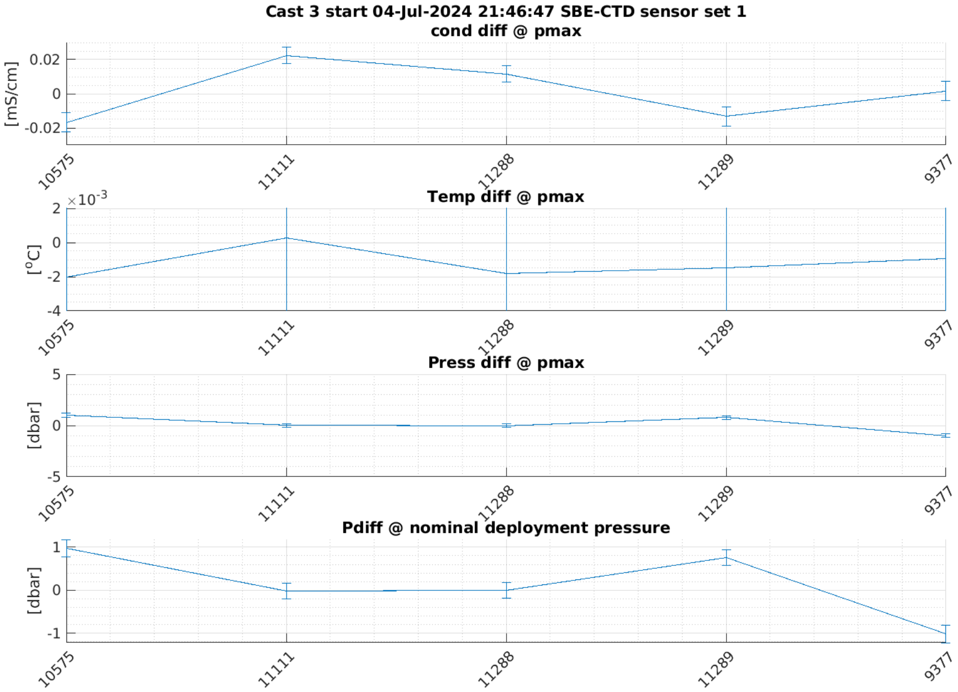
Caldip No	1		2			3		4		
CTD cast	3		4			5		46		
Station	CALDIP pre DM		N			N		H		
Depth (m)	1000		2100			2100		2000		
Stops (m)	1000		2090, 1500, 1000, 500, 100			2090, 1600, 945, 500, 50		2000, 1600,1400, 950, 500, 100		
Start datetime	04-Jul-24 21:52 UTC		06-Jul-24 06:53 UTC			06-Jul-24 09:49 UTC		Thu 11-Jul-24 21:09 UTC		
	S/N	To deploy DY181	S/N	Recovered DY181	To deploy DY181	S/N	To deploy DY181	S/N	Recovered DY181	To deploy DY181
Slot 1	9377	DM	10561			IMP-3279	EB1	4608 (SAMS)	EB1	
Slot 2	11111	DM	10559		WB1	IMP-3280	EB1	4609 (SAMS)	EB1	
Slot 3	10575	*spare DM*	14367		WB2	IMP-3795	EB1	4610 (SAMS)	EB1	
Slot 4	11288	*spare DM*	10575		RHADCP	IMP-3889	EB1	13019	EB1	
Slot 5	11289	*spare DM*	11288			IMP-4061	EB1	10578	EB1	IB5
Slot 6			11289		WB2	IMP-4073	EB1	10579	EB1	IB5
Slot 7			11290			IMP-4460	EB1	13021	EB1	
Slot 8			11320		WB1	IMP-4463	EB1	14368	EB1	IB4
Slot 9			11323		WB1	IMP-4465	EB1	13022	EB1	IB4
Slot 10			11326		WB1	IMP-4798	EB1	ODO-14149 (RAPID)	EB1	
Slot 11			11328		WB1	IMP-5989 (RAPID)	TelemTest	ODO-21317	EB1	
Slot 12			11329		WB1	IMP-7362 (RAPID)	TelemTest	ODO-15254	EB1	IB4
Slot 13			10562		WB1	ODO-21318		ODO-24104	EB1	IB4
Slot 14			11332		IB5	ODO-15298	EB1	7290	WB2	IB4
Slot 15			11339			ODO-15476	EB1	3244 (RAPID)	WB2	
Slot 16			11343		IB5	ODO-14987	EB1	3231 (RAPID)	WB2	
Slot 17			13020			ODO-21320	EB1			
Slot 18			14353		IB5	ODO-21560	IB4			
Slot 19			14354		IB5	ODO-21319	IB4			
Slot 20			14366		IB5	ODO-12900				
Slot 21			14355		WB2					
Slot 22			14356		WB1					
Slot 23			11109	DM	WB1					
Slot 24			10577	DM						

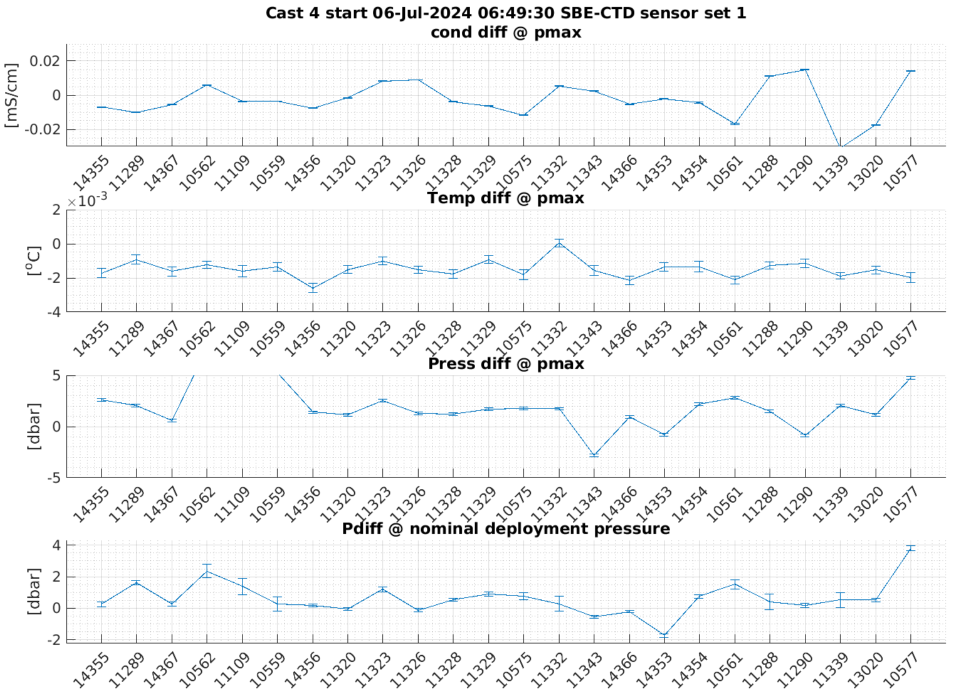
Caldip No	5	6	7	8

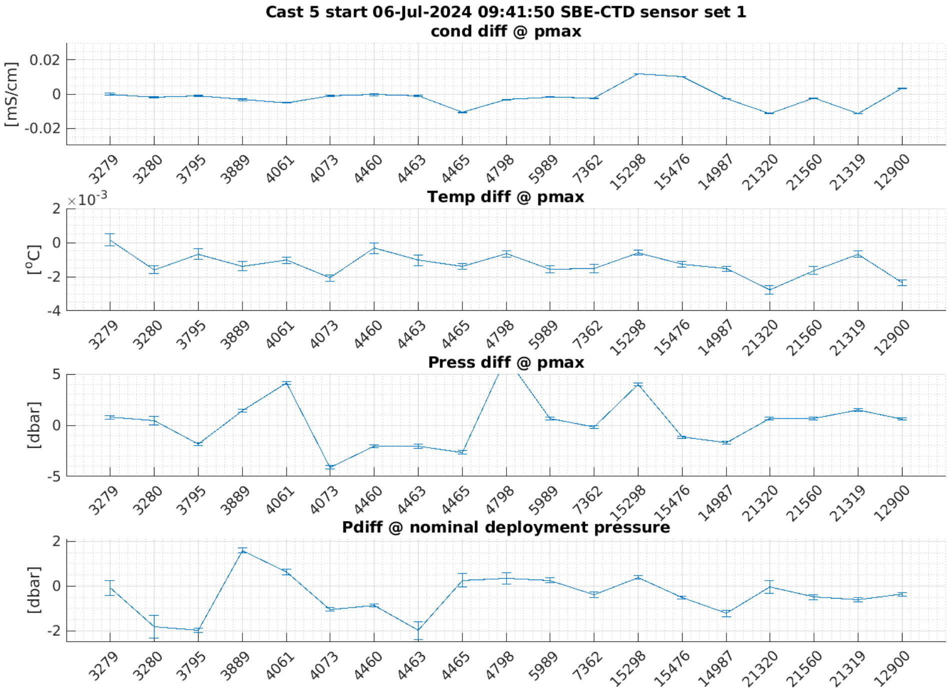
CTD cast	**63**		**66**			**67**			**76**	
Station	**O18**		**IB4 pre-recov**			**O23**			**O27**	
Depth (m)	**910m**		**3000**			**3000**			**3000**	
Stops (m)	**500**		**3000, 2000, 1000, 500, 100, 50**			**3000, 2300, 2000, 1500, 1000, 700, 500, 350, 80**			**3000, 2500, 2000, 1500, 1000, 700, 500, 250, 120**	
Start datetime	**15-Jul-24 15:42 UTC**		**16-Jul-24 03:48 UTC**			**16-Jul-24 16:04 UTC**			**19-Jul-24 09:14 UTC**	
	S/N	**Recovered DY181**	**S/N**	**Recovered DY181**	**To deploy DY181**	**S/N**	**Recovered DY181**	**To deploy DY181**	**S/N**	**Recovered DY181**
Slot 1	9140 (SAMS)	EB1	11321	WB1		ODO-12906	IB4		14364	IB3
Slot 2			11324	WB1	IB4	ODO-12908	IB4		11341	IB3
Slot 3			11325	WB1	IB4	ODO-12962	IB4		11342	IB3
Slot 4			11336	WB1	IB4	ODO-13000	IB4		10560	IB3
Slot 5			11340	WB1		3221 (RAPID)	IB4		11110	IB3
Slot 6			3254 (RAPID)	WB1		11330	IB4		11140	IB3
Slot 7			3256 (RAPID)	WB1		3224 (RAPID)	IB4		11322	IB3
Slot 8			3257 (RAPID)	WB1		3253 (RAPID)	IB4		11327	IB3
Slot 9			3276 (RAPID)	WB1		3248 (RAPID)	IB4		11139	IB3
Slot 10			9378	RHADCP	IB4	11334	IB4		11137	IB3
Slot 11			3212 (RAPID)	IB5		9375	IB4	IB4	10576	IB3
Slot 12			3213 (RAPID)	IB5		9390	IB4	IB4	11338	IB3
Slot 13			3219 (RAPID)	IB5		9396	IB4		3257	WB1
Slot 14			6115	IB5	IB4	11335	IB4		3276	WB1
Slot 15			3207 (RAPID)	IB5		3222 (RAPID)	IB4			
Slot 16			3264 (RAPID)	IB5		14365	IB4			
Slot 17			6123	IB5	IB4	3257	WB1			
Slot 18						3276	WB1			
Slot 19						11340	WB1	IB4		
Slot 20										

Note: some instruments were cal-dipped twice, either as backups for an earlier mooring or when the CTD stops at the first caldip were too far away from the planned deployment depth.

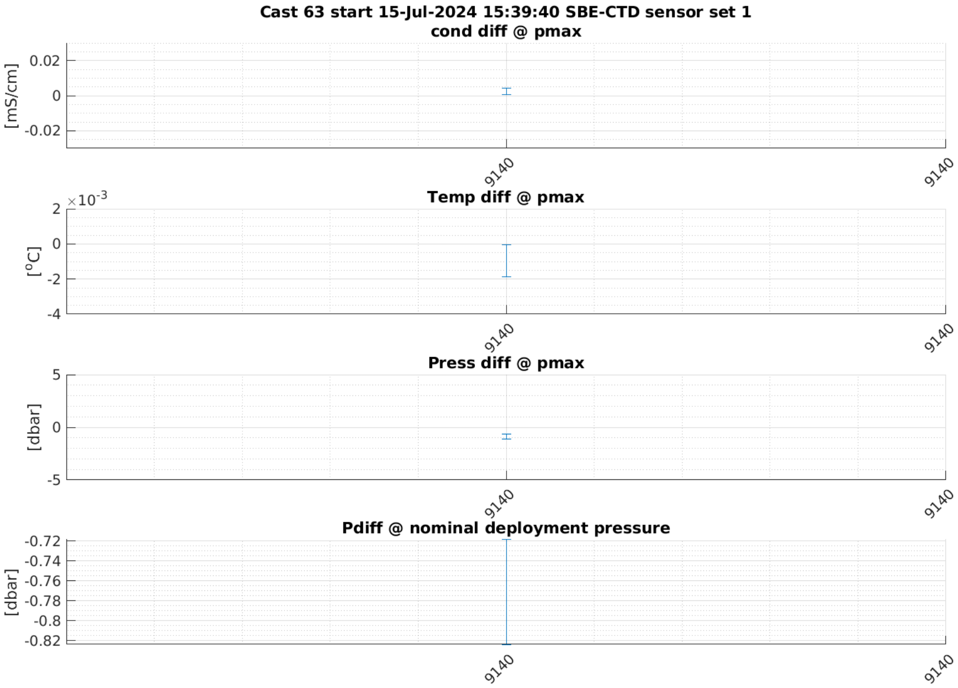
APPENDIX J CALIBRATION DIPS SUMMARY PLOTS



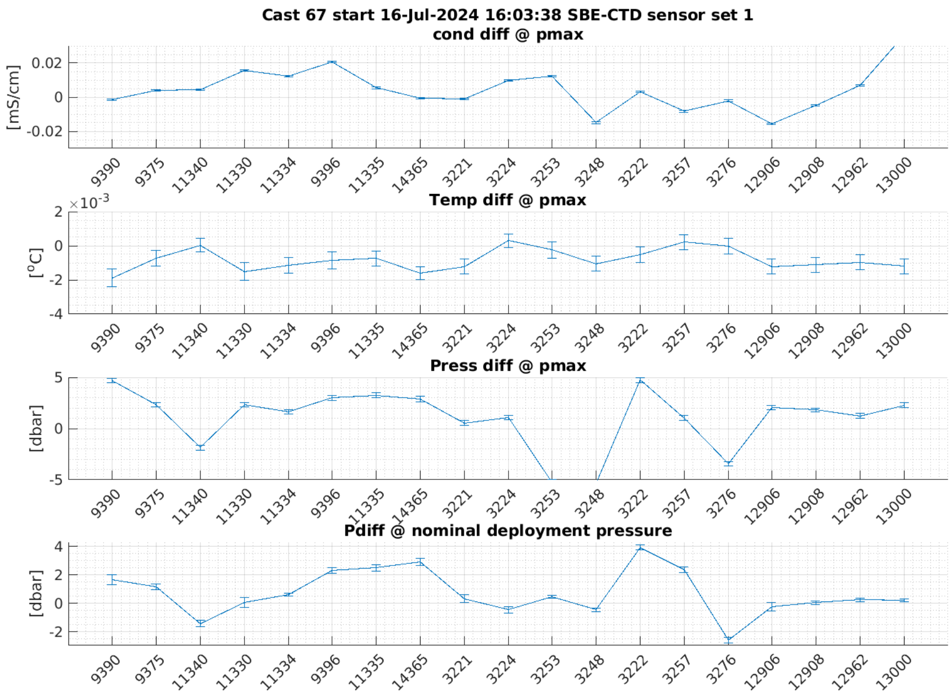


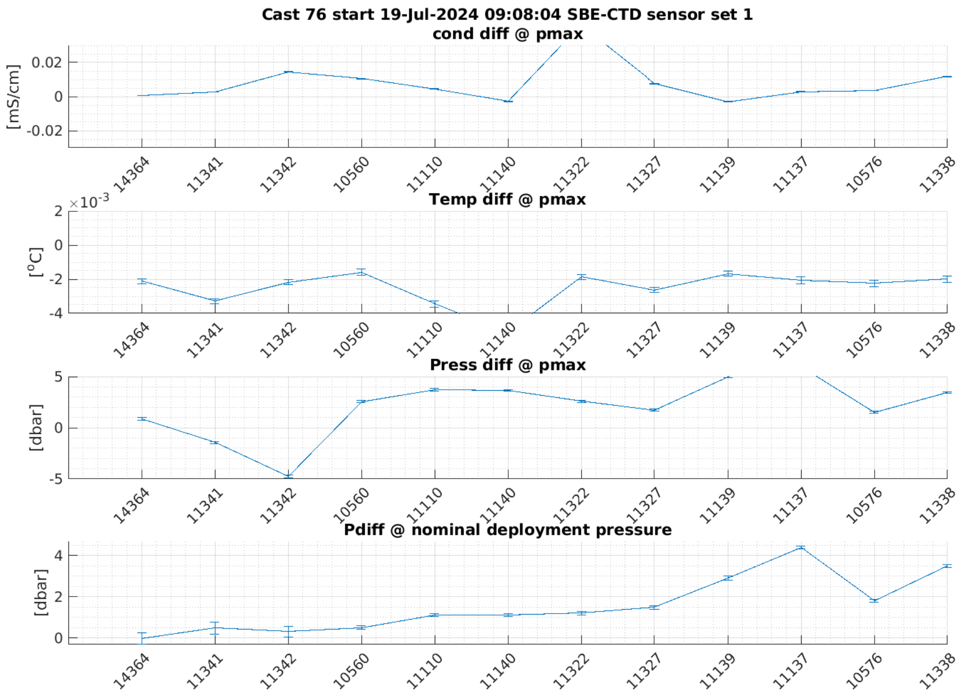

Cast 5 start 06-Jul-2024 09:41:50 SBE-CTD sensor set 1
cond diff @ pmax
[mS/cm]
Temp diff @ pmax
[°C]
$\times10^{-3}$
Press diff @ pmax
[dbar]
Pdiff @ nominal deployment pressure
[dbar]
3279 3280 3795 3889 4061 4073 4460 4463 4465 4798 5989 7362 15298 15476 14987 21320 21560 21319 12900


Cast 46 start 11-Jul-2024 21:08:53 SBE-CTD sensor set 1
cond diff @ pmax
[mS/cm]
Temp diff @ pmax
[°C]
$\times10^{-3}$
Press diff @ pmax
[dbar]
Pdiff @ nominal deployment pressure
[dbar]
10578 10579 14368 7290 13021 13022 24104 14149 21317 15254 4608 4609 4610 13019 3244 3231


Cast 63 start 15-Jul-2024 15:39:40 SBE-CTD sensor set 1
cond diff @ pmax
[mS/cm]
Temp diff @ pmax
[°C]
Press diff @ pmax
[dbar]
Pdiff @ nominal deployment pressure
[dbar]
9140


Cast 66 start 16-Jul-2024 03:43:57 SBE-CTD sensor set 1
cond diff @ pmax
[mS/cm]
Temp diff @ pmax
[°C]
Press diff @ pmax
[dbar]
Pdiff @ nominal deployment pressure
[dbar]
11321 11324 11325 11336 11340 9378 6115 6123 3254 3256 3257 3276 3212 3213 3219 3207 3264





APPENDIX K MICROCAT-IMP CTDS. DEPLOYED, CALIBRATION DIPS

Note: "good" = temperature offset < +/-0.005°C
conductivity offset < +/-0.015 mS/cm
pressure offset <5db at deployment depth

SN	Owner	Caldip ref	CTD Cast	Caldip result	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth
3279	NMF	3	5	good	-	-	RTEB1	50
3280	NMF	3	5	good	-	-	RTEB1	100

3795	NMF	3	5	good	-	-	RTEB1	1650
3889	NMF	3	5	good	-	-	RTEB1	1760
4061	NMF	3	5	good	-	-	RTEB1	1005
4073	NMF	3	5	pressure offset 2.7m at planned depth (1000m), moved to 750m	-	-	RTEB1	750
4460	NMF	3	5	good	-	-	RTEB1	1250
4463	NMF	3	5	good	-	-	RTEB1	1500
4465	NMF	3	5	pressure offset 2.7m at planned depth (1650m), moved to 250m	-	-	RTEB1	250
4798	NMF	3	5	pressure offset ~6m at planned depth (1760m), moved to 500m	-	-	RTEB1	500
5989	NMF	3	5	good	-	-	TeleTest	1708
7362	NMF	3	5	good	-	-	TeleTest	1766

APPENDIX L MICROCAT-SMP CTDS. DEPLOYED, RECOVERED, CALIBRATION DIPS

Note: "good" = temperature offset < +/-0.005°C
conductivity offset < +/-0.015 mS/cm
pressure offset <5db at deployment depth

SN	Owner	Caldip ref	CTD Cast	Caldip result (for recovered or planned depth)	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth
11109	NMF	2	4	pressure offset ~3.6db (1000m), good at 100m	DM	950	RTWB1	100
10577	NMF	2	4	pressure offset ~3.6db (1000m), cond offset ~0.017	DM	1025	-	-
4608	SAMS	4	46	good	RTEB1	50	-	-
4609	SAMS	4	46	good	RTEB1	100	-	-
4610	SAMS	4	46	cond offset ~0.025 mS/cm	RTEB1	250	-	-
9140	SAMS	5	63	good	RTEB1	500	-	-
13019	NMF	4	46	cond offset ~0.03 mS/cm	RTEB1	750	-	-
10578	NMF	4	46	good	RTEB1	1005	IB5	105
10579	NMF	4	46	good	RTEB1	1250	IB5	200
13021	NMF	4	46	cond offset ~0.018 mS/cm	RTEB1	1500	-	-
14368	NMF	4	46	good	RTEB1	1650	IB4	350
13022	NMF	4	46	good	RTEB1	1760	IB4	105
7290	NMF	4	46	good	RTWB2	1000	IB4	900
3244	NMF	4	46	good	RTWB2	1575	-	-
3231	NMF	4	46	good	RTWB2	1770	-	-
11321	NMF	6	66	cond offset ~0.034 mS/cm	RTWB1	50	-	-
11324	NMF	6	66	good	RTWB1	100	IB4	700
11325	NMF	6	66	good	RTWB1	250	IB4	200
11336	NMF	6	66	good	RTWB1	500	IB4	1900
11340*	NMF	6 + 7	66, 67	good	RTWB1	750	IB4	2305
3254	NMF	6	66	good	RTWB1	1000	-	-
3256	NMF	6	66	good	RTWB1	1250	-	-
3257*	NMF	6 + 7	66, 67	good	RTWB1	1500	-	-
3276*	NMF	6 + 7	66, 67	pressure offset ~3db (1575m)	RTWB1	1575	-	-
9378	NMF	6	66	good	RHADCP	1000	IB4	1200

SN	Owner	Caldip ref	CTD Cast	Caldip result (for recovered or planned depth)	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth
3212	NMF	6	66	good	IB5	50	-	-
3213	NMF	6	66	good	IB5	105	-	-
3219	NMF	6	66	cond offset ~0.016 mS/cm, pressure offset ~20db at depth	IB5	200	-	-
6115	NMF	6	66	good	IB5	350	IB4	2800
3207	NMF	6	66	good	IB5	500	-	-
3264	NMF	6	66	good	IB5	700	IB4	500
6123	NMF	6	66	good	IB5	920	-	-
3221	NMF	7	67	good	IB4	50	-	-
11330	NMF	7	67	cond offset ~0.020 mS/cm	IB4	100	-	-
3224	NMF	7	67	good	IB4	200	-	-
3253	NMF	7	67	cond offset ~0.015 mS/cm	IB4	350	-	-
3248	NMF	7	67	cond offset ~0.015 mS/cm	IB4	500	-	-
11334	NMF	7	67	cond offset ~0.015 mS/cm	IB4	700	-	-
9375	NMF	7	67	good	IB4	900	IB4	1500
9390	NMF	7	67	good for T&C, pressure offset at depth but ok at 50m	IB4	1200	IB4	50
9396	NMF	7	67	cond offset ~0.020 mS/cm	IB4	1500	-	-
11335	NMF	7	67	good	IB4	1900	-	-
3222	NMF	7	67	pressure offset ~4db (2300m)	IB4	2300	-	-
14365	NMF	7	67	good	IB4	2800	-	-
14364	NMF	8	76	good	IB3	50	-	-
11341	NMF	8	76	good	IB3	100	-	-
11342	NMF	8	76	cond offset potentially ~0.040 mS/cm? (noisy data at that stop)	IB3	200	-	-
10560	NMF	8	76	good	IB3	350	-	-
11110	NMF	8	76	cond offset ~0.015 mS/cm	IB3	500	-	-
11140	NMF	8	76	good	IB3	700	-	-
11322	NMF	8	76	cond offset ~0.050 mS/cm	IB3	900	-	-
11327	NMF	8	76	good	IB3	1200	-	-
11139	NMF	8	76	good	IB3	1500	-	-
11137	NMF	8	76	pressure offset ~4db (2000m)	IB3	1900	-	-
10576	NMF	8	76	good	IB3	2300	-	-
11338	NMF	8	76	good	IB3	2800	-	-
10561	NMF	2	4	cond offset ~0.013 mS/cm	-	-	-	-
11290	NMF	2	4	cond offset ~0.015 mS/cm	-	-	-	-
11339	NMF	2	4	cond offset ~0.03 mS/cm	-	-	-	-
13020	NMF	2	4	cond offset ~0.017 mS/cm	-	-	-	-
9377	NMF	1	3	good	-	-	DM	950
11111	NMF	1	3	cond offset ~0.02 mS/cm	-	-	DM	1025
14355	NMF	2	4	good	-	-	RTWB2	1000
11289	NMF	2	4	good	-	-	RTWB2	1575
14367	NMF	2	4	good	-	-	RTWB2	1770
10562	NMF	2	4	pressure offset ~5.5m (1000m), moved to 50m	-	-	RTWB1	50
11288	NMF	2	4	cond offset ~0.015 mS/cm	-	-	RTWB1	100

SN	Owner	Caldip ref	CTD Cast	Caldip result (for recovered or planned depth)	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth
10559	NMF	2	4	pressure offset ~4m (1575m), moved to 250m	-	-	RTWB1	250
14356	NMF	2	4	good	-	-	RTWB1	500
11320	NMF	2	4	good	-	-	RTWB1	750
11323	NMF	2	4	good	-	-	RTWB1	1000
11326	NMF	2	4	good	-	-	RTWB1	1250
11328	NMF	2	4	good	-	-	RTWB1	1500
11329	NMF	2	4	good	-	-	RTWB1	1575
10575	NMF	2	4	good	-	-	RHADCP	1000
11332	NMF	2	4	good	-	-	IB5	50
11343	NMF	2	4	good	-	-	IB5	350
14366	NMF	2	4	good	-	-	IB5	500
14353	NMF	2	4	good	-	-	IB5	700
14354	NMF	2	4	good	-	-	IB5	920

* First caldip nearest stop over 300m away from deployed depth, caldipped again.

APPENDIX M MICROCAT-SMP ODO CTDS. DEPLOYED, RECOVERED, CALIBRATION DIPS

Note: “good” = temperature offset < +/-0.005°C
conductivity offset < +/-0.015 mS/cm
pressure offset <5db at deployment depth

SN	Owner	Caldip ref	CTD cast	Caldip result (CT only)	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth	Comments
14149	NMF	4	46	good	RTEB1 (SeapHOx)	50	-	-	
21317	SAMS	4	46	good	RTEB1	500	-	-	Oxygen sensor failure in Apr24, oxygen sensor thermistor failure in Feb23 (first 7 months of data ok, next 13 months might be recoverable)
15254	SAMS	4	46	good	RTEB1	750	IB4	50	
24104	SAMS	4	46	good	RTEB1	950	IB4	700	
12906	NMF	7	67	cond offset ~0.015 mS/cm	IB4	50	-	-	Next to sbe37 on mooring
12908	NMF	7	67	good	IB4	350	-	-	Oxygen sensor failure at start of caldip (mooring data ok)
12962	NMF	7	67	good	IB4	500	-	-	
13000	NMF	7	67	cond offset ~0.045 mS/cm	IB4	700	-	-	Next to sbe37 on mooring
21318	SAMS	3	5	no record	-	-	-	-	Sampling failure during calidip, and communication issues after, not deployed
15298	SAMS	3	5	cond offset ~0.015 mS/cm	-	-	RTEB1	500	Next to sbe37 on mooring
15476	SAMS	3	5	cond offset ~0.015 mS/cm	-	-	RTEB1	750	Next to sbe37 on mooring
14987	SAMS	3	5	good	-	-	RTEB1	950	
21320	SAMS	3	5	good	-	-	RTEB1 (SeapHOx)	50	
21560	SAMS	3	5	good	-	-	IB4	350	
21319	SAMS	3	5	good	-	-	IB4	500	
12900	NMF	3	5	good	-	-	-	-	Not calibrated since 2014, and oxygen values during caldip offset from the others. Turned around an ODO recovered form RTEB1 instead of deploying this one.

APPENDIX N SEAFETS. DEPLOYED, RECOVERED

SN	Owner	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth
2002	NMF	RTEB1	50	-	-
2061	SAMS	-	-	RTEB1	50

APPENDIX O SEABIRD 16PLUS CTD & SUNA CTD. DEPLOYED, CALIBRATION DIPS

Instrument	SN	Owner	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth
SUNA	1540	NOCL	-	-	RTEB1	200
SBE16plus	50388	NOCL	-	-	RTEB1	200

APPENDIX P NORTEK 55KHZ ADCP. DEPLOYED, RECOVERED

SN	Owner	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth
200044	NMF?	RHADCP	1000	RHADCP	1000

APPENDIX Q WORK-HORSE 300 KHZ ADCPS. DEPLOYED, RECOVERED

SN	Owner	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth	Comments
24170	NMF	DM - D	1000	-	-	
20959	NMF	IB5 - D	100	-	-	
20957	NMF	IB5 - U	100	-	-	One transducer head missing, partially flooded. First 3.4 days data recovered.
24589	NMF	IB4 - D	100	-	-	Pressure sensor missing, flooded. No data recovered.
20960	NMF	IB4 - U	100	-	-	
24587	NMF	IB3 - D	100	-	-	Flooded. No data recovered.
24588	NMF	IB3 - U	100	-	-	
22790	NMF	-	-	DM - D	1000	
20958	NMF	-	-	IB5 - U	100	
20961	NMF	-	-	IB5 - D	100	
24840	NMF	-	-	IB4 - U	100	
24839	NMF	-	-	IB4 - D	100	

APPENDIX R NORTEK CURRENT METERS. DEPLOYED, RECOVERED

SN	Owner	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth	Comments
11034	NMF	RTEB1	100	-	-	
8364	NMF	RTEB1	250	-	-	
6242	NMF	RTEB1	500	-	-	
9822	NMF	RTEB1	1000	-	-	
9853	NMF	RTEB1	1350	-	-	
6273	NMF	RTEB1	1770	-	-	Compass data suspicious, all data probably bad
11026	NMF	IB3	1500	-	-	
11028	NMF	IB3	2300	-	-	
11029	NMF	IB3	2800	-	-	
11021	NMF	IB4	1500	-	-	Flooded, no data recovered

SN	Owner	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth	Comments
11979	NMF	IB4	2300	-	-	
12047	NMF	IB4	2800	-	-	
11990	NMF	IB5	500	-	-	
11992	NMF	IB5	925	-	-	
8120	NMF	RTWB1	100	-	-	
9881	NMF	RTWB1	500	-	-	
9213	NMF	RTWB1	1000	-	-	
11997	NMF	RTWB1	1350	-	-	
9874	NMF	RTWB1	1600	-	-	
6276	NMF	RTWB2	1000	-	-	
6534	NMF	RTWB2	1350	-	-	
6723	NMF	RTWB2	1770	-	-	
11023	NMF	-	-	RTEB1	95	
11042	NMF	-	-	RTEB1	245	
11046	NMF	-	-	RTEB1	495	
11047	NMF	-	-	RTEB1	1000	
11048	NMF	-	-	RTEB1	1350	
11051	NMF	-	-	RTEB1	1775	
8465	NMF	-	-	TelemTest	n/a	Not working, not deployed
11055	NMF	-	-	RTWB2	1000	
11058	NMF	-	-	RTWB2	1350	
11063	NMF	-	-	RTWB2	1765	
11064	NMF	-	-	RTWB1	95	
11067	NMF	-	-	RTWB1	495	
11069	NMF	-	-	RTWB1	995	
13018	NMF	-	-	RTWB1	1350	
13130	NMF	-	-	RTWB1	1570	
13142	NMF	-	-	IB5	505	
13558	NMF	-	-	IB5	925	
13513	NMF	-	-	IB4	1495	
13555	NMF	-	-	IB4	2300	
9861	NMF	-	-	IB4	2795	

APPENDIX S IRIDIUM & LIGHT BEACONS. DEPLOYED, RECOVERED

Beacon type	SN	IMEI	Owner	Recovered DY181	Buoy depth	Deployed DY181	Buoy depth
Iridium	**B11-041**	300234060475980	NMF	RTWB2	1000	-	-
Iridium	**B11-042**	300234060477980	NMF	RTEB1	500	-	-
Iridium	**B11-043**	?	NMF	DMLTM	1000	-	-
Iridium	**B11-046**	300234060475990	NMF	IB4	100	-	-
Iridium	**B11-048**	300234060474980	NMF	RTWB1	500	RHADCP	1050
Iridium	**B11-049**	300234060571000	NMF	RHADCP	1050	-	-
Iridium	**B11-050**	300234060572000	NMF	IB3	100	-	-
Iridium	**B11-052**	300234060573000	NMF	RTWB1	100	-	-
Iridium	**B11-054**	300234060475730	NMF	IB5	100	TeleTest2	2600
Iridium	**B11-055**	300234060570000	NMF	RTEB1	50	RTWB1	500
Iridium	**B11-042**	300234060477980	NMF	-	-	IB5	100
Iridium	**B11-044**	300234060471960	NMF	-	-	RTWB1	100
Iridium	**B11-045**	300234060476980	NMF	-	-	RTWB2	1000
Iridium	**B11-047**	300234060478980	NMF	-	-	DMLTM	1000
Iridium	**B11-052**	300234060573000	NMF	-	-	IB4	100

Iridium	**B11-053**	300234060479980	NMF	-	-	RTEB1	500
Iridium + light	**059**	300434061881140	NMF	-	-	TeleTest1 RTEB1	1725 50
Light	**812-084**	n/a	NMF	-	-	RHADCP	1050
Light	**B11-026**	n/a	NMF	IB5	100	-	-
Light	**B11-027**	n/a	NMF	DMLTM	1000	-	-
Light	**B11-029**	n/a	NMF	IB4	100	-	-
Light	**B11-030**	n/a	NMF	IB3	100	-	-
Light	**B11-033**	n/a	NMF	RTEB1	500	-	-
Light	**B11-034**	n/a	NMF	RTWB1	100	-	-
Light	**B11-035**	n/a	NMF	RTWB2	1000	-	-
Light	**B11-038**	n/a	NMF	RTWB1	500	-	-
Light	**B11-039**	n/a	NMF	RTEB1	50	IB4	100
Light	**B11-040**	n/a	NMF	RHADCP	1050	TeleTest2	2600
Light	**B11-032**	n/a	NMF	-	-	RTWB2	1000
Light	**B11-035**	n/a	NMF	-	-	IB5	100
Light	**B11-036**	n/a	NMF	-	-	RTWB1	100
Light	**Y02-045**	n/a	NMF	-	-	RTEB1	500
Light	**Z08-048**	n/a	NMF	-	-	DMLTM	1000
Light	**Z08-050**	n/a	NMF	-	-	RTWB1	500

APPENDIX T ACOUSTIC RELEASES. DEPLOYED, RECOVERED

SN	Recovered DY181	Recovered depth	Deployed DY181	Deployed depth
1758	DMLTM	1000	-	-
1761	RTEB1	1800	-	-
2000	RTEB1	1800	-	-
2307	RTWB2	1800	-	-
2326	RTWB2	1800	-	-
1754	RTWB1	1600	-	-
2308	RTWB1	1600	-	-
1272	RHADCP	1050	-	-
1753	RHADCP	1050	-	-
1756	IB5	900	TeleTest2	2700
1764	IB5	900	TeleTest2	2700
1757	IB4	2900	-	-
2310	IB4	2900	-	-
2311	IB3	2800	-	-
2330	IB3	2800	-	-
1766	Teletest	1800+2700	-	-
1999	Teletest	1800+2700	-	-
1498	-	-	DMLTM	1000
1766	-	-	TeleTest1, RTEB1	1800, 1800
1999	-	-	TeleTest1, RTEB1	1800, 1800
1759	-	-	RTWB2	1800
2329	-	-	RTWB2	1800
1135	-	-	RTWB1	1600
1614	-	-	RTWB1	1600
1750	-	-	RHADCP	1050
2253	-	-	RHADCP	1050
1765	-	-	IB5	900

2331	-	-	IB5	900
1136	-	-	IB4	2900
1752	-	-	IB4	2900

APPENDIX U MOORING DATA SUMMARY STATISTICS

Basic statistics generated by *stats_table*.m for the mooring RTEB1:

OSNAP Mooring Array.
Simple Statistics for Mooring:- rteb1_07_2022
Mooring deployment - start: 16/07/2022 12:00
end: 10/07/2024 06:50

SN	var	first record	last record	valid records	mean	stdev	min	max
4608	p	16/07/22 12:00	10/07/24 06:00	34789	69.1	11.3	61.6	206.5
	t	16/07/22 12:00	10/07/24 06:00	34785	11.1	0.8	9.7	14.3
	c	16/07/22 12:00	10/07/24 06:00	34773	39.5	0.7	38.0	42.7
11034	p	16/07/22 12:00	10/07/24 06:00	17395	109.9	11.1	103.3	244.6
	t	16/07/22 12:00	10/07/24 06:00	17395	10.8	0.4	9.8	12.8
	u	16/07/22 12:00	10/07/24 06:00	17395	-1.9	10.2	-43.8	35.3
	v	16/07/22 12:00	10/07/24 06:00	17395	6.2	14.9	-54.7	60.7
	spd	16/07/22 12:00	10/07/24 06:00	17395	6.5	9.9	0.2	64.1
	dir	16/07/22 12:00	10/07/24 06:00	17395	107.5	87.1	-72.5	287.4
4609	p	16/07/22 12:00	10/07/24 06:00	34789	119.3	11.1	112.6	253.6
	t	16/07/22 12:00	10/07/24 06:00	34785	10.7	0.4	9.7	12.3
	c	16/07/22 12:00	10/07/24 06:00	34769	39.2	0.4	37.1	40.8
8364	p	16/07/22 12:00	10/07/24 06:00	17395	253.8	10.6	247.2	382.3
	t	16/07/22 12:00	10/07/24 06:00	17395	10.4	0.2	9.4	11.3
	u	16/07/22 12:00	10/07/24 06:00	17395	-1.6	9.1	-36.8	39.7
	v	16/07/22 12:00	10/07/24 06:00	17395	5.7	13.9	-50.5	55.8
	spd	16/07/22 12:00	10/07/24 06:00	17395	6.0	9.4	0.0	57.0
	dir	16/07/22 12:00	10/07/24 06:00	17395	105.5	86.9	-74.5	285.5
4610	p	16/07/22 12:00	10/07/24 06:00	34789	259.8	10.5	253.4	386.9
	t	16/07/22 12:00	10/07/24 06:30	34790	10.4	0.2	9.4	11.3
	c	16/07/22 12:00	10/07/24 06:30	34782	39.0	0.3	38.0	39.9
6242	p	16/07/22 12:00	10/07/24 06:00	17395	511.1	8.6	501.7	611.0
	t	16/07/22 12:00	10/07/24 06:00	17395	9.9	0.3	9.1	10.6
	u	16/07/22 12:00	10/07/24 06:00	17395	-2.4	8.5	-43.0	29.4
	v	16/07/22 12:00	10/07/24 06:00	17395	3.6	12.0	-46.3	47.5
	spd	16/07/22 12:00	10/07/24 06:00	17395	4.3	7.9	0.0	51.1
	dir	16/07/22 12:00	10/07/24 06:00	17395	124.2	91.2	-55.8	304.2
21317	p	16/07/22 12:00	10/07/24 06:01	17395	511.7	7.9	506.5	605.5
	t	16/07/22 12:00	10/07/24 06:01	17395	9.8	0.3	9.0	10.5
	c	16/07/22 12:00	10/07/24 06:01	17394	38.5	0.3	37.7	39.3
	o2	16/07/22 12:00	16/06/24 11:01	15532	238.5	10.8	189.0	279.1
9140	p	16/07/22 12:30	10/07/24 06:00	34788	512.0	7.9	506.8	606.2
	t	16/07/22 12:30	10/07/24 06:00	34788	9.8	0.3	9.0	10.5
	c	16/07/22 12:30	10/07/24 06:00	34788	38.5	0.3	37.7	39.3
13019	p	16/07/22 12:30	10/07/24 06:00	34788	761.5	6.1	757.1	834.7
	t	16/07/22 12:30	10/07/24 06:00	34788	9.0	0.2	7.7	10.2
	c	16/07/22 12:30	10/07/24 06:00	34788	37.8	0.2	36.5	39.0
15254	p	16/07/22 12:00	10/07/24 06:01	17395	762.9	6.1	758.4	835.1
	t	16/07/22 12:00	10/07/24 06:01	17395	9.0	0.2	7.7	10.2
	c	16/07/22 12:00	10/07/24 06:01	17395	37.8	0.2	36.5	39.0
	o2	16/07/22 12:00	10/07/24 06:01	17395	229.1	11.2	197.7	261.1
24104	p	16/07/22 12:00	10/07/24 05:46	13916	964.9	5.0	960.9	1024.3
	t	16/07/22 12:00	10/07/24 05:46	13916	7.7	0.3	6.1	8.7
	c	16/07/22 12:00	10/07/24 05:46	13916	36.6	0.3	35.0	37.6
	o2	16/07/22 14:31	10/07/24 05:46	13914	203.4	4.1	190.7	224.6
9822	p	16/07/22 12:00	10/07/24 06:00	17395	1013.9	4.7	1010.0	1069.8
	t	16/07/22 12:00	10/07/24 06:00	17395	7.3	0.3	5.8	8.5
	u	16/07/22 12:00	10/07/24 06:00	17395	-0.2	7.2	-29.6	28.7
	v	16/07/22 12:00	10/07/24 06:00	17395	0.8	10.5	-35.9	35.6
	spd	16/07/22 12:00	10/07/24 06:00	17395	0.9	6.0	0.0	38.1
	dir	16/07/22 12:00	10/07/24 06:00	17395	106.0	102.8	-74.0	286.0
10578	p	16/07/22 12:30	10/07/24 06:00	34788	1022.2	4.6	1018.4	1077.9
	t	16/07/22 12:30	10/07/24 06:00	34788	7.3	0.3	5.7	8.4
	c	16/07/22 12:30	10/07/24 06:00	34788	36.2	0.3	34.7	37.3
10579	p	16/07/22 12:30	10/07/24 06:00	34788	1271.5	3.3	1268.3	1309.6
	t	16/07/22 12:30	10/07/24 06:00	34788	5.5	0.3	4.6	6.3
	c	16/07/22 12:30	10/07/24 06:00	34788	34.5	0.3	33.6	35.3
9853	p	16/07/22 12:00	10/07/24 06:00	17395	1377.2	2.6	1374.2	1406.7
	t	16/07/22 12:00	10/07/24 06:00	17395	4.8	0.2	4.1	5.6
	u	16/07/22 12:00	10/07/24 06:00	17395	-0.1	5.2	-19.9	21.3
	v	16/07/22 12:00	10/07/24 06:00	17395	0.4	7.8	-27.5	27.5
	spd	16/07/22 12:00	10/07/24 06:00	17395	0.4	4.5	0.0	29.2
	dir	16/07/22 12:00	10/07/24 06:00	17395	103.1	103.6	-76.8	283.1
13021	p	16/07/22 12:30	10/07/24 06:00	34788	1522.2	1.8	1519.4	1540.6
	t	16/07/22 12:30	10/07/24 06:00	34788	4.4	0.1	3.9	4.9
	c	16/07/22 12:30	10/07/24 06:00	34788	33.6	0.1	33.1	34.1
14368	p	16/07/22 12:30	10/07/24 06:00	34788	1676.0	1.2	1673.3	1685.4
	t	16/07/22 12:30	10/07/24 06:00	34788	4.0	0.1	3.7	4.4
	c	16/07/22 12:30	10/07/24 06:00	34788	33.2	0.1	32.9	33.6
13022	p	16/07/22 12:30	10/07/24 06:00	34788	1793.6	0.9	1790.5	1797.1
	t	16/07/22 12:30	10/07/24 06:00	34788	3.8	0.1	3.5	4.1
	c	16/07/22 12:30	10/07/24 06:00	34788	33.1	0.1	32.9	33.4
6273	p	16/07/22 12:00	10/07/24 06:00	17395	1813.9	8.9	1802.3	1834.2
	t	16/07/22 12:00	10/07/24 06:00	17395	3.8	0.1	3.5	4.0
	u	16/07/22 12:00	10/07/24 06:00	17395	-1.1	8.1	-33.7	30.1
	v	16/07/22 12:00	10/07/24 06:00	17395	-1.0	6.6	-29.9	27.7
	spd	16/07/22 12:00	10/07/24 06:00	17395	1.5	4.9	0.0	36.8
	dir	16/07/22 12:00	10/07/24 06:00	17395	-139.9	95.7	-319.8	40.1

Basic statistics generated by *stats_table*.m for the mooring RTWB1:

OSNAP Mooring Array.
Simple Statistics for Mooring:- rtwb1_07_2022
Mooring deployment - start: 19/07/2022 10:30
end: 12/07/2024 09:10

SN	var	first record	last record	valid records	mean	stdev	min	max
11321	p	19/07/22 10:30	12/07/24 09:00	34747	47.1	9.5	39.2	165.9
	t	19/07/22 10:30	12/07/24 09:00	34750	11.3	1.2	9.2	15.3
	c	19/07/22 10:30	12/07/24 09:00	34750	39.7	1.1	37.7	43.7
8120	p	19/07/22 11:00	12/07/24 09:00	17375	94.1	9.4	87.7	211.0
	t	19/07/22 11:00	12/07/24 09:00	17375	10.7	0.7	9.3	12.8
	u	19/07/22 11:00	12/07/24 09:00	17375	-0.1	11.9	-49.3	51.8
	v	19/07/22 11:00	12/07/24 09:00	17375	-3.6	17.9	-63.4	59.0
	spd	19/07/22 11:00	12/07/24 09:00	17375	3.6	10.8	0.1	64.4
	dir	19/07/22 11:00	12/07/24 09:00	17375	-92.1	97.7	-272.1	87.9
11324	p	19/07/22 10:30	12/07/24 09:00	34746	100.9	9.3	93.9	218.2
	t	19/07/22 10:30	12/07/24 09:00	34746	10.6	0.6	9.2	12.8
	c	19/07/22 10:30	12/07/24 09:00	34743	39.1	0.6	37.2	41.2
11325	p	19/07/22 10:30	12/07/24 09:00	34746	243.9	8.6	237.4	352.8
	t	19/07/22 10:30	12/07/24 09:00	34750	10.1	0.5	9.2	11.5
	c	19/07/22 10:30	12/07/24 09:00	34750	38.7	0.5	37.7	40.1
9881	p	19/07/22 11:00	12/07/24 09:00	17375	495.0	5.9	490.3	570.8
	t	19/07/22 11:00	12/07/24 09:00	17375	9.4	0.3	8.6	10.3
	u	19/07/22 11:00	12/07/24 09:00	17375	0.0	9.4	-41.5	44.2
	v	19/07/22 11:00	12/07/24 09:00	17375	-4.4	15.5	-59.8	41.0
	spd	19/07/22 11:00	12/07/24 09:00	17375	4.4	9.4	0.2	60.2
	dir	19/07/22 11:00	12/07/24 09:00	17375	-89.8	98.4	-269.7	90.2
11336	p	19/07/22 10:30	12/07/24 09:00	34746	498.6	5.8	493.9	574.3
	t	19/07/22 10:30	12/07/24 09:00	34750	9.5	0.3	8.5	10.4
	c	19/07/22 10:30	12/07/24 09:00	34750	38.1	0.3	37.2	39.1
11340	p	19/07/22 10:30	12/07/24 09:00	34746	753.6	4.6	749.4	813.8
	t	19/07/22 10:30	12/07/24 09:00	34750	8.5	0.4	7.0	9.4
	c	19/07/22 10:30	12/07/24 09:00	34750	37.3	0.3	35.8	38.2
9213	p	19/07/22 11:00	12/07/24 09:00	17375	1002.9	3.1	999.5	1042.6
	t	19/07/22 11:00	12/07/24 09:00	17375	6.7	0.4	5.5	7.9
	u	19/07/22 11:00	12/07/24 09:00	17375	-0.2	7.9	-29.3	41.9
	v	19/07/22 11:00	12/07/24 09:00	17375	-5.9	11.6	-44.8	37.3
	spd	19/07/22 11:00	12/07/24 09:00	17375	5.9	7.3	0.0	45.4
	dir	19/07/22 11:00	12/07/24 09:00	17375	-91.9	85.2	-271.9	88.1
3254	p	19/07/22 10:30	12/07/24 09:00	34747	1007.0	3.0	1003.9	1046.3
	t	19/07/22 10:30	12/07/24 09:00	34750	6.7	0.4	5.5	7.9
	c	19/07/22 10:30	12/07/24 09:00	34750	35.6	0.4	34.4	36.8
3256	p	19/07/22 10:30	12/07/24 09:00	34750	1260.6	1.7	1258.0	1282.0
	t	19/07/22 10:30	12/07/24 09:00	34750	5.2	0.3	4.3	6.0
	c	19/07/22 10:30	12/07/24 09:00	34750	34.2	0.3	33.4	35.1
11997	p	19/07/22 11:00	12/07/24 09:00	17375	1349.4	1.5	1345.2	1364.5
	t	19/07/22 11:00	12/07/24 09:00	17375	4.7	0.2	4.0	5.6
	u	19/07/22 11:00	12/07/24 09:00	17375	-1.8	7.6	-30.9	28.6
	v	19/07/22 11:00	12/07/24 09:00	17375	-8.7	10.3	-55.7	31.9
	spd	19/07/22 11:00	12/07/24 09:00	17375	8.9	7.7	0.0	55.7
	dir	19/07/22 11:00	12/07/24 09:00	17375	-101.4	70.1	-281.4	78.6
3257	p	19/07/22 10:30	12/07/24 09:00	34750	1516.5	0.8	1512.7	1522.2
	t	19/07/22 10:30	12/07/24 09:00	34750	4.4	0.2	3.6	5.2
	c	19/07/22 10:30	12/07/24 09:00	34750	33.6	0.2	32.8	34.3
9874	p	19/07/22 11:00	12/07/24 09:00	17375	1601.3	0.7	1599.2	1603.6
	t	19/07/22 11:00	12/07/24 09:00	17375	4.2	0.3	3.4	5.1
	u	19/07/22 11:00	12/07/24 09:00	17375	-1.6	8.4	-34.7	30.9
	v	19/07/22 11:00	12/07/24 09:00	17375	-6.4	11.1	-63.5	42.2
	spd	19/07/22 11:00	12/07/24 09:00	17375	6.6	7.6	0.0	63.7
	dir	19/07/22 11:00	12/07/24 09:00	17375	-104.3	82.3	-284.3	75.7
3276	p	19/07/22 10:30	12/07/24 09:00	34750	1587.7	0.7	1585.9	1589.5
	t	19/07/22 10:30	12/07/24 09:00	34747	4.2	0.3	3.3	5.2
	c	19/07/22 10:30	12/07/24 09:00	34743	33.5	0.3	32.6	34.3

Basic statistics generated by *stats_table.*m for the mooring RTWB2:

OSNAP Mooring Array.
Simple Statistics for Mooring:- rtwb2_07_2022
Mooring deployment - start: 17/07/2022 15:00
end: 11/07/2024 11:40

SN	var	first record	last record	valid records	mean	stdev	min	max
6276	p	17/07/22 15:00	11/07/24 11:00	17397	1031.1	7.2	1020.6	1120.6
	t	17/07/22 15:00	11/07/24 11:00	17397	6.8	0.5	5.4	8.6
	u	17/07/22 15:00	11/07/24 11:00	17397	0.3	9.2	-36.5	35.2
	v	17/07/22 15:00	11/07/24 11:00	17397	2.1	10.3	-39.8	42.5
	spd	17/07/22 15:00	11/07/24 11:00	17397	2.2	6.5	0.1	44.6
	dir	17/07/22 15:00	11/07/24 11:00	17397	81.5	95.5	-98.4	261.5
7290	p	17/07/22 15:00	11/07/24 11:30	34788	1019.3	5.7	1014.5	1101.9
	t	17/07/22 15:00	11/07/24 11:30	34794	6.7	0.5	5.4	8.5
	c	17/07/22 15:00	11/07/24 11:30	34794	35.7	0.5	34.3	37.4
6534	p	17/07/22 15:00	11/07/24 11:00	17397	1394.8	4.6	1388.9	1449.0
	t	17/07/22 15:00	11/07/24 11:00	17397	4.7	0.2	4.0	5.6
	u	17/07/22 15:00	11/07/24 11:00	17397	0.5	11.0	-32.5	34.9
	v	17/07/22 15:00	11/07/24 11:00	17397	-0.1	11.7	-41.5	36.4
	spd	17/07/22 15:00	11/07/24 11:00	17397	0.5	6.8	0.1	41.7
	dir	17/07/22 15:00	11/07/24 11:00	17397	-16.3	101.0	-196.3	163.7
3244	p	17/07/22 15:00	11/07/24 11:30	34794	1599.1	2.9	1595.9	1631.6
	t	17/07/22 15:00	11/07/24 11:30	34794	4.1	0.1	3.7	4.9
	c	17/07/22 15:00	11/07/24 11:30	34794	33.3	0.1	32.9	34.1
6723	p	17/07/22 15:00	11/07/24 11:00	17397	1824.3	1.9	1820.0	1831.8
	t	17/07/22 15:00	11/07/24 11:00	17397	3.6	0.1	3.1	4.0
	u	17/07/22 15:00	11/07/24 11:00	17397	0.1	13.0	-37.1	41.7
	v	17/07/22 15:00	11/07/24 11:00	17397	-0.8	13.1	-44.7	36.8
	spd	17/07/22 15:00	11/07/24 11:00	17397	0.8	7.5	0.0	46.6
	dir	17/07/22 15:00	11/07/24 11:00	17397	-82.9	100.9	-262.9	97.1
3231	p	17/07/22 15:00	11/07/24 11:30	34794	1812.2	0.7	1809.6	1815.6
	t	17/07/22 15:00	11/07/24 11:30	34783	3.6	0.1	3.2	4.0
	c	17/07/22 15:00	11/07/24 11:30	34780	33.0	0.1	32.6	33.4

Basic statistics generated by *stats_table.*m for the mooring RHADCP:

```
OSNAP Mooring Array.
Simple Statistics for Mooring:-  rhadcp_02_2022
Mooring deployment - start:  20/07/2022 15:00
                       end:  14/07/2024 07:00
```

SN	var	first record	last record	valid records	mean	stdev	min	max
9378	p	20/07/22 15:00	14/07/24 06:30	34784	1081.7	0.6	1080.1	1083.5
	t	20/07/22 15:00	14/07/24 06:30	34783	5.6	0.3	4.7	6.6
	c	20/07/22 15:00	14/07/24 06:30	34783	34.5	0.3	33.7	35.5

Basic statistics generated by *stats_table*.m for the mooring IB5:

```
OSNAP Mooring Array.
Simple Statistics for Mooring:-  ib5_03_2022
Mooring deployment - start:  21/07/2022 12:00
                     end:  15/07/2024 08:00
```

SN	var	first record	last record	valid records	mean	stdev	min	max
3212	p	21/07/22 12:30	15/07/24 07:30	34788	48.9	5.0	44.1	116.3
	t	21/07/22 12:30	15/07/24 07:30	34775	11.1	1.1	9.2	14.3
	c	21/07/22 12:30	15/07/24 07:30	34545	39.5	1.0	37.6	42.5
3213	p	21/07/22 12:30	15/07/24 07:30	34785	104.9	4.4	101.6	166.2
	t	21/07/22 12:30	15/07/24 07:30	34790	10.6	0.7	9.2	12.7
	c	21/07/22 12:30	15/07/24 07:30	34584	39.1	0.7	37.6	41.3
3219	p	21/07/22 12:30	15/07/24 07:30	34787	200.6	4.2	196.1	258.9
	t	21/07/22 12:30	15/07/24 07:30	34791	10.3	0.5	9.0	11.7
	c	21/07/22 12:30	15/07/24 07:30	34790	38.9	0.5	37.3	40.2
6115	p	21/07/22 12:30	15/07/24 07:30	34784	352.5	3.6	349.7	401.3
	t	21/07/22 12:30	15/07/24 07:30	34791	9.9	0.4	8.5	11.0
	c	21/07/22 12:30	15/07/24 07:30	34791	38.5	0.4	36.9	39.6
3207	p	21/07/22 12:30	15/07/24 07:30	34786	501.1	2.8	498.4	539.8
	t	21/07/22 12:30	15/07/24 07:30	34791	9.3	0.4	7.3	10.3
	c	21/07/22 12:30	15/07/24 07:30	34791	37.9	0.4	35.7	39.0
11990	p	21/07/22 12:00	15/07/24 08:00	17397	501.5	2.8	498.2	539.6
	t	21/07/22 12:00	15/07/24 08:00	17397	9.3	0.4	7.2	10.3
	u	21/07/22 12:00	15/07/24 08:00	17397	3.0	9.0	-38.5	38.7
	v	21/07/22 12:00	15/07/24 08:00	17397	3.0	11.2	-46.1	49.3
	spd	21/07/22 12:00	15/07/24 08:00	17397	4.2	7.6	0.1	49.3
	dir	21/07/22 12:00	15/07/24 08:00	17397	45.7	82.6	-134.3	225.7
3264	p	21/07/22 12:30	15/07/24 07:30	34791	706.2	1.8	704.1	729.5
	t	21/07/22 12:30	15/07/24 07:30	34791	8.0	0.5	6.2	9.7
	c	21/07/22 12:30	15/07/24 07:30	34791	36.7	0.5	34.9	38.4
6123	p	21/07/22 12:30	15/07/24 07:30	34791	932.5	0.6	931.0	935.1
	t	21/07/22 12:30	15/07/24 07:30	34783	6.3	0.5	3.8	7.5
	c	21/07/22 12:30	15/07/24 07:30	34749	35.1	0.5	32.7	36.4
11992	p	21/07/22 12:00	15/07/24 08:00	17397	925.6	0.7	922.8	928.1
	t	21/07/22 12:00	15/07/24 08:00	17397	6.4	0.5	4.0	7.5
	u	21/07/22 12:00	15/07/24 08:00	17397	4.7	6.5	-25.7	26.7
	v	21/07/22 12:00	15/07/24 08:00	17397	5.8	7.7	-27.3	55.0
	spd	21/07/22 12:00	15/07/24 08:00	17397	7.5	6.4	0.0	60.3
	dir	21/07/22 12:00	15/07/24 08:00	17397	50.9	66.2	-129.0	230.8

Basic statistics generated by *stats_table.*m for the mooring IB4:

OSNAP Mooring Array.
Simple Statistics for Mooring:- ib4_03_2022
Mooring deployment - start: 22/07/2022 17:30
end: 16/07/2024 07:00

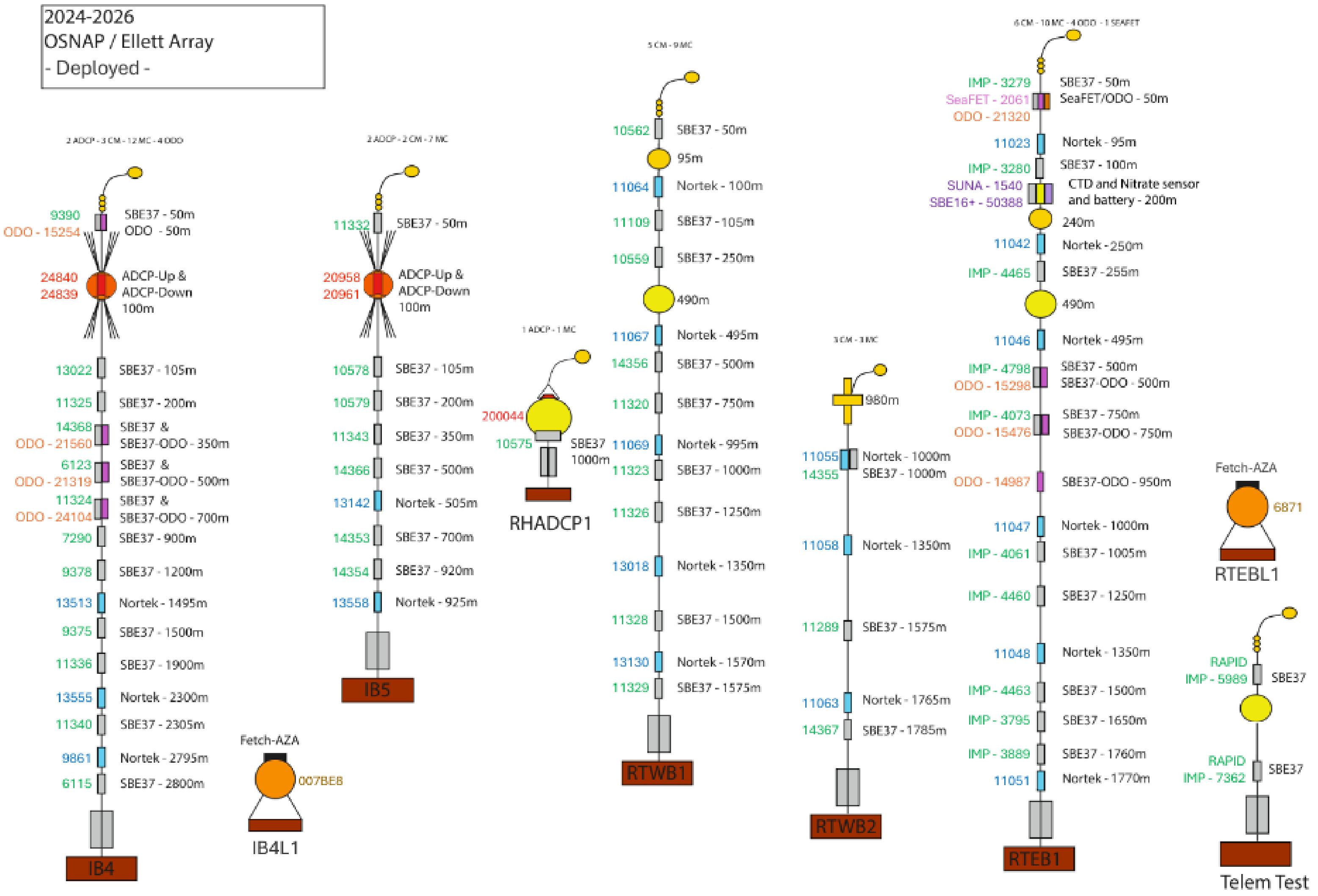
SN	var	first record	last record	valid records	mean	stdev	min	max
3221	p	22/07/22 17:30	16/07/24 06:30	34771	63.3	20.5	48.0	260.1
	t	22/07/22 17:30	16/07/24 06:30	34768	10.8	1.0	8.5	13.8
	c	22/07/22 17:30	16/07/24 06:30	34772	39.1	1.0	36.8	41.9
12906	p	22/07/22 18:00	16/07/24 06:00	17387	64.3	20.5	49.1	261.0
	t	22/07/22 18:00	16/07/24 06:00	17380	10.8	1.0	8.5	13.7
	c	22/07/22 18:00	16/07/24 06:00	17383	39.1	1.0	36.8	41.9
	o2	22/07/22 18:00	16/07/24 06:00	17389	255.3	8.2	211.8	299.0
11330	p	22/07/22 17:30	16/07/24 06:30	34771	117.5	19.8	103.6	311.6
	t	22/07/22 17:30	16/07/24 06:30	34777	10.3	0.7	8.3	12.8
	c	22/07/22 17:30	16/07/24 06:30	34777	38.8	0.7	36.7	41.3
3224	p	22/07/22 17:30	16/07/24 06:30	34771	211.7	19.7	197.9	405.4
	t	22/07/22 17:30	16/07/24 06:30	34779	10.0	0.6	8.1	11.7
	c	22/07/22 17:30	16/07/24 06:30	34779	38.5	0.6	36.5	40.3
3253	p	22/07/22 17:30	16/07/24 06:30	34771	362.7	19.0	349.4	552.2
	t	22/07/22 17:30	16/07/24 06:30	34779	9.5	0.6	6.9	11.0
	c	22/07/22 17:30	16/07/24 06:30	34397	38.0	0.6	35.4	39.5
12908	p	22/07/22 18:01	16/07/24 06:01	17387	363.3	19.1	350.0	553.2
	t	22/07/22 18:01	16/07/24 06:01	17389	9.5	0.6	6.9	10.9
	c	22/07/22 18:01	16/07/24 06:01	17389	38.0	0.6	35.4	39.5
	o2	22/07/22 18:01	16/07/24 06:01	17371	241.9	16.0	194.1	269.1
3248	p	22/07/22 17:30	16/07/24 06:30	34771	512.8	18.3	499.9	699.3
	t	22/07/22 17:30	16/07/24 06:30	34779	8.6	0.7	6.1	10.1
	c	22/07/22 17:30	16/07/24 06:30	34779	37.2	0.7	34.7	38.7
12962	p	22/07/22 18:01	16/07/24 06:01	17387	514.7	18.4	502.1	701.8
	t	22/07/22 18:01	16/07/24 06:01	17389	8.6	0.7	6.1	10.0
	c	22/07/22 18:01	16/07/24 06:01	17388	37.2	0.7	34.7	38.7
	o2	22/07/22 18:01	16/07/24 06:01	17389	227.4	20.4	189.5	271.2
11334	p	22/07/22 17:30	16/07/24 06:30	34771	717.6	17.2	705.5	899.8
	t	22/07/22 17:30	16/07/24 06:30	34779	7.1	0.7	5.0	9.5
	c	22/07/22 17:30	16/07/24 06:30	34779	35.8	0.7	33.8	38.3
13000	p	22/07/22 18:31	16/07/24 06:01	13909	718.1	17.2	706.1	900.2
	t	22/07/22 18:31	16/07/24 06:01	13911	7.1	0.7	5.1	9.5
	c	22/07/22 18:31	16/07/24 06:01	13911	35.8	0.7	33.8	38.3
	o2	22/07/22 18:31	16/07/24 06:01	13911	214.0	11.1	190.7	268.4
9375	p	22/07/22 17:30	16/07/24 06:30	34770	920.8	15.6	909.8	1096.7
	t	22/07/22 17:30	16/07/24 06:30	34779	5.6	0.5	4.2	7.5
	c	22/07/22 17:30	16/07/24 06:30	34778	34.4	0.5	33.2	36.3
9390	p	22/07/22 17:30	16/07/24 06:30	34771	1226.5	13.8	1216.8	1393.4
	t	22/07/22 17:30	16/07/24 06:30	34779	4.3	0.2	3.8	5.4
	c	22/07/22 17:30	16/07/24 06:30	34777	33.4	0.2	32.9	34.4
9396	p	22/07/22 17:30	16/07/24 06:30	34770	1530.6	11.5	1522.5	1685.3
	t	22/07/22 17:30	16/07/24 06:30	34779	3.9	0.1	3.6	4.4
	c	22/07/22 17:30	16/07/24 06:30	34692	33.0	0.1	32.8	33.6
11335	p	22/07/22 17:30	16/07/24 06:30	34769	1935.3	8.9	1928.8	2070.4
	t	22/07/22 17:30	16/07/24 06:30	34778	3.6	0.0	3.5	3.9
	c	22/07/22 17:30	16/07/24 06:30	34773	33.0	0.0	32.9	33.2
11979	p	22/07/22 18:00	16/07/24 07:00	17390	2324.2	6.2	2318.3	2425.8
	t	22/07/22 18:00	16/07/24 07:00	17390	3.3	0.1	2.9	3.5
	u	22/07/22 18:00	16/07/24 07:00	17390	-0.7	7.9	-24.0	41.5
	v	22/07/22 18:00	16/07/24 07:00	17390	-0.2	7.3	-20.9	51.3
	spd	22/07/22 18:00	16/07/24 07:00	17390	0.7	6.0	0.0	61.5
	dir	22/07/22 18:00	16/07/24 07:00	17390	-160.8	100.1	-340.8	19.2
3222	p	22/07/22 17:30	16/07/24 06:30	34769	2345.6	6.1	2340.9	2448.1
	t	22/07/22 17:30	16/07/24 06:30	34779	3.3	0.1	2.9	3.6
	c	22/07/22 17:30	16/07/24 06:30	34770	32.9	0.1	32.6	33.1
12047	p	22/07/22 18:00	16/07/24 07:00	17390	2835.0	1.7	2831.4	2858.3
	t	22/07/22 18:00	16/07/24 07:00	17390	2.8	0.1	2.7	3.1
	u	22/07/22 18:00	16/07/24 07:00	17390	2.8	9.9	-32.5	52.5
	v	22/07/22 18:00	16/07/24 07:00	17390	2.2	9.2	-30.2	40.1
	spd	22/07/22 18:00	16/07/24 07:00	17390	3.6	8.8	0.0	61.5
	dir	22/07/22 18:00	16/07/24 07:00	17390	38.3	97.5	-141.6	218.3
14365	p	22/07/22 17:30	16/07/24 06:30	34779	2852.8	1.6	2849.6	2876.6
	t	22/07/22 17:30	16/07/24 06:30	34778	2.9	0.1	2.7	3.2
	c	22/07/22 17:30	16/07/24 06:30	34778	32.7	0.1	32.6	33.0

Basic statistics generated by *stats_table.*m for the mooring IB3:

OSNAP Mooring Array.
Simple Statistics for Mooring:- ib3_03_2022
Mooring deployment - start: 24/07/2022 15:30
end: 18/07/2024 08:00

SN	var	first record	last record	valid records	mean	stdev	min	max
14364	p	24/07/22 15:30	18/07/24 07:30	34785	88.1	65.1	1.4	390.4
	t	24/07/22 16:00	18/07/24 07:30	34781	10.1	1.3	7.3	14.2
	c	24/07/22 16:00	18/07/24 07:30	34784	38.4	1.2	35.7	42.2
11341	p	24/07/22 16:00	18/07/24 07:30	34784	140.5	64.4	83.8	440.0
	t	24/07/22 16:00	18/07/24 07:30	34784	9.6	0.9	6.7	12.2
	c	24/07/22 16:00	18/07/24 07:30	34784	37.9	0.9	35.1	40.7
11342	p	24/07/22 16:00	18/07/24 07:30	34784	233.4	63.5	176.6	530.7
	t	24/07/22 16:00	18/07/24 07:30	34784	9.0	0.8	6.3	10.9
	c	24/07/22 16:00	18/07/24 07:30	34784	37.4	0.9	34.7	39.5
10560	p	24/07/22 16:00	18/07/24 07:30	34784	384.5	61.6	330.5	674.7
	t	24/07/22 16:00	18/07/24 07:30	34784	7.9	0.9	5.3	10.3
	c	24/07/22 16:00	18/07/24 07:30	34784	36.4	0.9	33.9	38.8
11110	p	24/07/22 16:00	18/07/24 07:30	34784	535.0	58.6	483.3	812.5
	t	24/07/22 16:00	18/07/24 07:30	34784	6.7	0.8	4.8	9.2
	c	24/07/22 16:00	18/07/24 07:30	34784	35.3	0.8	33.5	37.7
11140	p	24/07/22 16:00	18/07/24 07:30	34784	734.5	53.9	687.0	993.8
	t	24/07/22 16:00	18/07/24 07:30	34784	5.4	0.5	4.3	7.7
	c	24/07/22 16:00	18/07/24 07:30	34784	34.2	0.5	33.1	36.4
11322	p	24/07/22 16:00	18/07/24 07:30	34784	938.4	48.4	895.8	1178.1
	t	24/07/22 16:00	18/07/24 07:30	34784	4.6	0.3	4.0	5.9
	c	24/07/22 16:00	18/07/24 07:30	34784	33.4	0.2	33.0	34.7
11327	p	24/07/22 16:00	18/07/24 07:30	34784	1235.1	41.3	1198.5	1446.9
	t	24/07/22 16:00	18/07/24 07:30	34784	4.0	0.1	3.7	4.4
	c	24/07/22 16:00	18/07/24 07:30	34771	33.0	0.1	32.8	33.4
11026	p	24/07/22 16:00	18/07/24 08:00	17393	1535.0	33.2	1505.3	1712.2
	t	24/07/22 16:00	18/07/24 08:00	17393	3.7	0.0	3.5	3.9
	u	24/07/22 16:00	18/07/24 08:00	17393	-2.9	8.2	-25.2	28.1
	v	24/07/22 16:00	18/07/24 08:00	17393	0.5	7.9	-30.2	26.3
	spd	24/07/22 16:00	18/07/24 08:00	17393	2.9	5.2	0.1	31.3
	dir	24/07/22 16:00	18/07/24 08:00	17393	171.0	86.5	-9.0	350.9
11139	p	24/07/22 16:00	18/07/24 07:30	34784	1538.9	33.0	1509.4	1715.1
	t	24/07/22 16:00	18/07/24 07:30	34784	3.7	0.0	3.5	3.9
	c	24/07/22 16:00	18/07/24 07:30	34769	32.9	0.0	32.6	33.1
11137	p	24/07/22 16:00	18/07/24 07:30	34784	1940.3	22.9	1919.3	2067.9
	t	24/07/22 16:00	18/07/24 07:30	34782	3.5	0.0	3.4	3.7
	c	24/07/22 15:30	18/07/24 07:30	34782	32.9	0.0	32.8	33.0
11028	p	24/07/22 16:00	18/07/24 08:00	17393	2342.6	13.5	2329.7	2421.0
	t	24/07/22 16:00	18/07/24 08:00	17393	3.3	0.1	3.1	3.5
	u	24/07/22 16:00	18/07/24 08:00	17393	-3.2	8.4	-30.6	35.6
	v	24/07/22 16:00	18/07/24 08:00	17393	-1.6	7.8	-33.5	22.6
	spd	24/07/22 16:00	18/07/24 08:00	17393	3.6	5.7	0.0	37.5
	dir	24/07/22 16:00	18/07/24 08:00	17393	-153.8	85.5	-333.7	26.2
10576	p	24/07/22 16:00	18/07/24 07:30	34784	2342.7	13.4	2330.0	2419.9
	t	24/07/22 16:00	18/07/24 07:30	34784	3.2	0.1	3.0	3.4
	c	24/07/22 15:30	18/07/24 07:30	34785	32.8	0.0	32.7	33.0
11029	p	24/07/22 16:00	18/07/24 08:00	17393	2846.6	1.4	2844.3	2854.3
	t	24/07/22 16:00	18/07/24 08:00	17393	2.8	0.0	2.6	2.9
	u	24/07/22 16:00	18/07/24 08:00	17393	-3.2	8.8	-31.1	33.1
	v	24/07/22 16:00	18/07/24 08:00	17393	-2.7	8.1	-38.8	22.5
	spd	24/07/22 16:00	18/07/24 08:00	17393	4.2	6.1	0.0	41.1
	dir	24/07/22 16:00	18/07/24 08:00	17393	-139.7	82.8	-319.6	40.2
11338	p	24/07/22 16:00	18/07/24 07:30	34784	2845.8	1.3	2842.2	2852.7
	t	24/07/22 16:00	18/07/24 07:30	34783	2.8	0.0	2.6	2.9
	c	24/07/22 16:00	18/07/24 07:30	34782	32.6	0.0	32.5	32.7

APPENDIX V MOORING INSTRUMENT ALLOCATION SCHEMATICS

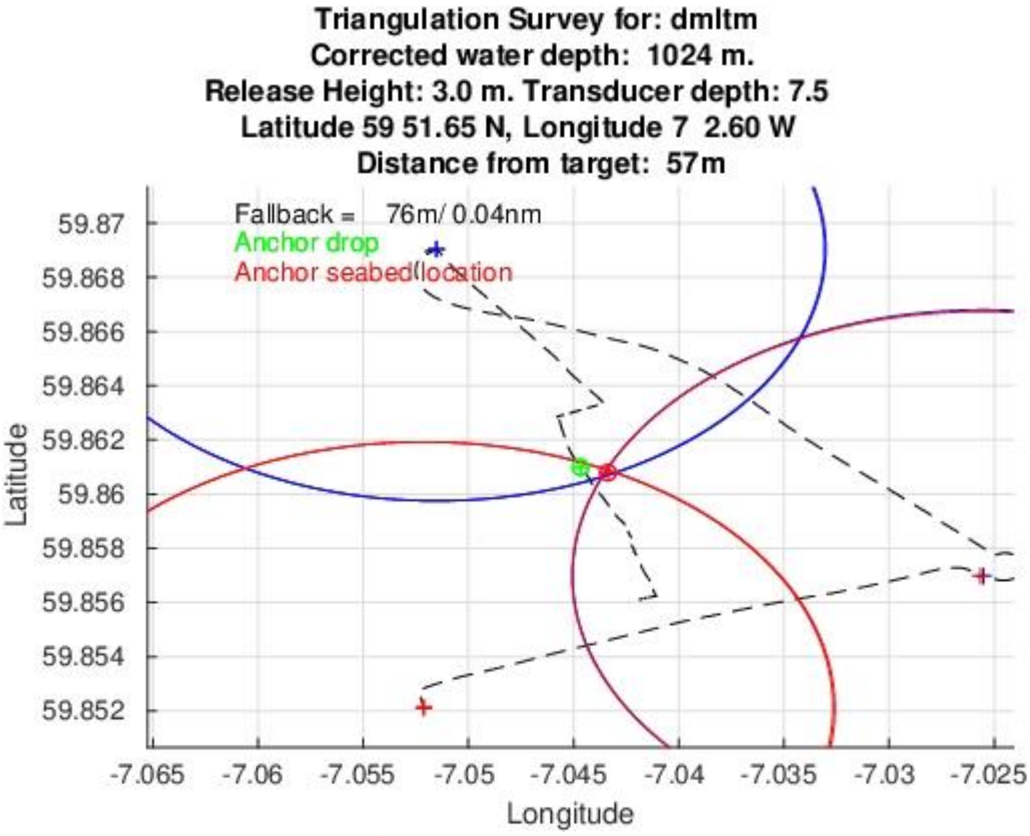


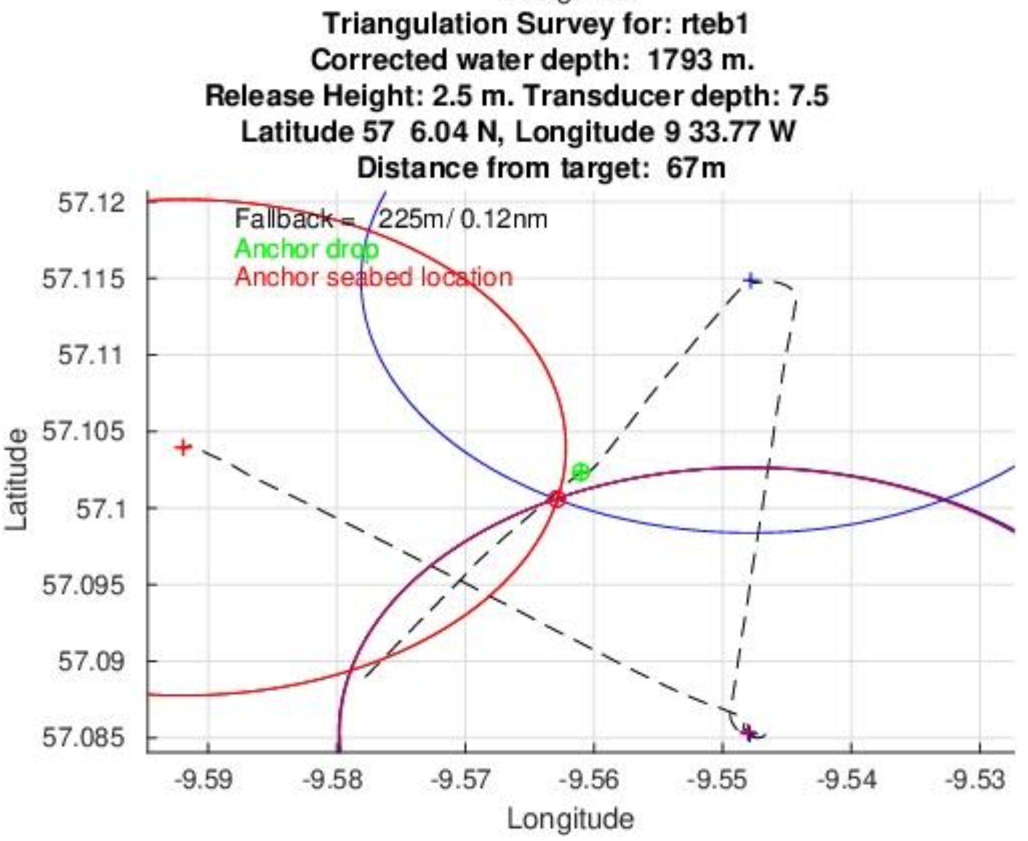
APPENDIX W MOORING DEPLOYMENT SUMMARY TABLE

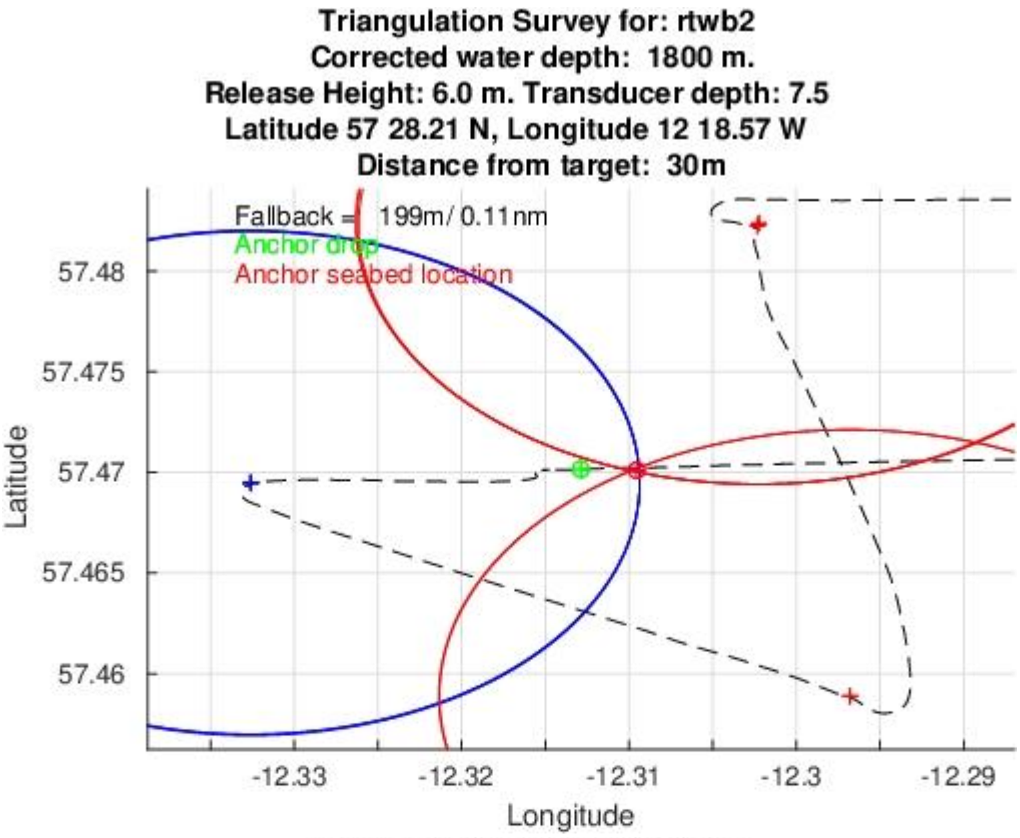
Moor	Date	Anchor_Drop	Anchor_Seabed_Trilateration						Water_depth	Setup_distance	Planned_Fallback
Name	dd/mm/yy	hh:mm	Lat_N	Lon_W	Lat_deg	Lat_min	Lon_deg	Lon_min	m	nm	m
DMLTM	05/07/2024	10:17	59.8610	007.0447	59	51.66	007	2.68	1024	0.25	60
RTEB1	10/07/2024	15:56	57.1006	009.5629	57	6.04	009	33.77	1793	3	250
RTWB2	11/07/2024	16:36	57.4701	012.3095	57	28.21	012	18.57	1800	1.5	150
RTWB1	12/07/2024	15:11	57.4694	012.7046	57	28.16	012	42.28	1586	1.5	150
RHADCP	14/07/2024	12:45	57.6144	015.4010	57	36.86	015	24.06	1058	0	80
IB5	15/07/2024	13:29	57.8010	019.1709	57	48.06	019	10.25	942	1.5	125
IB4	17/07/2024	10:45	57.9884	021.1463	57	59.30	021	8.78	2922	3	250
IB4L1	16/07/2024	14:21	57.9916	021.1323	57	59.50	021	7.94	2911	0	0

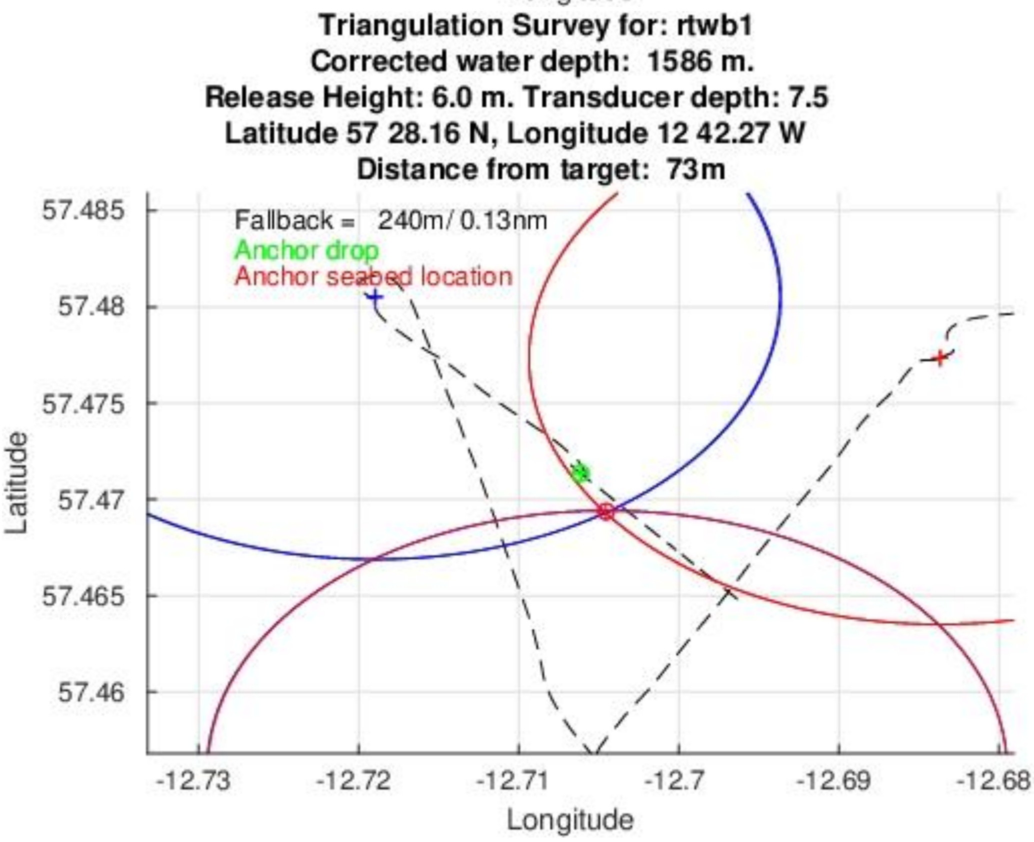
Moor	Date	Start deploy	Anchor Drop	Tow	Fallback from Trilateration	Distance from target	Irdium beacon1	Irdium beacon2	AR1	AR2
Name	dd/mm/yy	hh:mm	hh:mm	min	m	m	IMEI	IMEI	S/N	S/N
DMLTM	05/07/2024	10:00	10:17	3	76	57	300234060478980	n/a	1498	n/a
RTEB1	10/07/2024	15:00	15:56	56	225	67	300434061881140	300234060479980	1766	1999
RTWB2	11/07/2024	14:51	16:36	54	199	30	300234060476980	n/a	1759	2329
RTWB1	12/07/2024	13:03	15:11	38	240	73	300234060471960	300234060570000	1135	1614
RHADCP	14/07/2024	12:40	12:45	2	52	70	300234060474980	n/a	1750	2253
IB5	15/07/2024	12:00	13:29	35	90	51	300234060477980	n/a	1765	2331
IB4	17/07/2024	07:47	10:45	58	249	173	300234060573000	n/a	1136	1752
IB4L1	16/07/2024	12:30	14:21	81	84	84	n/a	n/a	n/a	n/a

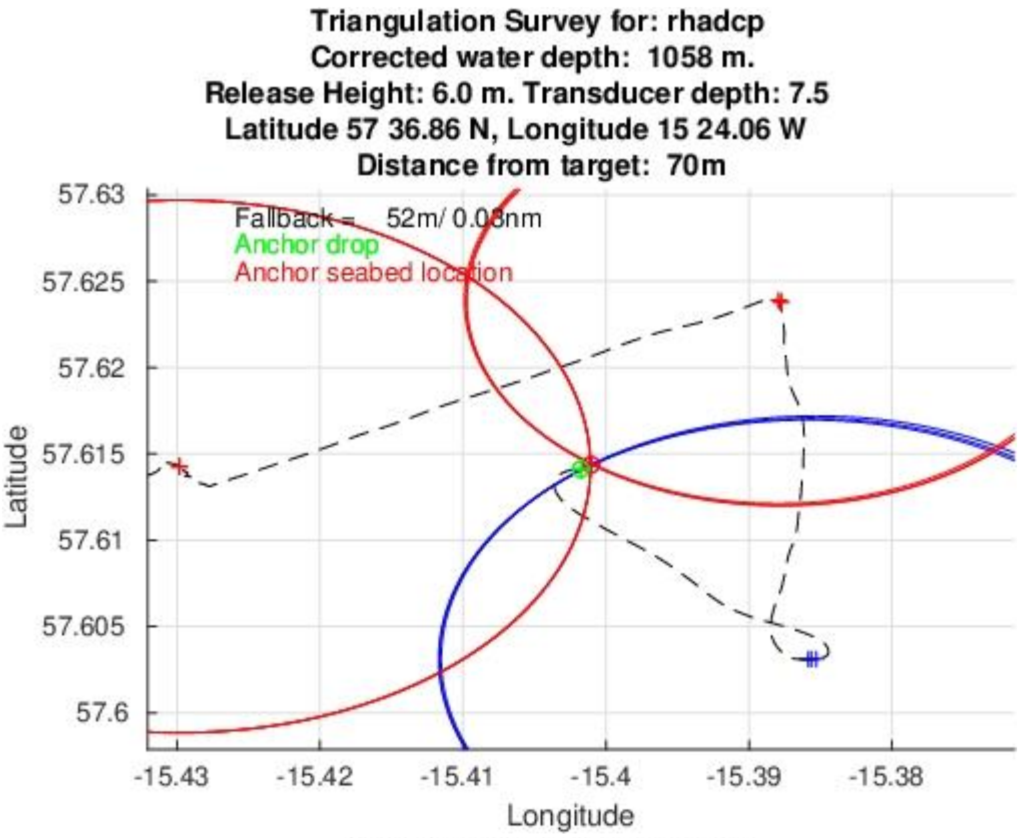
APPENDIX X MOORING TRILATERATION RESULTS

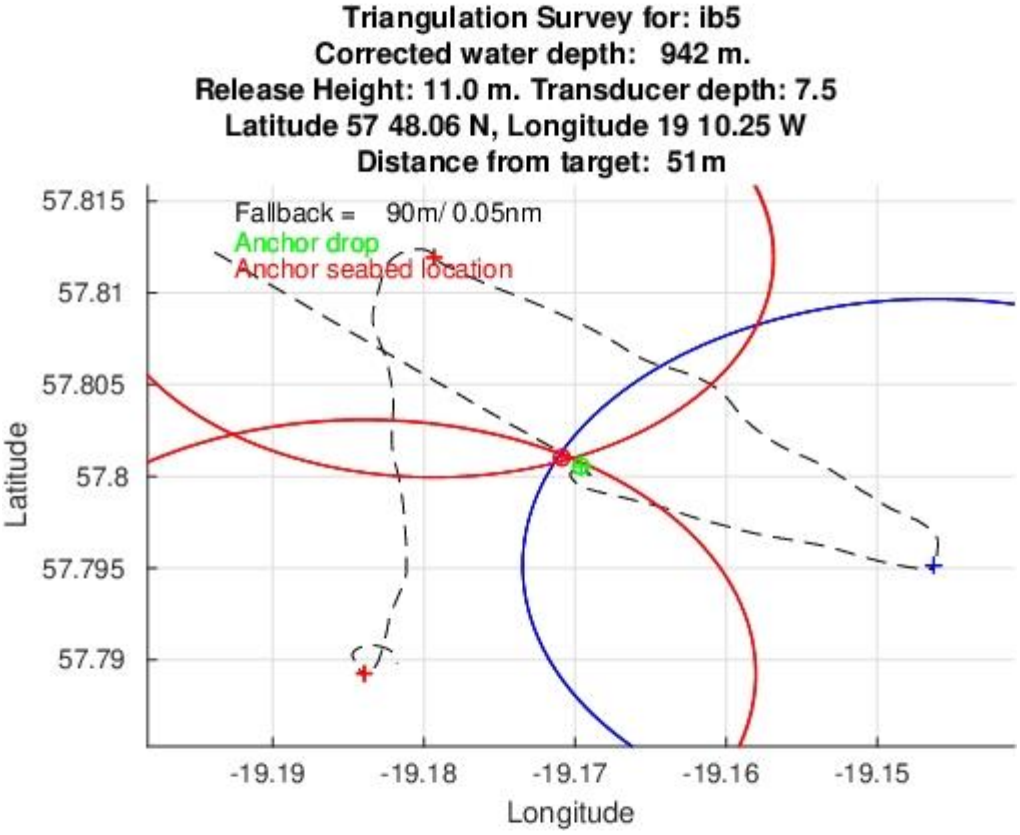


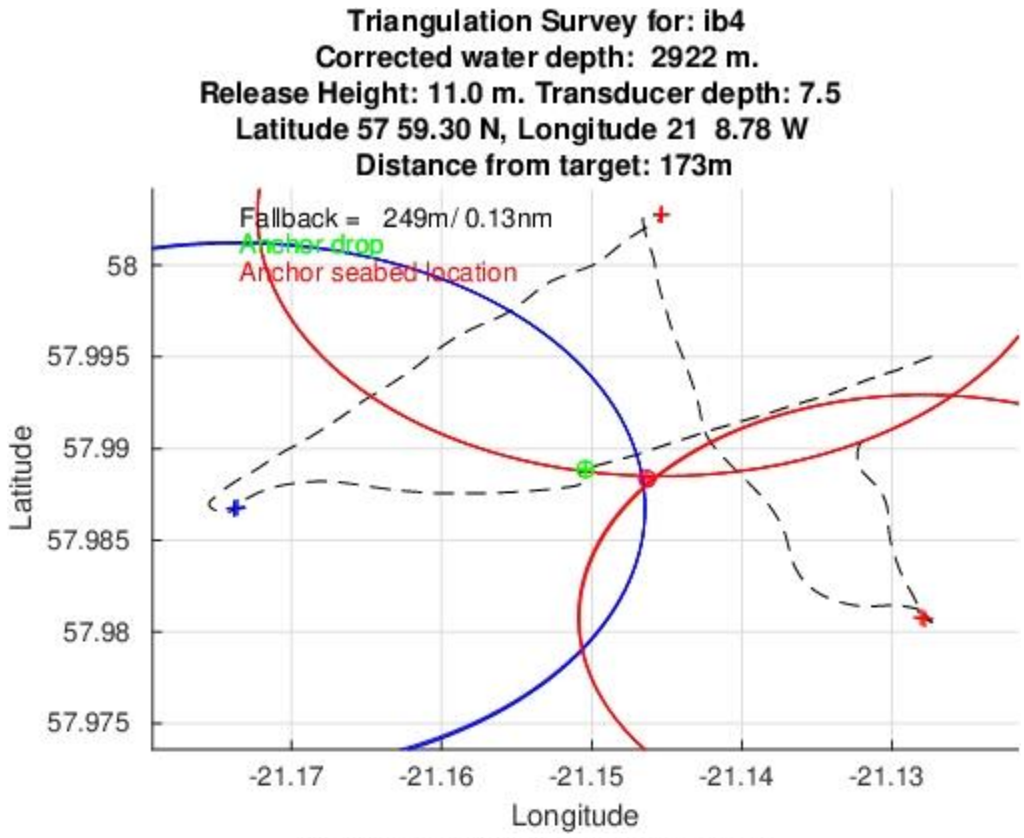


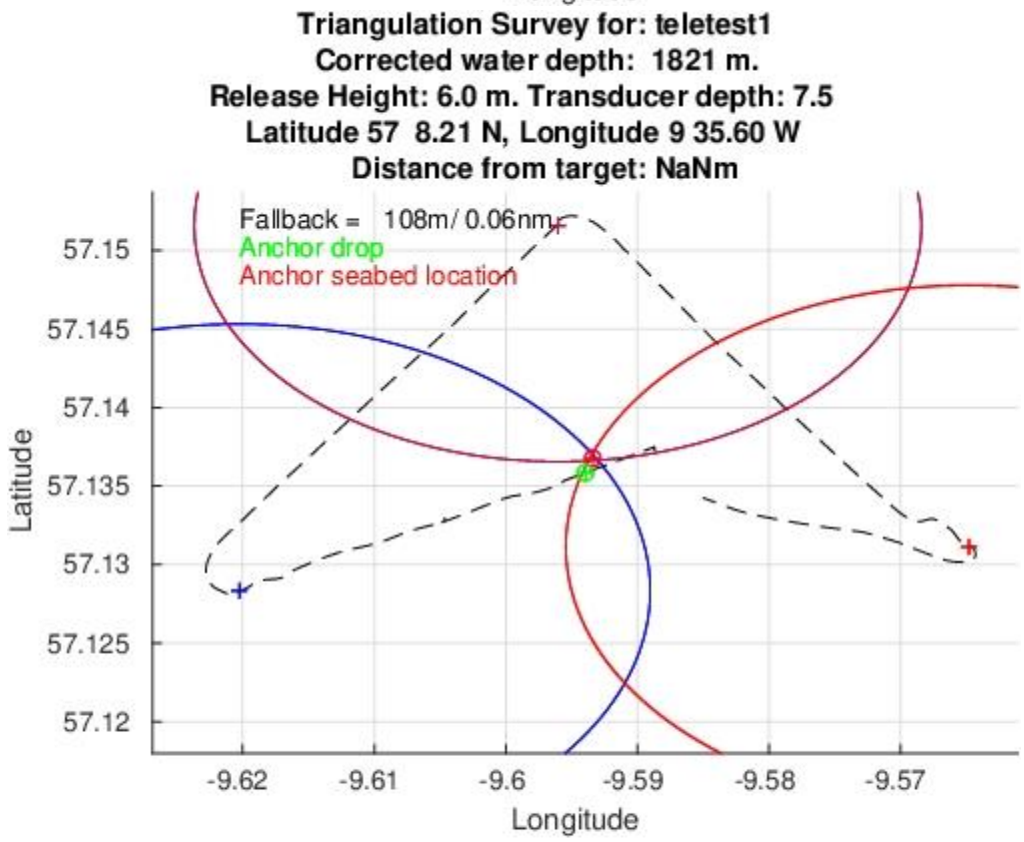

Triangulation Survey for: rtwb2
Corrected water depth: 1800 m.
Release Height: 6.0 m. Transducer depth: 7.5
Latitude 57 28.21 N, Longitude 12 18.57 W
Distance from target: 30m
Fallback = 199m/ 0.11nm
Anchor drop
Anchor seabed location
Latitude
57.48
57.475
57.47
57.465
57.46
Longitude
-12.33
-12.32
-12.31
-12.3
-12.29

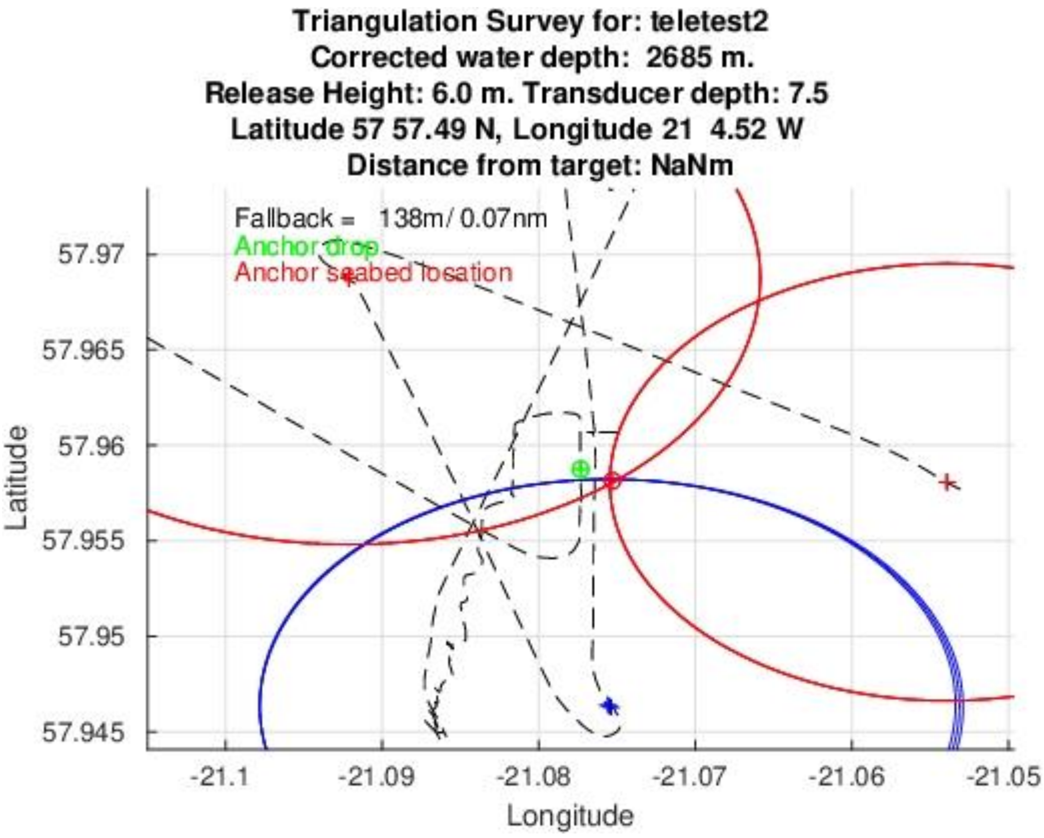

Triangulation Survey for: rtwb1
Corrected water depth: 1586 m.
Release Height: 6.0 m. Transducer depth: 7.5
Latitude 57 28.16 N, Longitude 12 42.27 W
Distance from target: 73m
Fallback = 240m/ 0.13nm
Anchor drop
Anchor seabed location
Latitude
57.485
57.48
57.475
57.47
57.465
57.46
Longitude
-12.73
-12.72
-12.71
-12.7
-12.69
-12.68


Triangulation Survey for: rhadcp
Corrected water depth: 1058 m.
Release Height: 6.0 m. Transducer depth: 7.5
Latitude 57 36.86 N, Longitude 15 24.06 W
Distance from target: 70m
Fallback = 52m/ 0.03nm
Anchor drop
Anchor seabed location
57.63
57.625
57.62
57.615
57.61
57.605
57.6
Latitude
-15.43
-15.42
-15.41
-15.4
-15.39
-15.38
Longitude

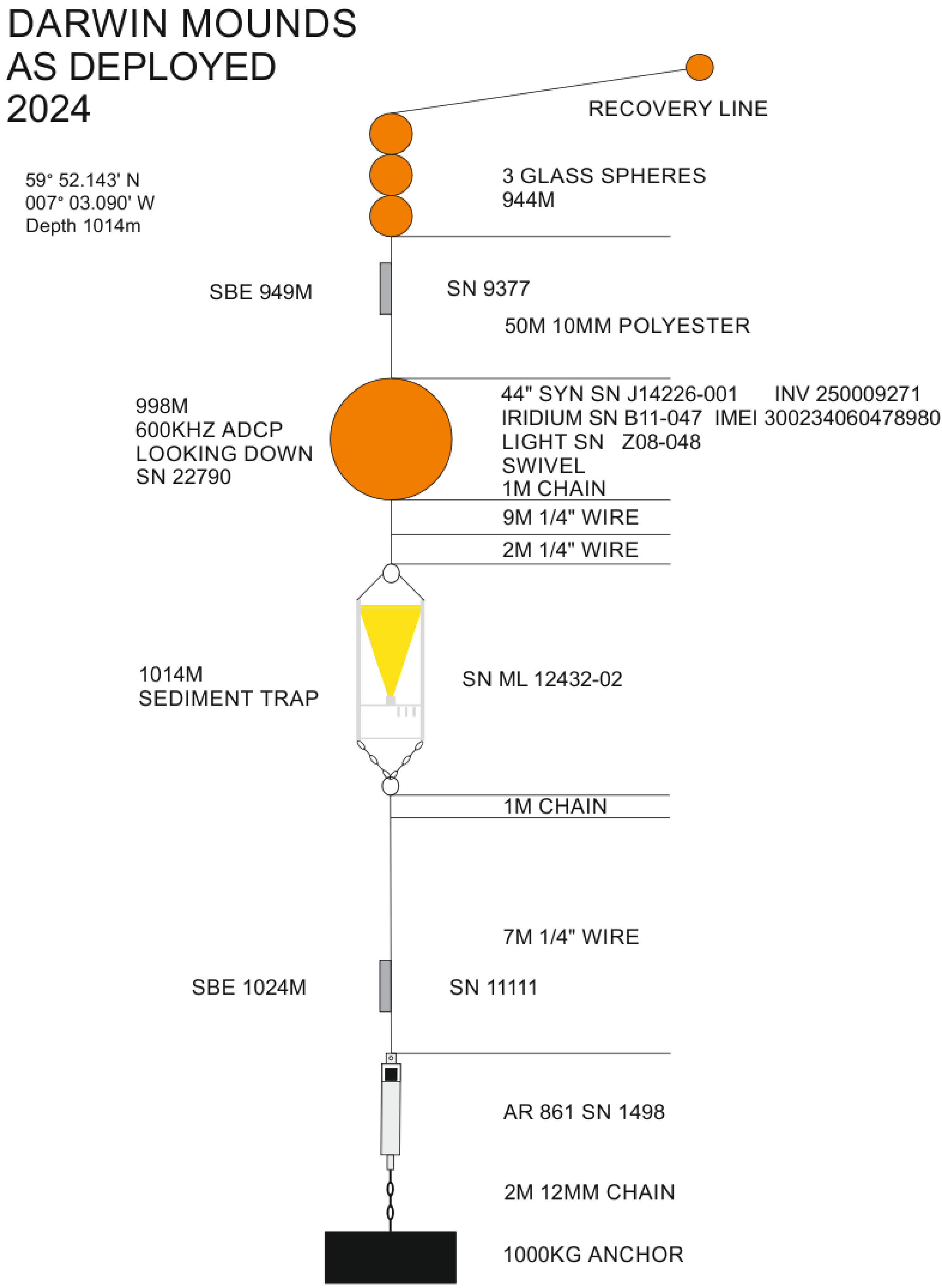

Triangulation Survey for: ib5
Corrected water depth: 942 m.
Release Height: 11.0 m. Transducer depth: 7.5
Latitude 57 48.06 N, Longitude 19 10.25 W
Distance from target: 51m
Fallback = 90m/ 0.05nm
Anchor drop
Anchor seabed location
57.815
57.81
57.805
57.8
57.795
57.79
Latitude
-19.19
-19.18
-19.17
-19.16
-19.15
Longitude

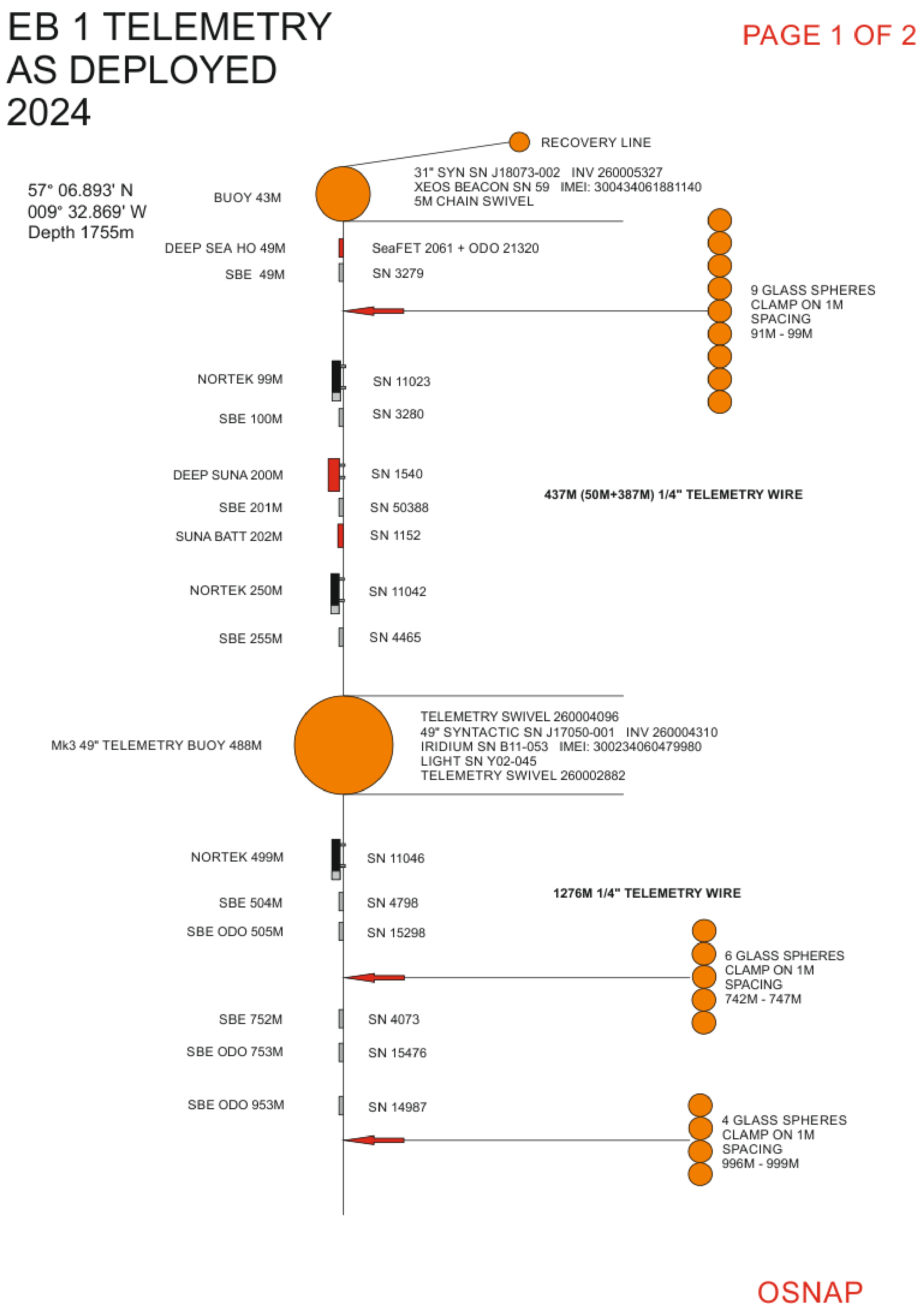

Triangulation Survey for: ib4
Corrected water depth: 2922 m.
Release Height: 11.0 m. Transducer depth: 7.5
Latitude 57 59.30 N, Longitude 21 8.78 W
Distance from target: 173m
Fallback = 249m/ 0.13nm
Anchor drop
Anchor seabed location
58
57.995
57.99
57.985
57.98
57.975
Latitude
-21.17
-21.16
-21.15
-21.14
-21.13
Longitude

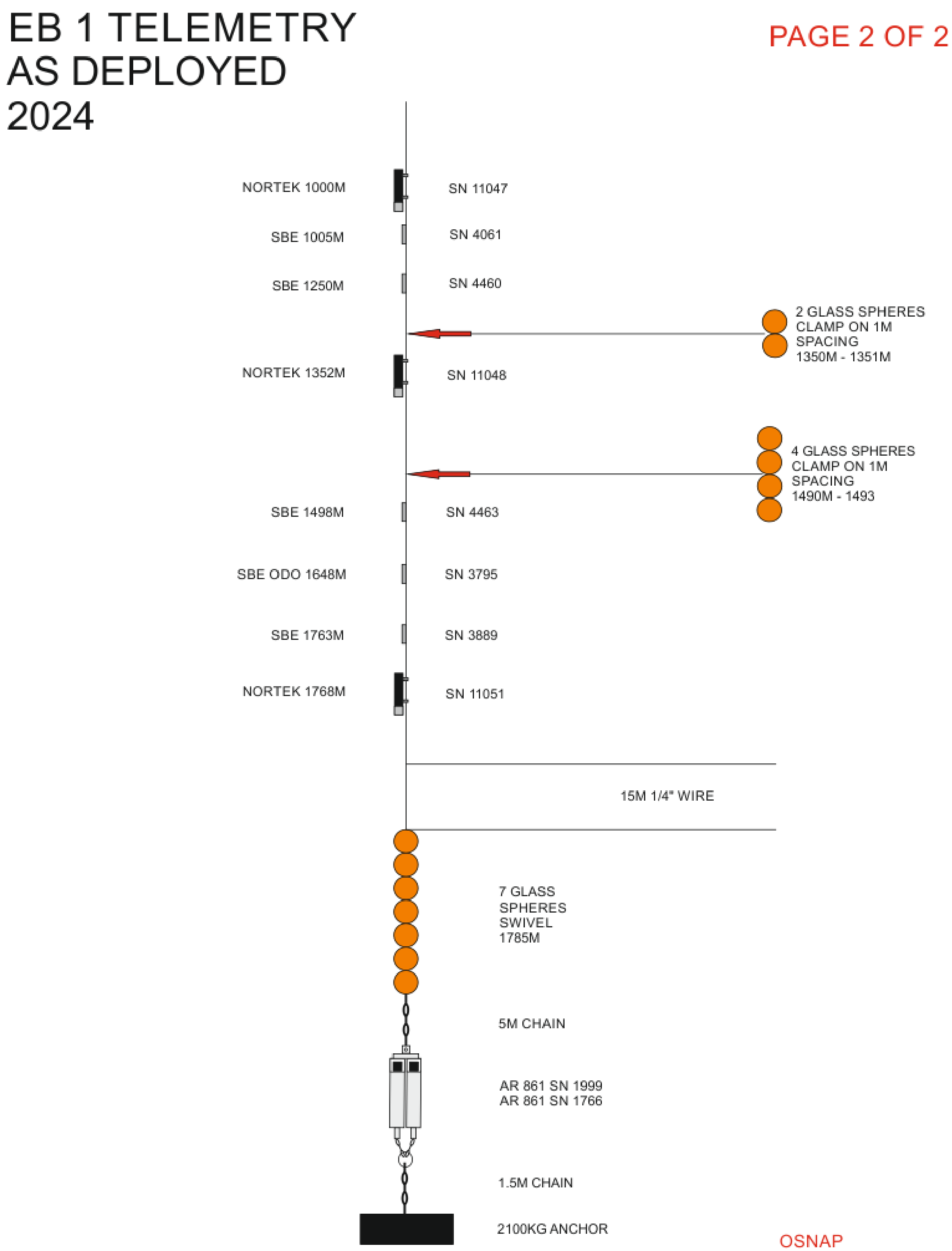

Triangulation Survey for: teletest1
Corrected water depth: 1821 m.
Release Height: 6.0 m. Transducer depth: 7.5
Latitude 57 8.21 N, Longitude 9 35.60 W
Distance from target: NaNm
Fallback = 108m/ 0.06nm
Anchor drop
Anchor seabed location
57.15
57.145
57.14
57.135
57.13
57.125
57.12
Latitude
-9.62
-9.61
-9.6
-9.59
-9.58
-9.57
Longitude

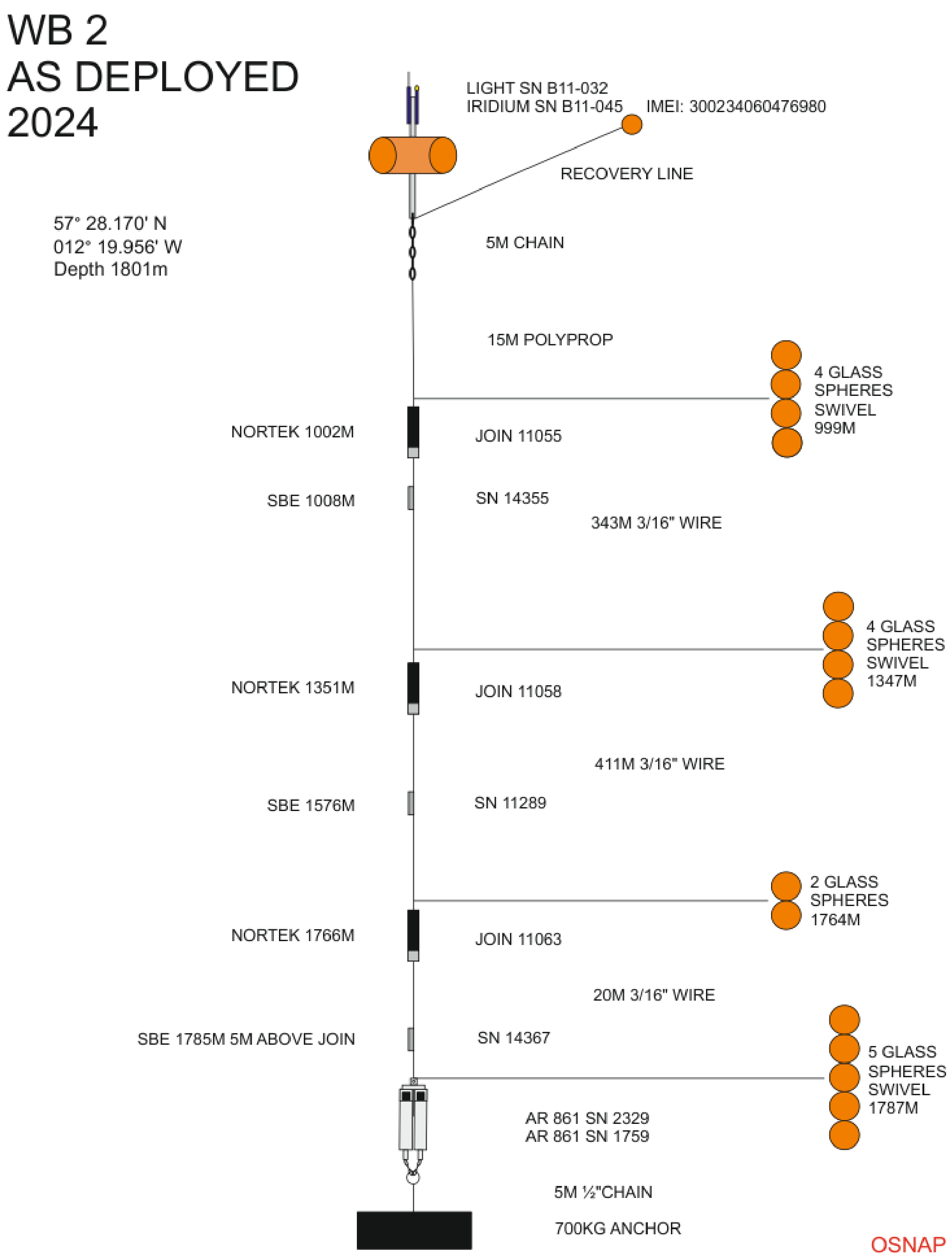

Triangulation Survey for: teletest2
Corrected water depth: 2685 m.
Release Height: 6.0 m. Transducer depth: 7.5
Latitude 57 57.49 N, Longitude 21 4.52 W
Distance from target: NaNm
Fallback = 138m/ 0.07nm
Anchor drop
Anchor seabed location
Latitude
Longitude
57.97
57.965
57.96
57.955
57.95
57.945
-21.1
-21.09
-21.08
-21.07
-21.06
-21.05

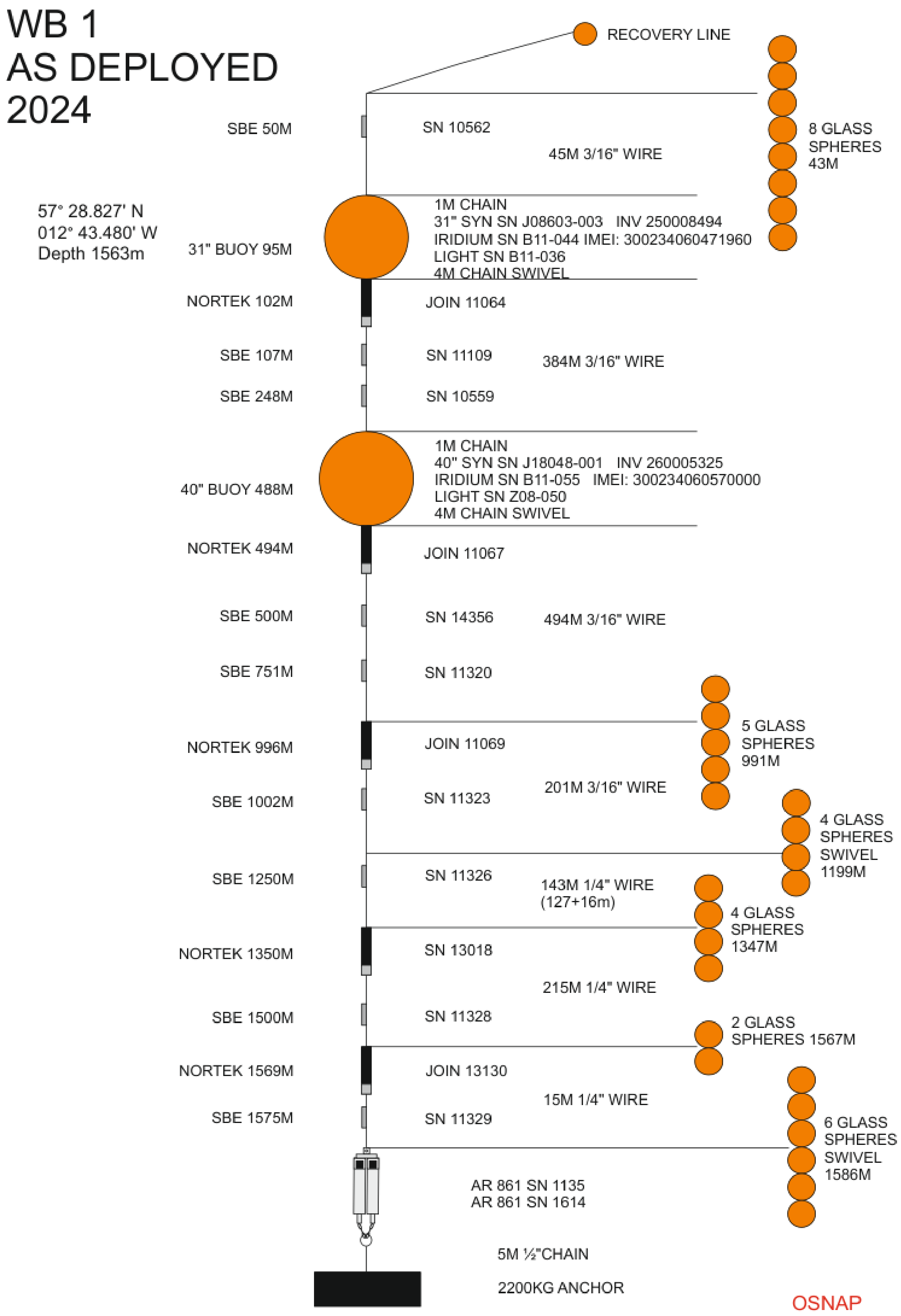
APPENDIX Y DIAGRAMS OF DEPLOYED MOORINGS

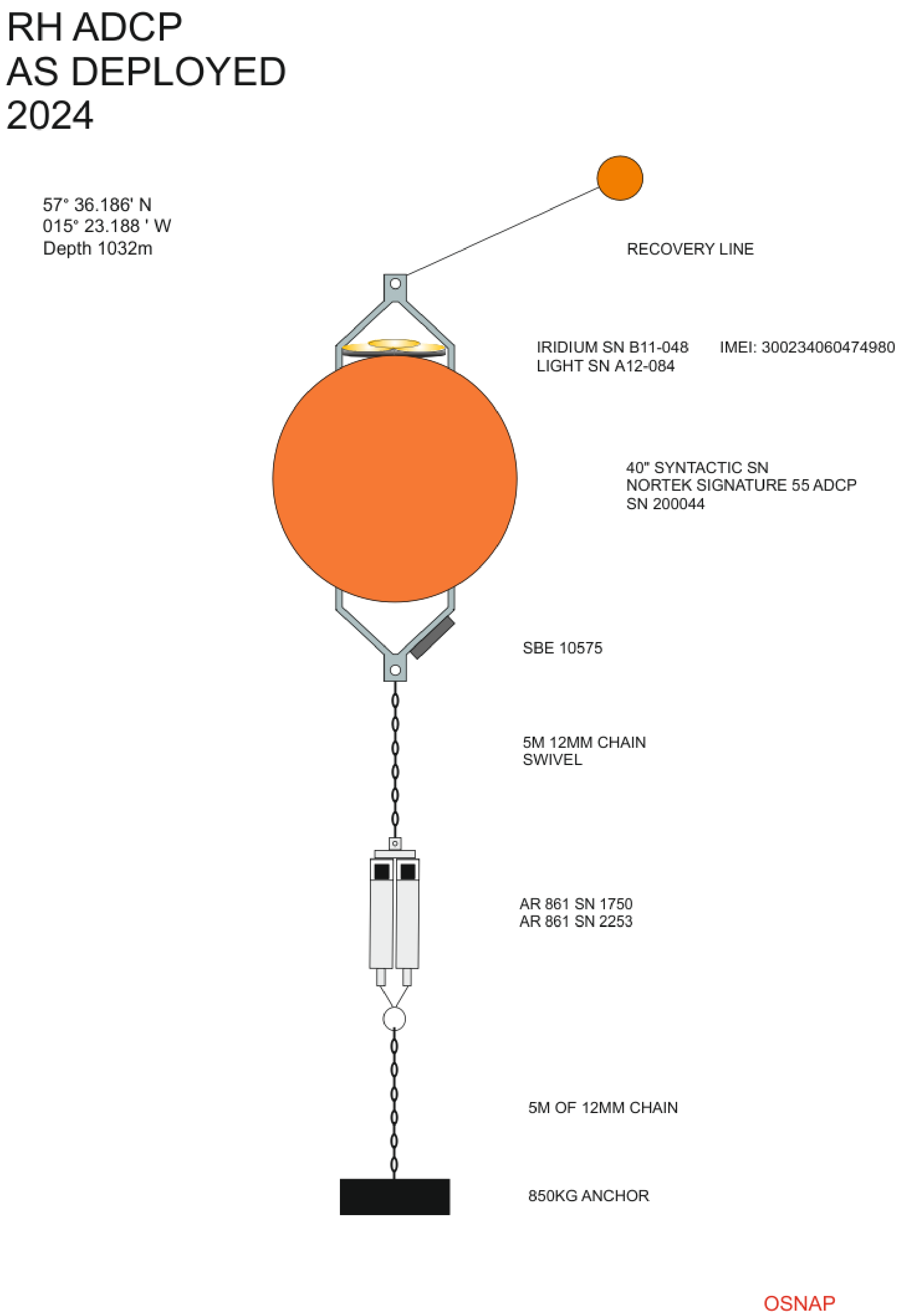


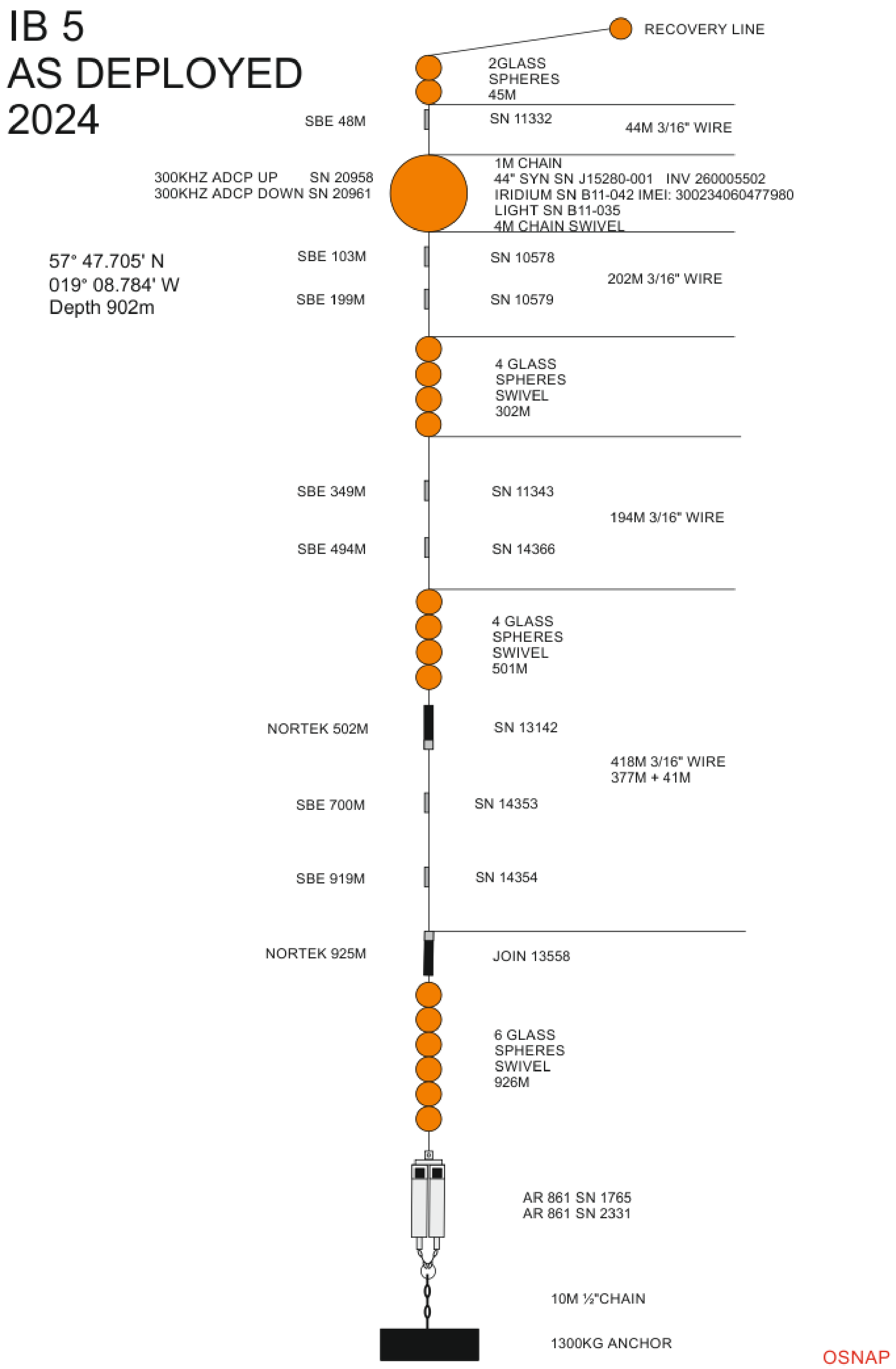

EB 1 TELEMETRY
AS DEPLOYED
2024
PAGE 1 OF 2
57° 06.893' N
009° 32.869' W
Depth 1755m
RECOVERY LINE
BUOY 43M
31" SYN SN J18073-002 INV 260005327
XEOS BEACON SN 59 IMEI: 300434061881140
5M CHAIN SWIVEL
DEEP SEA HO 49M
SeaFET 2061 + ODO 21320
SBE 49M
SN 3279
9 GLASS SPHERES
CLAMP ON 1M
SPACING
91M - 99M
NORTEK 99M
SN 11023
SBE 100M
SN 3280
DEEP SUNA 200M
SN 1540
437M (50M+387M) 1/4" TELEMETRY WIRE
SBE 201M
SN 50388
SUNA BATT 202M
SN 1152
NORTEK 250M
SN 11042
SBE 255M
SN 4465
Mk3 49" TELEMETRY BUOY 488M
TELEMETRY SWIVEL 260004096
49" SYNTACTIC SN J17050-001 INV 260004310
IRIDIUM SN B11-053 IMEI: 300234060479980
LIGHT SN Y02-045
TELEMETRY SWIVEL 260002882
NORTEK 499M
SN 11046
1276M 1/4" TELEMETRY WIRE
SBE 504M
SN 4798
SBE ODO 505M
SN 15298
6 GLASS SPHERES
CLAMP ON 1M
SPACING
742M - 747M
SBE 752M
SN 4073
SBE ODO 753M
SN 15476
SBE ODO 953M
SN 14987
4 GLASS SPHERES
CLAMP ON 1M
SPACING
996M - 999M
OSNAP

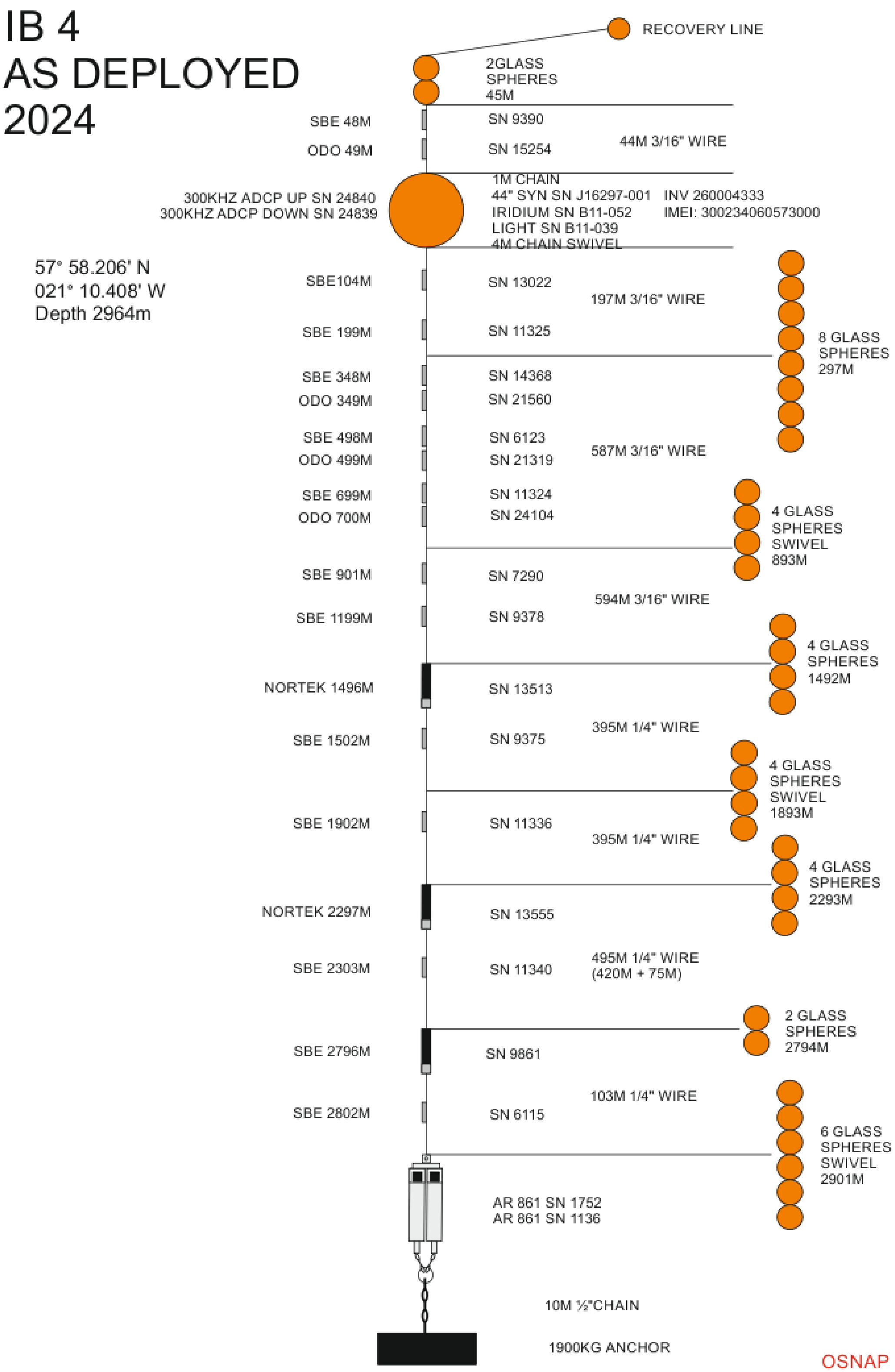

EB 1 TELEMETRY
AS DEPLOYED
2024
PAGE 2 OF 2
NORTEK 1000M
SN 11047
SBE 1005M
SN 4061
SBE 1250M
SN 4460
2 GLASS SPHERES
CLAMP ON 1M
SPACING
1350M - 1351M
NORTEK 1352M
SN 11048
4 GLASS SPHERES
CLAMP ON 1M
SPACING
1490M - 1493
SBE 1498M
SN 4463
SBE ODO 1648M
SN 3795
SBE 1763M
SN 3889
NORTEK 1768M
SN 11051
15M 1/4" WIRE
7 GLASS
SPHERES
SWIVEL
1785M
5M CHAIN
AR 861 SN 1999
AR 861 SN 1766
1.5M CHAIN
2100KG ANCHOR
OSNAP


WB 2
AS DEPLOYED
2024
57° 28.170' N
012° 19.956' W
Depth 1801m
LIGHT SN B11-032
IRIDIUM SN B11-045
IMEI: 300234060476980
RECOVERY LINE
5M CHAIN
15M POLYPROP
4 GLASS
SPHERES
SWIVEL
999M
NORTEK 1002M
JOIN 11055
SBE 1008M
SN 14355
343M 3/16" WIRE
4 GLASS
SPHERES
SWIVEL
1347M
NORTEK 1351M
JOIN 11058
411M 3/16" WIRE
SBE 1576M
SN 11289
2 GLASS
SPHERES
1764M
NORTEK 1766M
JOIN 11063
20M 3/16" WIRE
SBE 1785M 5M ABOVE JOIN
SN 14367
5 GLASS
SPHERES
SWIVEL
1787M
AR 861 SN 2329
AR 861 SN 1759
5M ½"CHAIN
700KG ANCHOR
OSNAP

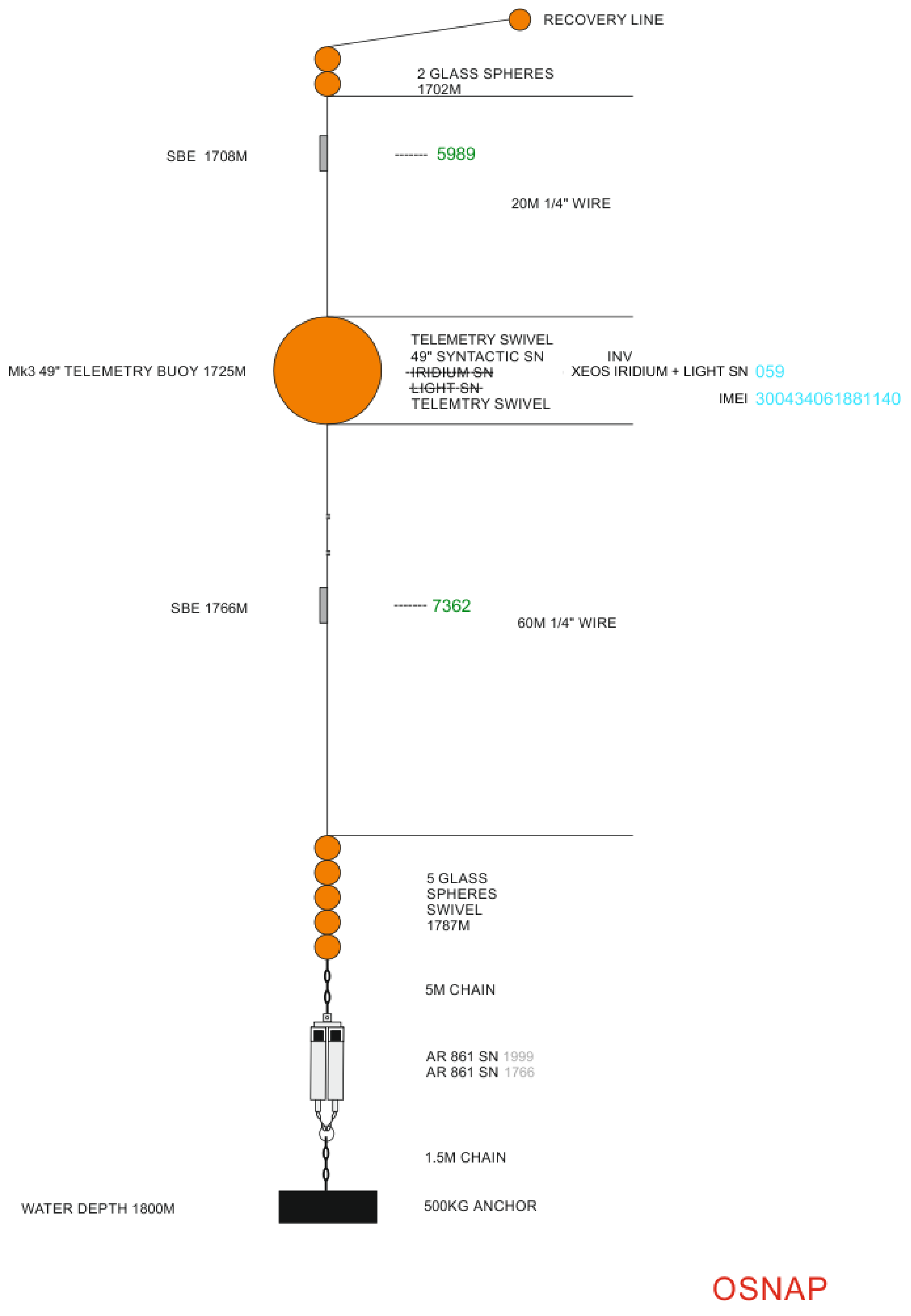

WB 1
AS DEPLOYED
2024
57° 28.827' N
012° 43.480' W
Depth 1563m
RECOVERY LINE
8 GLASS SPHERES 43M
SBE 50M
SN 10562
45M 3/16" WIRE
1M CHAIN
31" SYN SN J08603-003 INV 250008494
IRIDIUM SN B11-044 IMEI: 300234060471960
LIGHT SN B11-036
4M CHAIN SWIVEL
31" BUOY 95M
NORTEK 102M
JOIN 11064
SBE 107M
SN 11109
384M 3/16" WIRE
SBE 248M
SN 10559
1M CHAIN
40" SYN SN J18048-001 INV 260005325
IRIDIUM SN B11-055 IMEI: 300234060570000
LIGHT SN Z08-050
4M CHAIN SWIVEL
40" BUOY 488M
NORTEK 494M
JOIN 11067
SBE 500M
SN 14356
494M 3/16" WIRE
SBE 751M
SN 11320
5 GLASS SPHERES 991M
NORTEK 996M
JOIN 11069
SBE 1002M
SN 11323
201M 3/16" WIRE
4 GLASS SPHERES SWIVEL 1199M
SBE 1250M
SN 11326
143M 1/4" WIRE (127+16m)
4 GLASS SPHERES 1347M
NORTEK 1350M
SN 13018
215M 1/4" WIRE
SBE 1500M
SN 11328
2 GLASS SPHERES 1567M
NORTEK 1569M
JOIN 13130
15M 1/4" WIRE
SBE 1575M
SN 11329
6 GLASS SPHERES SWIVEL 1586M
AR 861 SN 1135
AR 861 SN 1614
5M ½"CHAIN
2200KG ANCHOR
OSNAP


RH ADCP
AS DEPLOYED
2024
57° 36.186' N
015° 23.188 ' W
Depth 1032m
RECOVERY LINE
IRIDIUM SN B11-048
IMEI: 300234060474980
LIGHT SN A12-084
40" SYNTACTIC SN
NORTEK SIGNATURE 55 ADCP
SN 200044
SBE 10575
5M 12MM CHAIN
SWIVEL
AR 861 SN 1750
AR 861 SN 2253
5M OF 12MM CHAIN
850KG ANCHOR
OSNAP

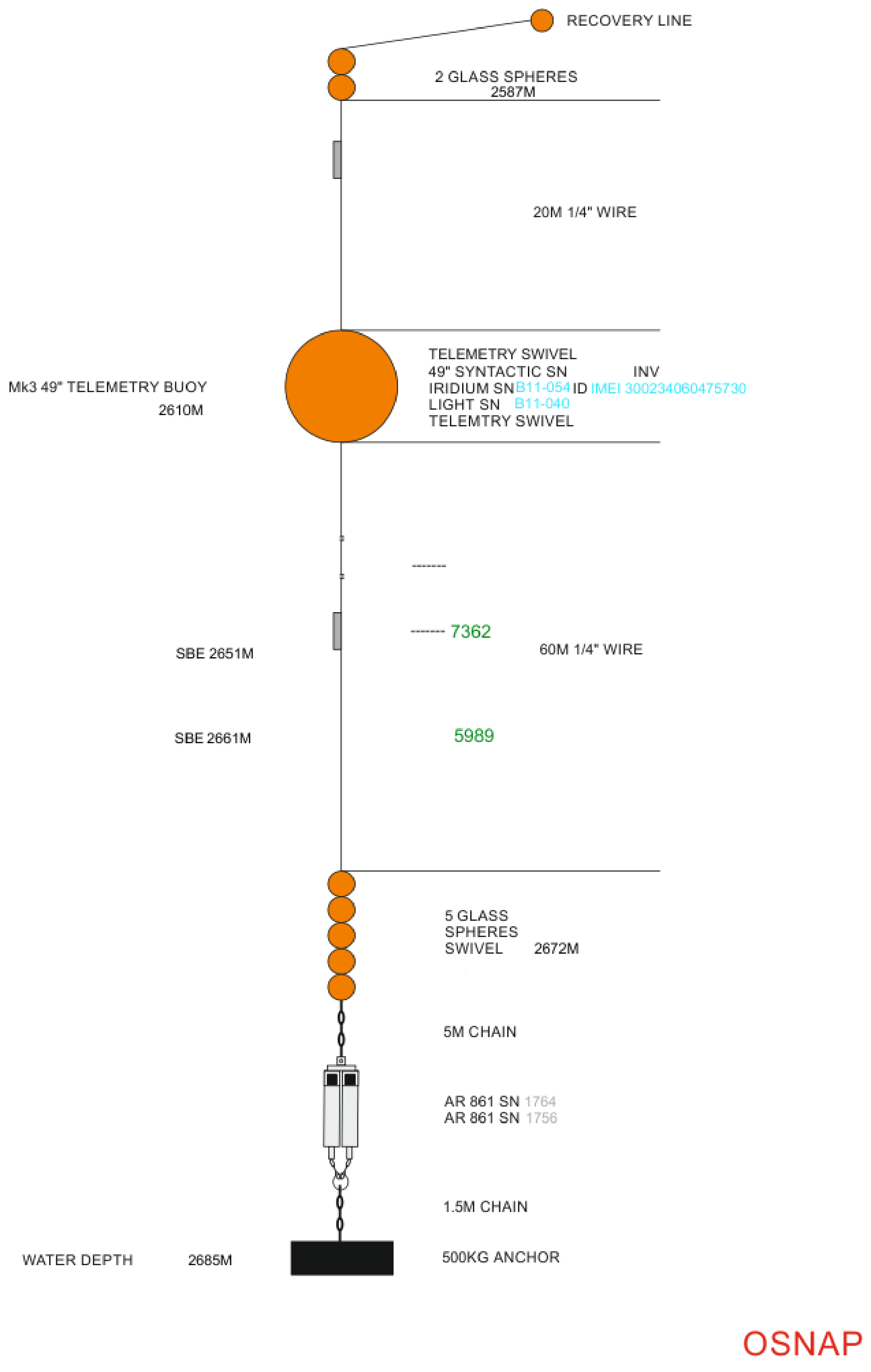

IB 5
AS DEPLOYED
2024
57° 47.705' N
019° 08.784' W
Depth 902m
RECOVERY LINE
2GLASS
SPHERES
45M
SBE 48M
SN 11332
44M 3/16" WIRE
300KHZ ADCP UP SN 20958
300KHZ ADCP DOWN SN 20961
1M CHAIN
44" SYN SN J15280-001 INV 260005502
IRIDIUM SN B11-042 IMEI: 300234060477980
LIGHT SN B11-035
4M CHAIN SWIVEL
SBE 103M
SN 10578
202M 3/16" WIRE
SBE 199M
SN 10579
4 GLASS
SPHERES
SWIVEL
302M
SBE 349M
SN 11343
194M 3/16" WIRE
SBE 494M
SN 14366
4 GLASS
SPHERES
SWIVEL
501M
NORTEK 502M
SN 13142
418M 3/16" WIRE
377M + 41M
SBE 700M
SN 14353
SBE 919M
SN 14354
NORTEK 925M
JOIN 13558
6 GLASS
SPHERES
SWIVEL
926M
AR 861 SN 1765
AR 861 SN 2331
10M ½"CHAIN
1300KG ANCHOR
OSNAP


IB 4
AS DEPLOYED
2024
57° 58.206' N
021° 10.408' W
Depth 2964m
RECOVERY LINE
2GLASS
SPHERES
45M
SBE 48M
SN 9390
ODO 49M
SN 15254
44M 3/16" WIRE
1M CHAIN
300KHZ ADCP UP SN 24840
300KHZ ADCP DOWN SN 24839
44" SYN SN J16297-001
INV 260004333
IRIDIUM SN B11-052
IMEI: 300234060573000
LIGHT SN B11-039
4M CHAIN SWIVEL
SBE104M
SN 13022
197M 3/16" WIRE
SBE 199M
SN 11325
8 GLASS
SPHERES
297M
SBE 348M
SN 14368
ODO 349M
SN 21560
SBE 498M
SN 6123
587M 3/16" WIRE
ODO 499M
SN 21319
SBE 699M
SN 11324
ODO 700M
SN 24104
4 GLASS
SPHERES
SWIVEL
893M
SBE 901M
SN 7290
594M 3/16" WIRE
SBE 1199M
SN 9378
4 GLASS
SPHERES
1492M
NORTEK 1496M
SN 13513
395M 1/4" WIRE
SBE 1502M
SN 9375
4 GLASS
SPHERES
SWIVEL
1893M
SBE 1902M
SN 11336
395M 1/4" WIRE
4 GLASS
SPHERES
2293M
NORTEK 2297M
SN 13555
495M 1/4" WIRE
(420M + 75M)
SBE 2303M
SN 11340
2 GLASS
SPHERES
2794M
SBE 2796M
SN 9861
103M 1/4" WIRE
SBE 2802M
SN 6115
6 GLASS
SPHERES
SWIVEL
2901M
AR 861 SN 1752
AR 861 SN 1136
10M ½"CHAIN
1900KG ANCHOR
OSNAP

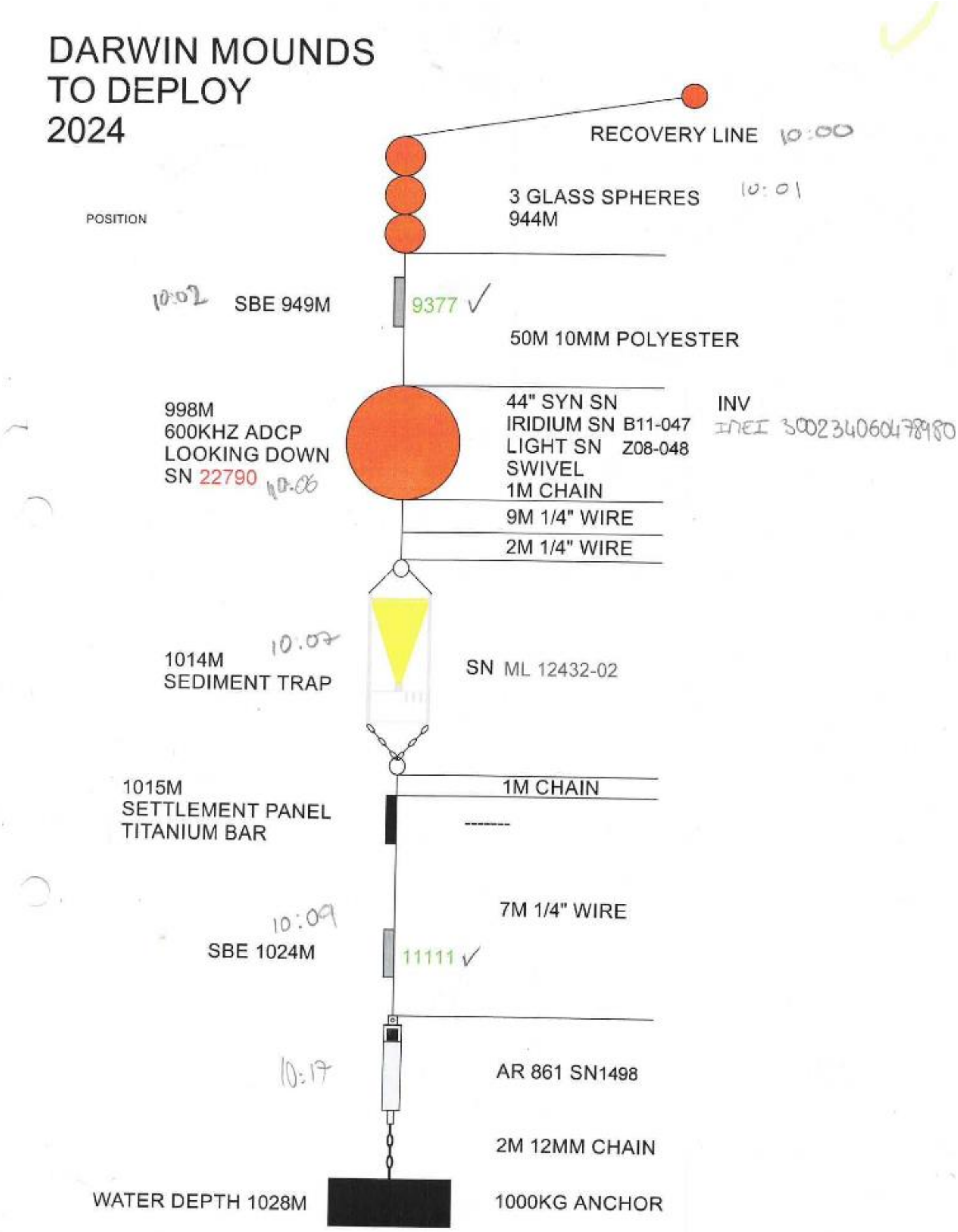
TELEMETRY TEST 1 (RTEB1)
DEPLOYED + RECOVERED
2024

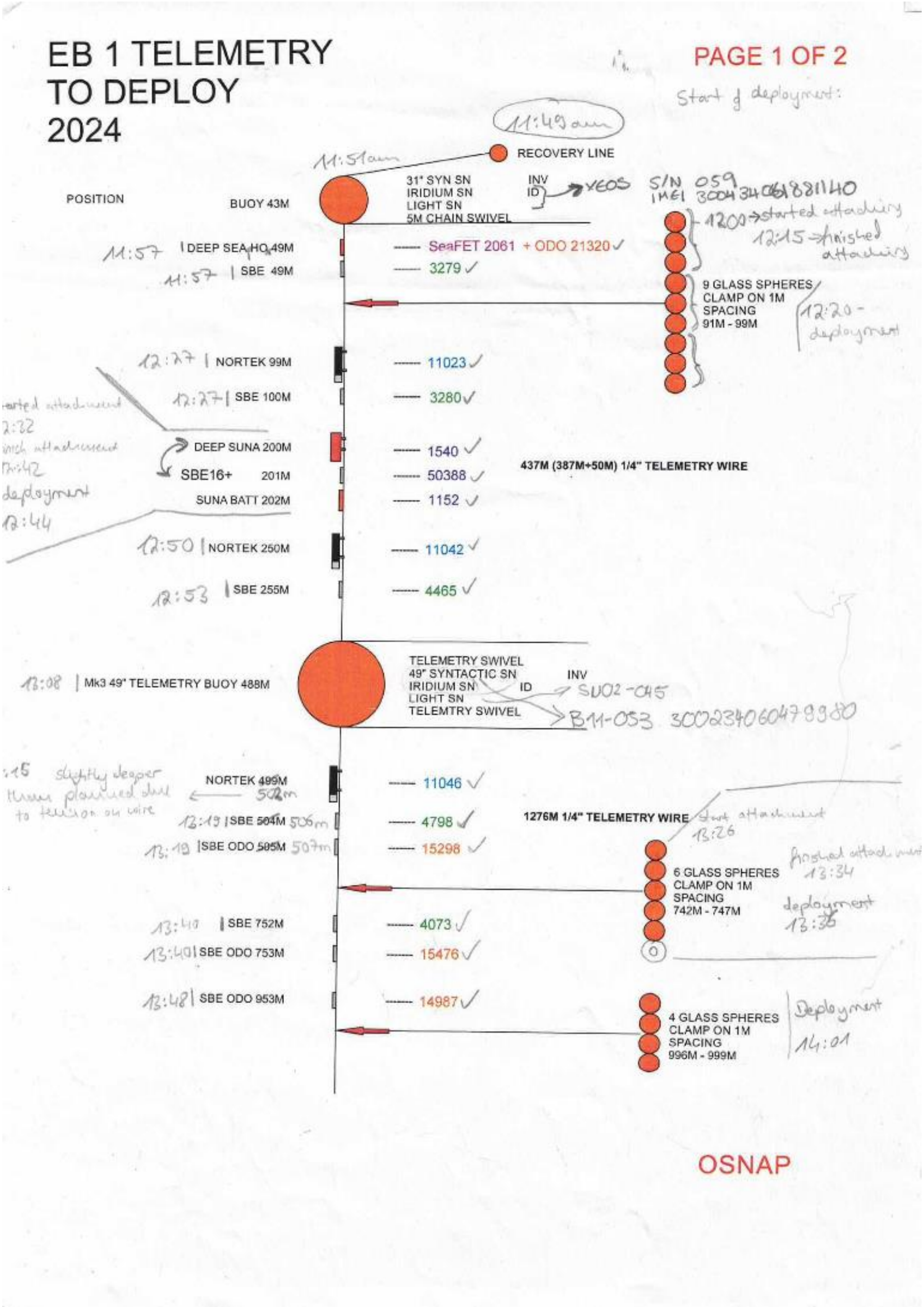


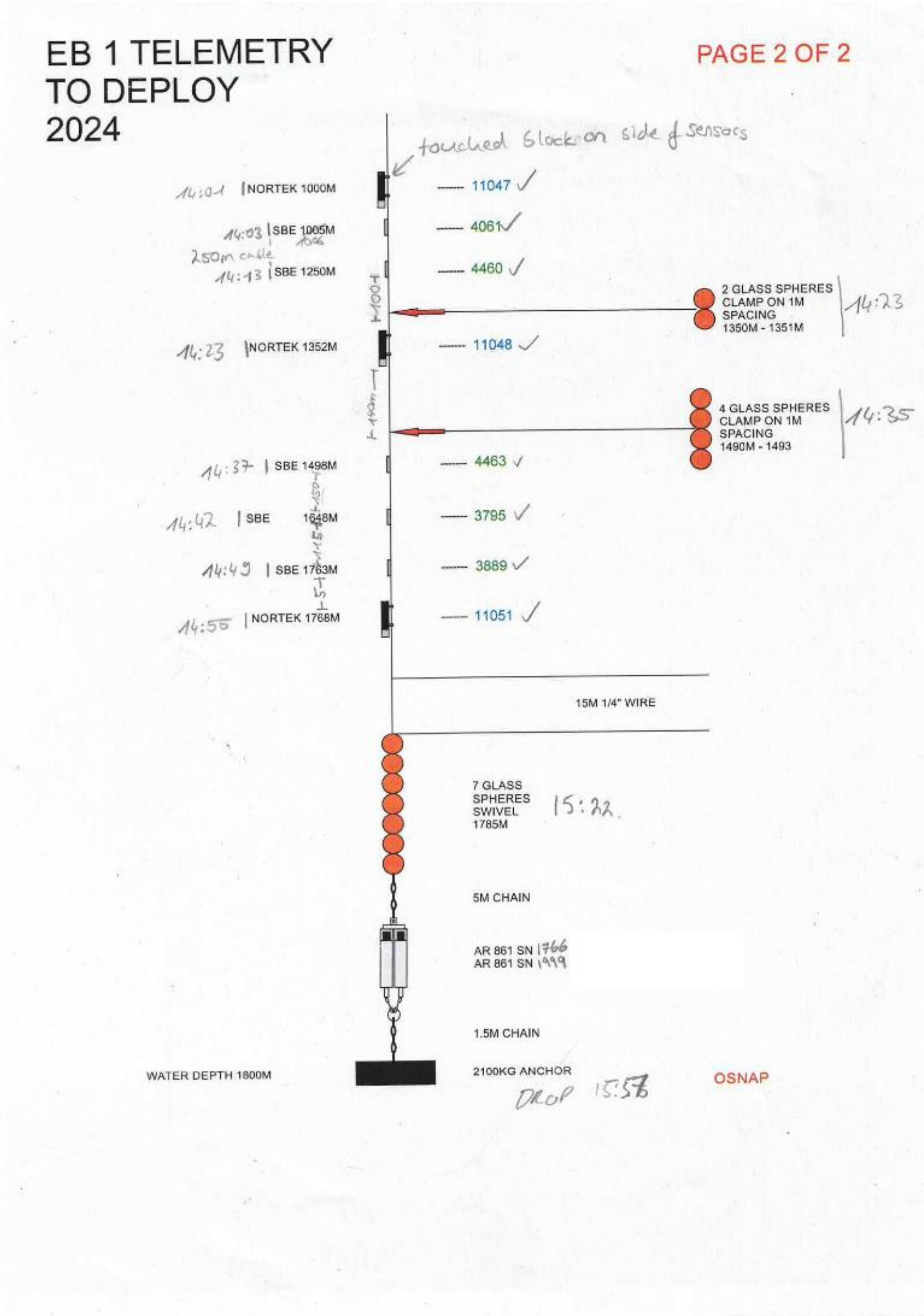
TELEMETRY TEST 2 (IB4)
DEPLOYED + RECOVERED
2024

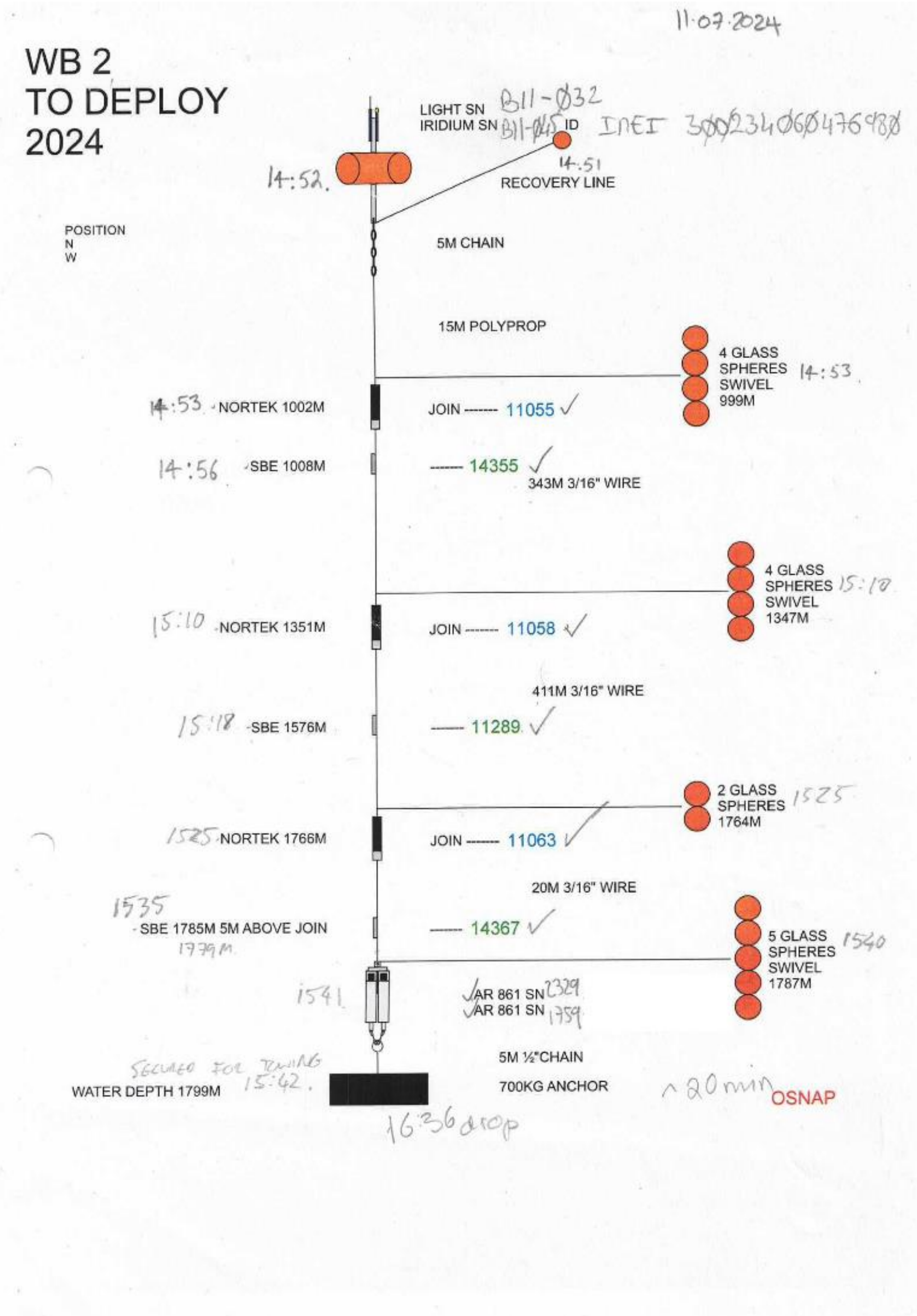


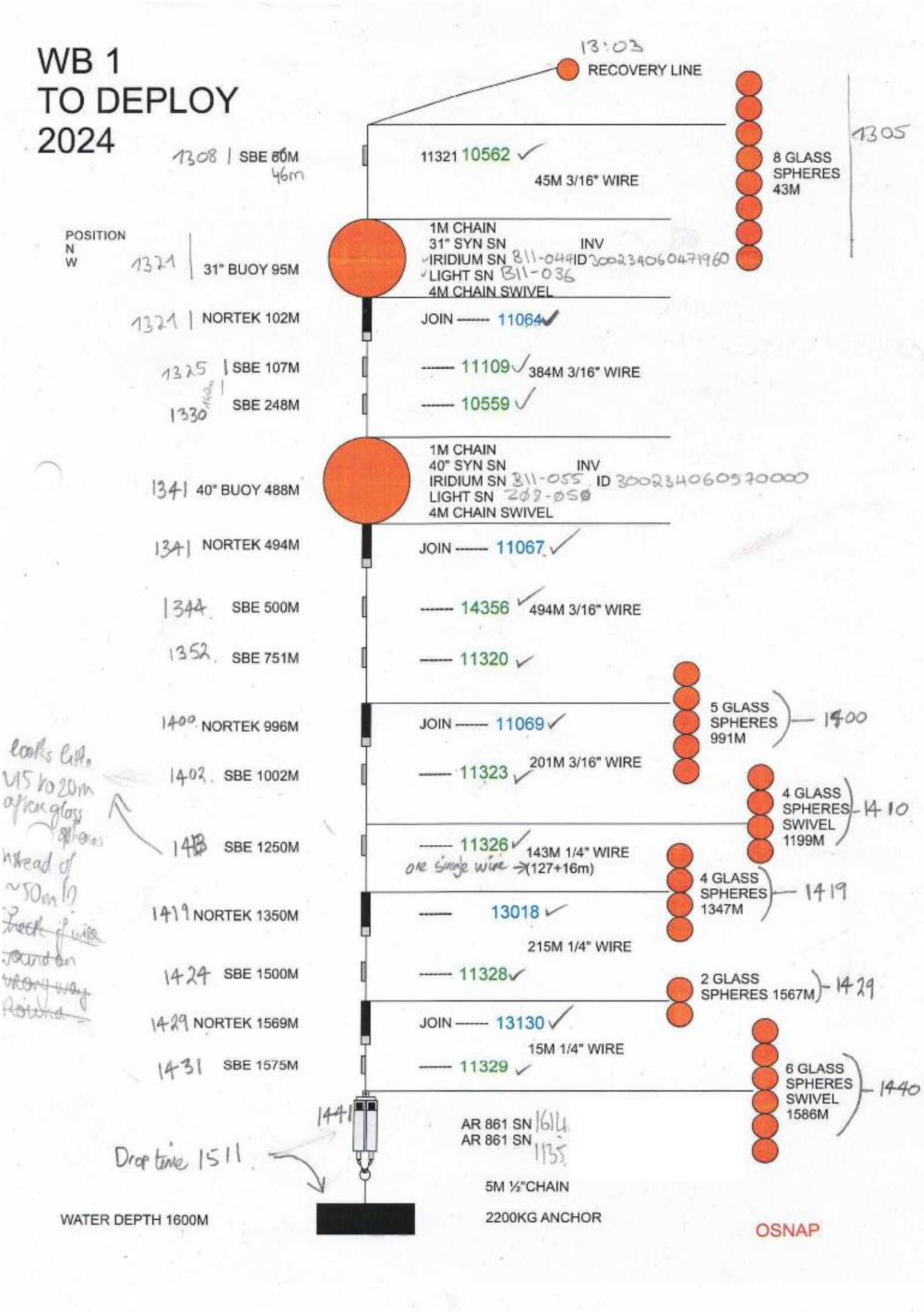
APPENDIX Z DECK LOGS OF DEPLOYED MOORINGS

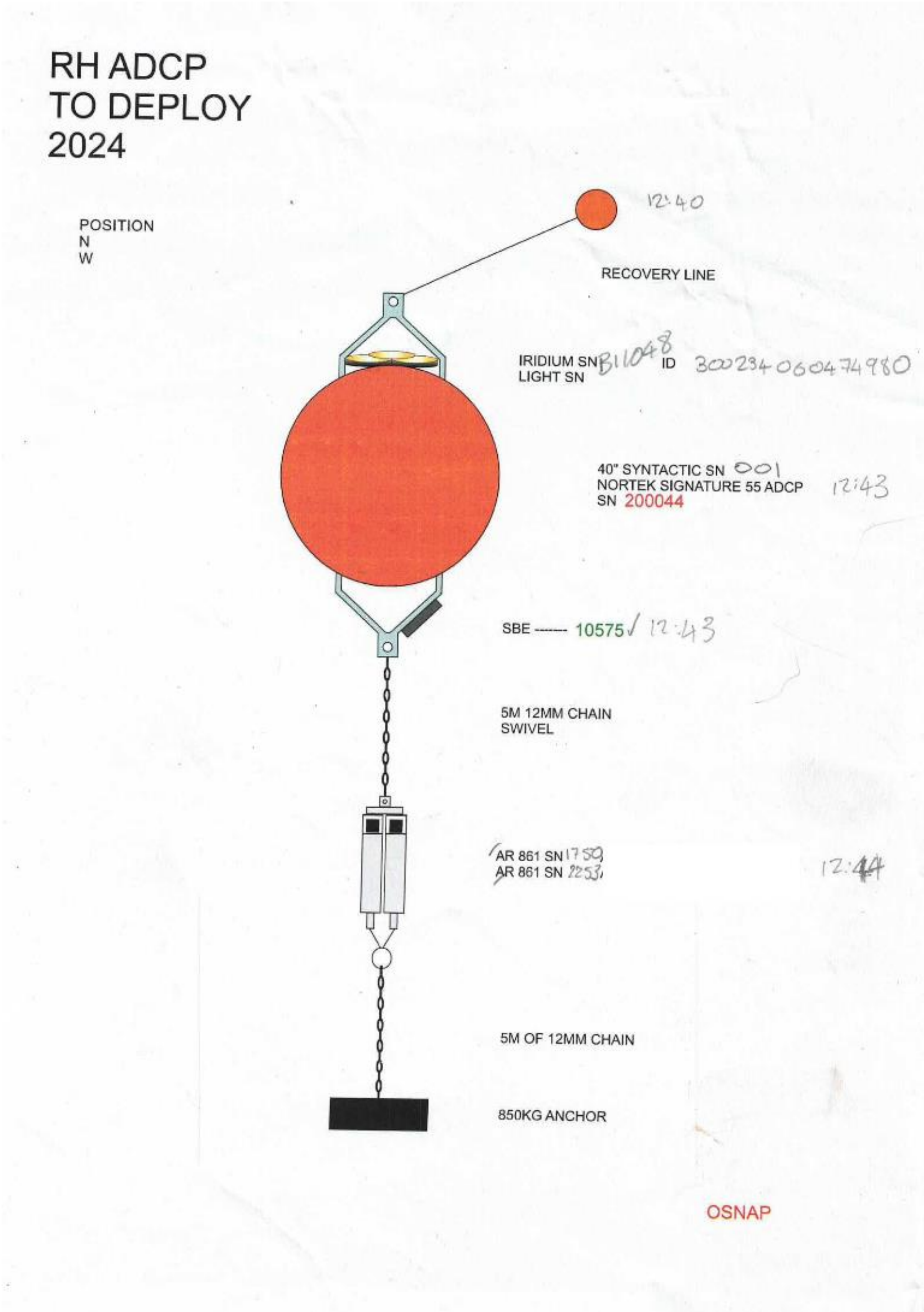


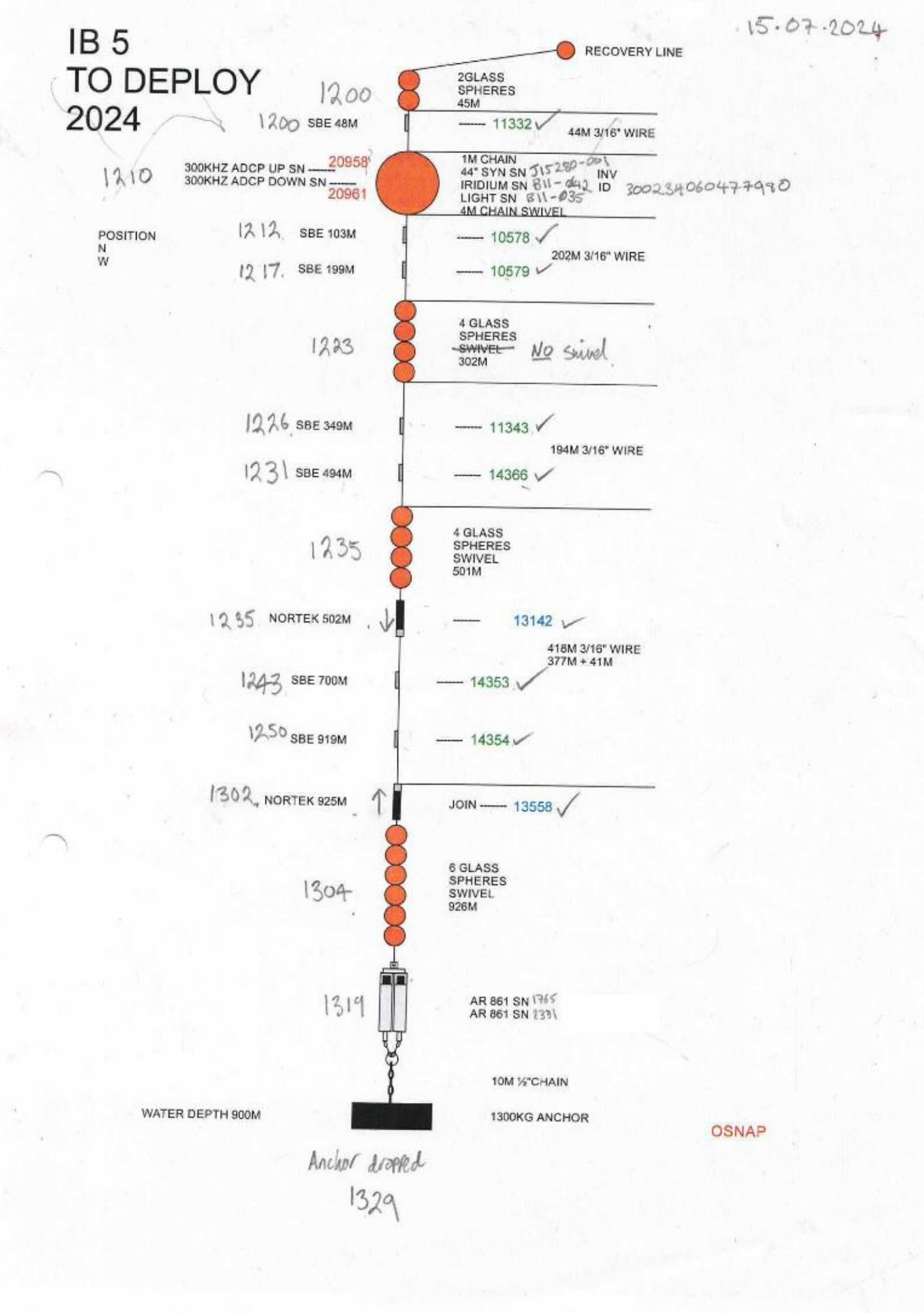

EB 1 TELEMETRY
TO DEPLOY
2024
PAGE 1 OF 2
Start of deployment:
11:49 am
RECOVERY LINE
11:51 am
POSITION
BUOY 43M
31" SYN SN
IRIDIUM SN
LIGHT SN
5M CHAIN SWIVEL
INV ID
XEOS
S/N 059
IMEI 300434061881140
1200 started attaching
12:15 finished attaching
11:57 DEEP SEA HQ 49M
SeaFET 2061 + ODO 21320
11:57 SBE 49M
3279
9 GLASS SPHERES
CLAMP ON 1M
SPACING
91M - 99M
12:20 - deployment
12:27 NORTEK 99M
11023
12:27 SBE 100M
3280
started attachment
12:32
finish attachment
12:42
deployment
12:44
DEEP SUNA 200M
1540
SBE16+ 201M
50388
SUNA BATT 202M
1152
437M (387M+50M) 1/4" TELEMETRY WIRE
12:50 NORTEK 250M
11042
12:53 SBE 255M
4465
13:08 Mk3 49" TELEMETRY BUOY 488M
TELEMETRY SWIVEL
49" SYNTACTIC SN
IRIDIUM SN
LIGHT SN
TELEMTRY SWIVEL
INV ID
SU02-045
B11-053 300234060479980
:15 slightly deeper than planned due to tension on wire
NORTEK 499M 502m
11046
13:19 SBE 504M 506m
4798
1276M 1/4" TELEMETRY WIRE
start attachment 13:26
13:19 SBE ODO 505M 507m
15298
6 GLASS SPHERES
CLAMP ON 1M
SPACING
742M - 747M
finished attachment 13:34
deployment 13:36
13:40 SBE 752M
4073
13:40 SBE ODO 753M
15476
13:48 SBE ODO 953M
14987
4 GLASS SPHERES
CLAMP ON 1M
SPACING
996M - 999M
Deployment 14:01
OSNAP


EB 1 TELEMETRY
TO DEPLOY
2024
PAGE 2 OF 2
touched block on side of sensors
14:01 NORTEK 1000M
11047 ✓
14:03 SBE 1005M
4061 ✓
250m cable
14:13 SBE 1250M
4460 ✓
2 GLASS SPHERES
CLAMP ON 1M
SPACING
1350M - 1351M
14:23
14:23 NORTEK 1352M
11048 ✓
4 GLASS SPHERES
CLAMP ON 1M
SPACING
1490M - 1493
14:35
14:37 SBE 1498M
4463 ✓
14:42 SBE 1648M
3795 ✓
14:49 SBE 1763M
3889 ✓
14:55 NORTEK 1768M
11051 ✓
15M 1/4" WIRE
7 GLASS
SPHERES
SWIVEL
1785M
15:22.
5M CHAIN
AR 861 SN 1766
AR 861 SN 1999
1.5M CHAIN
WATER DEPTH 1800M
2100KG ANCHOR
DROP 15:56
OSNAP

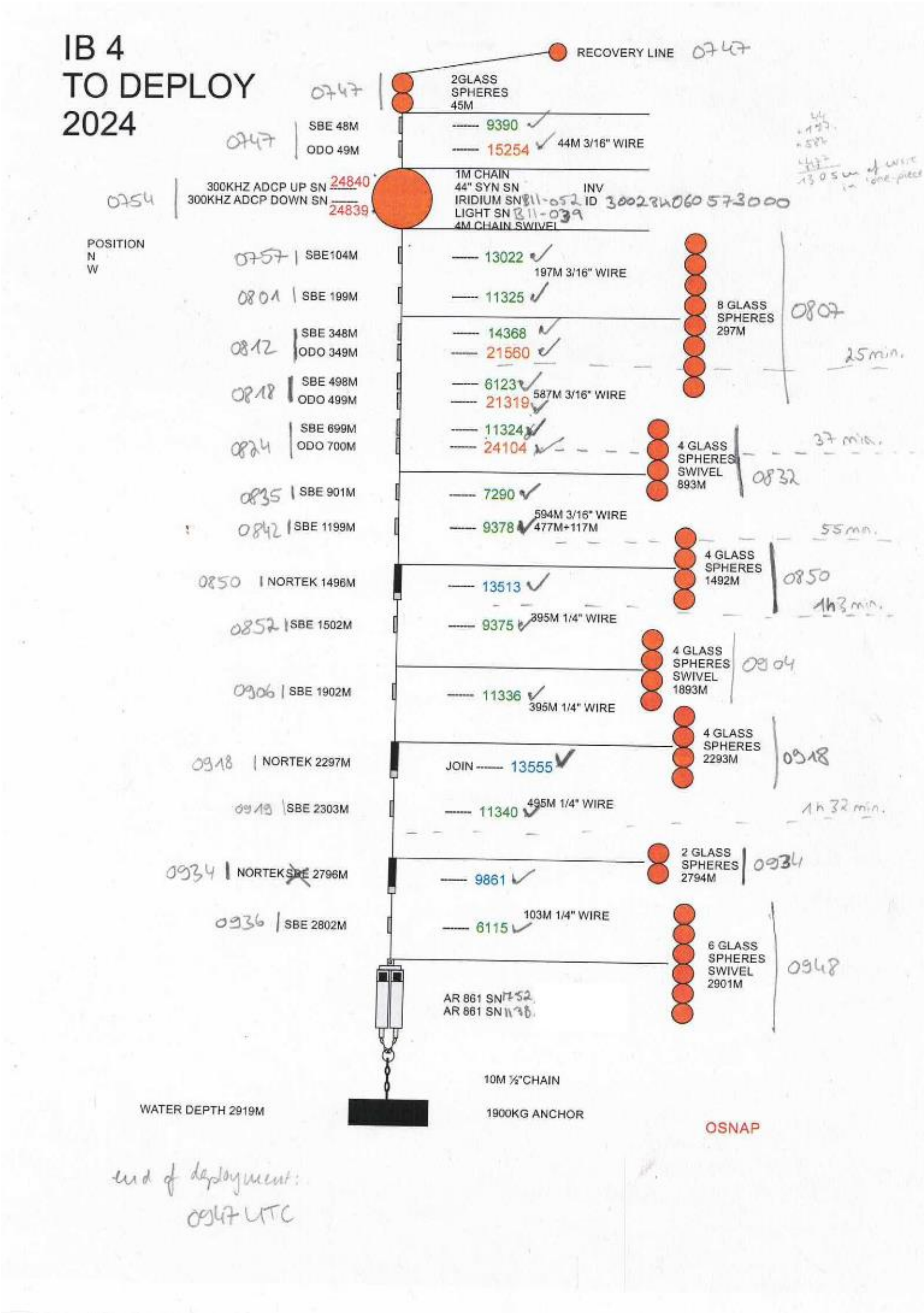

11.07.2024
WB 2
TO DEPLOY
2024
LIGHT SN B11-032
IRIDIUM SN B11-045 ID IMEI 300234060476980
14:52.
14:51
RECOVERY LINE
POSITION
N
W
5M CHAIN
15M POLYPROP
4 GLASS
SPHERES
SWIVEL
999M
14:53
14:53 NORTEK 1002M
JOIN ------- 11055
14:56 SBE 1008M
------- 14355
343M 3/16" WIRE
4 GLASS
SPHERES
SWIVEL
1347M
15:10
15:10 NORTEK 1351M
JOIN ------- 11058
411M 3/16" WIRE
15:18 SBE 1576M
------- 11289
2 GLASS
SPHERES
1764M
1525
1525 NORTEK 1766M
JOIN ------- 11063
20M 3/16" WIRE
1535
SBE 1785M 5M ABOVE JOIN
1779M
------- 14367
5 GLASS
SPHERES
SWIVEL
1787M
1540
1541
AR 861 SN 2329
AR 861 SN 1759
5M ½"CHAIN
SECURED FOR TOWING 15:42.
WATER DEPTH 1799M
700KG ANCHOR
~20min
OSNAP
16:36 drop

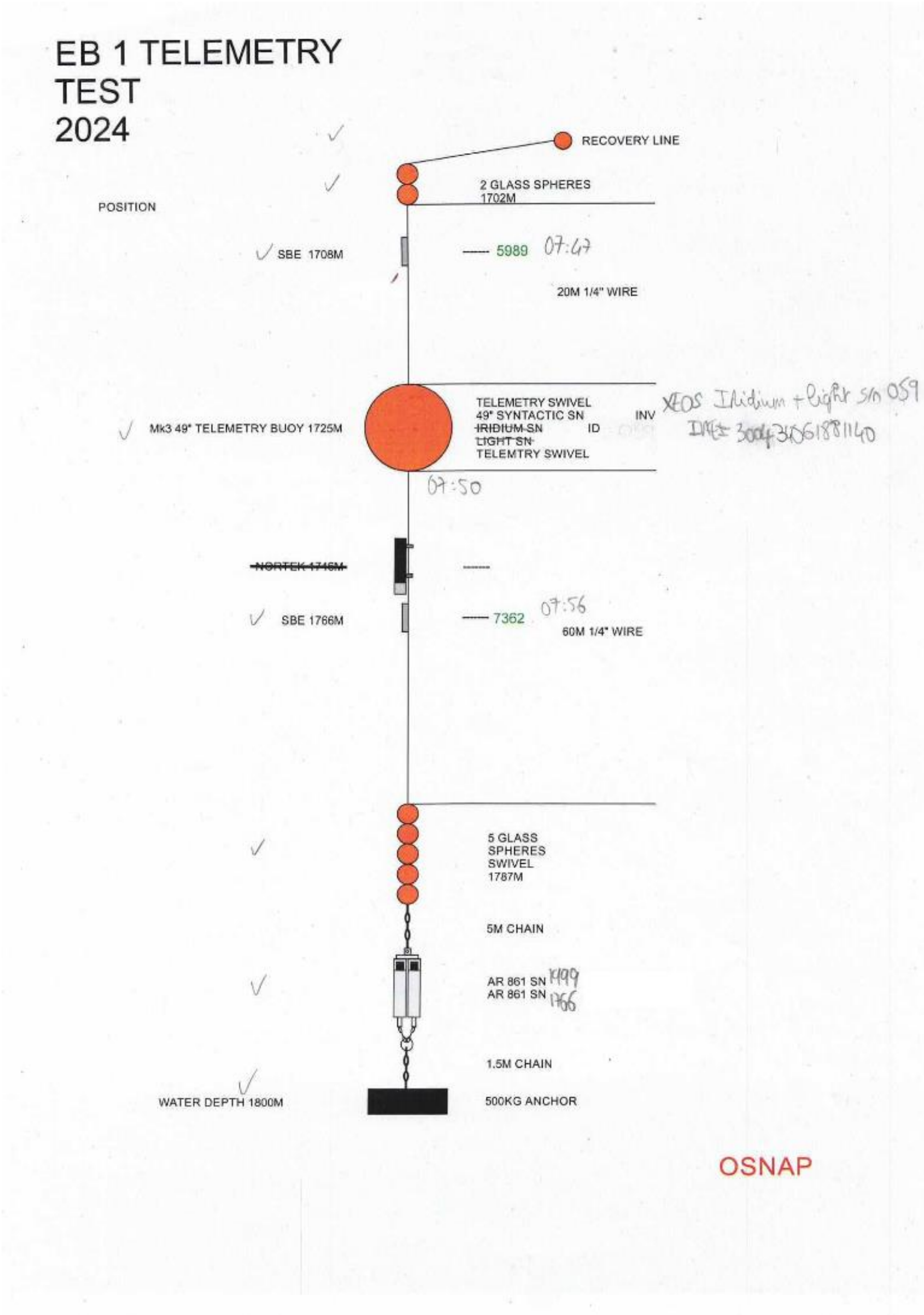

WB 1
TO DEPLOY
2024
13:03
RECOVERY LINE
1308 | SBE 60M
46m
11321 10562
45M 3/16" WIRE
8 GLASS
SPHERES
43M
1305
POSITION
N
W
1321 | 31" BUOY 95M
1M CHAIN
31" SYN SN
INV
IRIDIUM SN 811-044 ID 300234060471960
LIGHT SN B11-036
4M CHAIN SWIVEL
1321 | NORTEK 102M
JOIN ------ 11064
1325 | SBE 107M
------ 11109
384M 3/16" WIRE
1330 SBE 248M
------ 10559
1M CHAIN
40" SYN SN
INV
IRIDIUM SN B11-055 ID 300234060570000
LIGHT SN 208-050
4M CHAIN SWIVEL
1341 40" BUOY 488M
1341 NORTEK 494M
JOIN ------ 11067
1344 SBE 500M
------ 14356
494M 3/16" WIRE
1352 SBE 751M
------ 11320
1400 NORTEK 996M
JOIN ------ 11069
5 GLASS
SPHERES
991M
1400
looks like
U15 to 20m
after glass
spheres
instead of
~50m !?
1402 SBE 1002M
------ 11323
201M 3/16" WIRE
4 GLASS
SPHERES
SWIVEL
1199M
1410
1413 SBE 1250M
------ 11326
143M 1/4" WIRE
one single wire (127+16m)
4 GLASS
SPHERES
1347M
1419
1419 NORTEK 1350M
------ 13018
215M 1/4" WIRE
1424 SBE 1500M
------ 11328
2 GLASS
SPHERES 1567M
1429
1429 NORTEK 1569M
JOIN ------ 13130
15M 1/4" WIRE
1431 SBE 1575M
------ 11329
6 GLASS
SPHERES
SWIVEL
1586M
1440
1441
AR 861 SN 1614
AR 861 SN 1135
Drop time 1511
5M ½"CHAIN
WATER DEPTH 1600M
2200KG ANCHOR
OSNAP

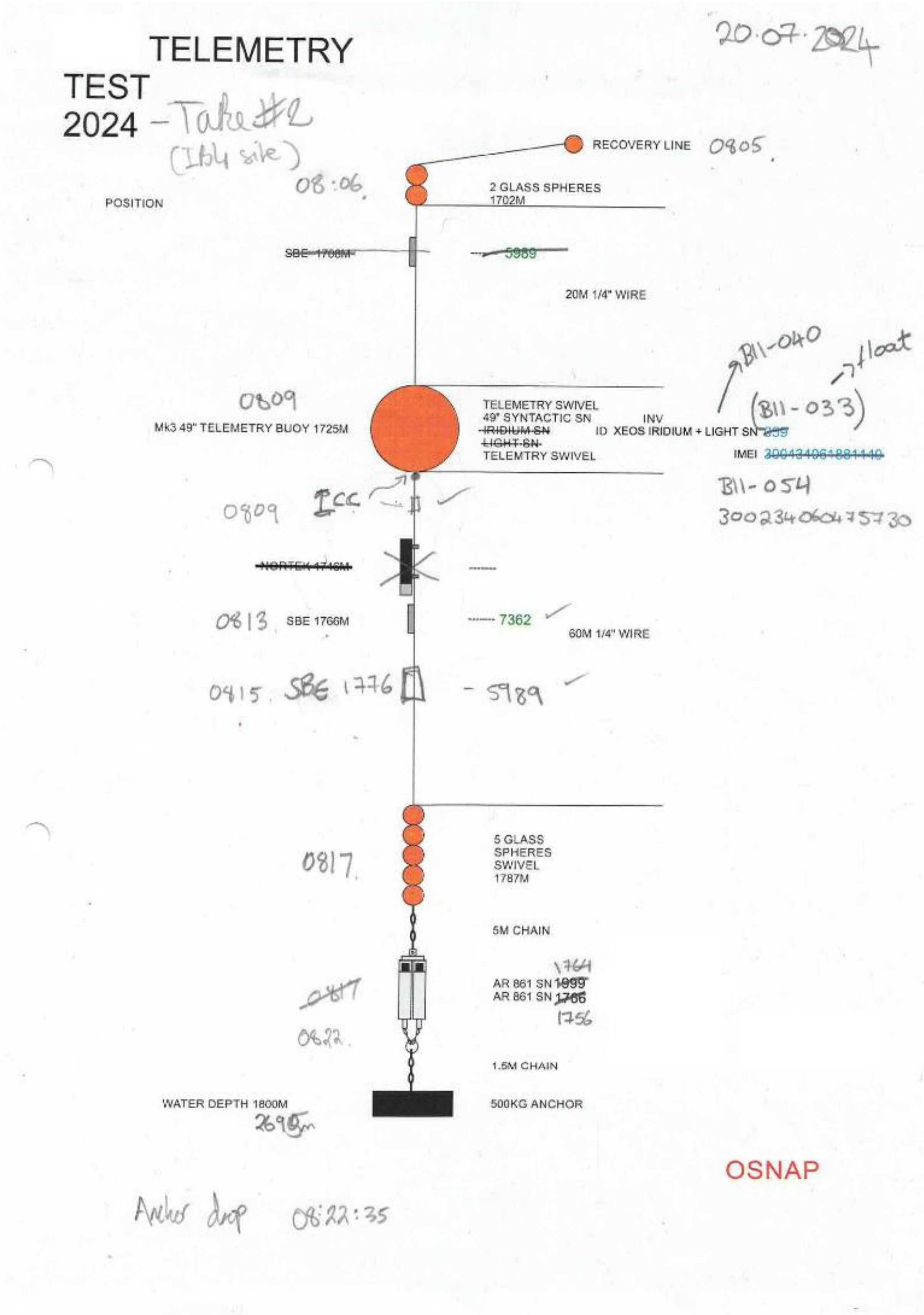

RH ADCP
TO DEPLOY
2024
POSITION
N
W
12:40
RECOVERY LINE
IRIDIUM SN B11048 ID 300234060474980
LIGHT SN
40" SYNTACTIC SN 001
NORTEK SIGNATURE 55 ADCP
SN 200044
12:43
SBE ------ 10575 ✓ 12:43
5M 12MM CHAIN
SWIVEL
AR 861 SN 1759
AR 861 SN 2253
12:44
5M OF 12MM CHAIN
850KG ANCHOR
OSNAP



IB 5
TO DEPLOY
2024
15.07.2024
RECOVERY LINE
1200
2GLASS SPHERES 45M
1200 SBE 48M
11332
44M 3/16" WIRE
1210
300KHZ ADCP UP SN 20958
300KHZ ADCP DOWN SN 20961
1M CHAIN
44" SYN SN J15280-001
IRIDIUM SN B11-042
LIGHT SN B11-035
4M CHAIN SWIVEL
INV ID 300234060477990
POSITION
N
W
1212 SBE 103M
10578
1217 SBE 199M
10579
202M 3/16" WIRE
1223
4 GLASS SPHERES ~~SWIVEL~~ 302M
No swivel
1226 SBE 349M
11343
194M 3/16" WIRE
1231 SBE 494M
14366
1235
4 GLASS SPHERES SWIVEL 501M
1235 NORTEK 502M
13142
418M 3/16" WIRE
377M + 41M
1243 SBE 700M
14353
1250 SBE 919M
14354
1302 NORTEK 925M
JOIN 13558
1304
6 GLASS SPHERES SWIVEL 926M
1319
AR 861 SN 1765
AR 861 SN 2331
10M ½"CHAIN
WATER DEPTH 900M
1300KG ANCHOR
OSNAP
Anchor dropped
1329


IB 4
TO DEPLOY
2024
RECOVERY LINE 0747
0747 2GLASS SPHERES 45M
0747 SBE 48M 9390
ODO 49M 15254
44M 3/16" WIRE
1M CHAIN
0754 300KHZ ADCP UP SN 24840
300KHZ ADCP DOWN SN 24839
44" SYN SN
IRIDIUM SN B11-052 INV ID 300234060573000
LIGHT SN B11-039
4M CHAIN SWIVEL
POSITION
N
W
0757 SBE104M 13022
197M 3/16" WIRE
0801 SBE 199M 11325
8 GLASS SPHERES 297M 0807
0812 SBE 348M 14368
ODO 349M 21560
25min.
0818 SBE 498M 6123
ODO 499M 21319
587M 3/16" WIRE
0824 SBE 699M 11324
ODO 700M 24104
37 min.
4 GLASS SPHERES SWIVEL 893M 0832
0835 SBE 901M 7290
0842 SBE 1199M 9378
594M 3/16" WIRE
477M+117M
55 min.
4 GLASS SPHERES 1492M 0850
0850 NORTEK 1496M 13513
1h3 min.
0852 SBE 1502M 9375
395M 1/4" WIRE
4 GLASS SPHERES SWIVEL 1893M 0904
0906 SBE 1902M 11336
395M 1/4" WIRE
4 GLASS SPHERES 2293M 0918
0918 NORTEK 2297M JOIN 13555
0919 SBE 2303M 11340
495M 1/4" WIRE
1h 32 min.
2 GLASS SPHERES 2794M 0934
0934 NORTEK ~~SBE~~ 2796M 9861
0936 SBE 2802M 6115
103M 1/4" WIRE
6 GLASS SPHERES SWIVEL 2901M 0948
AR 861 SN 1752
AR 861 SN 1138
10M ½"CHAIN
WATER DEPTH 2919M
1900KG ANCHOR
OSNAP
end of deployment:
0947 UTC


EB 1 TELEMETRY
TEST
2024
RECOVERY LINE
2 GLASS SPHERES
1702M
POSITION
SBE 1708M
5989
07:47
20M 1/4" WIRE
TELEMETRY SWIVEL
49" SYNTACTIC SN
INV
~~IRIDIUM SN~~
ID
~~LIGHT SN~~
TELEMTRY SWIVEL
XEOS Iridium + light S/n 059
IMEI= 300434061881140
Mk3 49" TELEMETRY BUOY 1725M
07:50
~~NORTEK 1746M~~
SBE 1766M
7362
07:56
60M 1/4" WIRE
5 GLASS
SPHERES
SWIVEL
1787M
5M CHAIN
AR 861 SN 1499
AR 861 SN 1466
1.5M CHAIN
WATER DEPTH 1800M
500KG ANCHOR
OSNAP


20.07.2024
TELEMETRY
TEST
2024 – Take #2
(IB4 site)
RECOVERY LINE 0805.
08:06.
2 GLASS SPHERES
1702M
POSITION
~~SBE 1708M~~
~~5989~~
20M 1/4" WIRE
B11-040
float
(B11-033)
0809
TELEMETRY SWIVEL
49" SYNTACTIC SN
~~IRIDIUM SN~~
~~LIGHT SN~~
TELEMTRY SWIVEL
Mk3 49" TELEMETRY BUOY 1725M
INV
ID XEOS IRIDIUM + LIGHT SN ~~239~~
IMEI ~~300434061881140~~
B11-054
300234060475730
0809 ICC
~~NORTEK 1746M~~
0813. SBE 1766M
7362
60M 1/4" WIRE
0415. SBE 1776
- 5989
5 GLASS
SPHERES
SWIVEL
1787M
0817.
5M CHAIN
1764
AR 861 SN ~~1999~~
AR 861 SN ~~1766~~
1756
~~0817~~
0822.
1.5M CHAIN
WATER DEPTH 1800M
2690m
500KG ANCHOR
OSNAP
Anchor drop 08:22:35

APPENDIX AA META DATA FROM DEPLOYED MOORINGS

Cruise DY181

Mooring deployment metadata log

Mooring: DMLTM
Date: 05/07/24

Arrival on site time: 09:00 Setup distance: 500 m ~~nm~~

	Time (UTC)	Latitude	Longitude	Uncorrected depth (m)	Corrected depth (m)
Start deployment	10:00	59°51.483'N	007° 02.532'W	1033	
End deployment (winch)	10:15:00	—	—	—	
Anchor drop	10:17:45	59° 51.662'N	007° 02.684'W	1027	

Deployment comments:
Line deployed by hand, no winch.
A/R diagnostic: vertical @ seabed

Acoustic tracking of descent	
Time (UTC)	Range (m)
10:20:10	576.8
10:22:10	721.8
10:23:10	898.3
10:24:10	1022.9
10:24:40	1053.9
10:25:10	1055.4
10:25:40	1055.1

Acoustic release S/N: 1498

ARM code:

DIAG code:

Mooring on seabed time: 10:25
Trilaterated latitude:
Trilaterated longitude:
Corrected depth: m
Fallback distance: m

Cruise ~~JC238~~ DY181

Mooring deployment metadata log

Mooring: EB1
Date: 10-Jul-24

Arrival on site time: overnight   Setup distance: 3 nm , Planned fallback: 250m

	Time (UTC)	Latitude	Longitude	Uncorrected depth (m)	Corrected depth (m)
Start deployment	11:49	57.05773	-9.61395		
End deployment (winch)	15:00	57.08913	-9.57761		
Anchor drop	15:56:52	57° 06.141 'N	009° 33.661 'W	1799	1793

Deployment comments:
Took longer to deploy due to inductive elements, used setup distance of 3nm instead of 2nm.

→ s/n 1766

Acoustic tracking of descent	
Time (UTC)	Range (m)
16:01:05	774 / 790
16:02:05	932 / 948
16:03:05	1091 / 1107
16:04:05	1243 / 1258
16:05:05	1393 / 1408
16:06:05	1554 / 1567
16:07:05	1673 / 1686
16:08:05	1789 / 1802
16:09:00	1807 / 1807

Acoustic release S/N: 1766   1999
ARM code:
DIAG code:

Mooring on seabed time: 16:09
Trilaterated latitude: 57.1006
Trilaterated longitude: -9.5629
Corrected depth: m
Fallback distance: 225 m

Cruise DY181 Mooring deployment metadata log

Mooring: WB2
Date: 11-Jul-24

Arrival on site time: Setup distance: 1.5 nm Planned fallback: 150m

	Time (UTC)	Latitude	Longitude	Uncorrected depth (m)	Corrected depth (m)
Start deployment	14:51	57° 28.260'N	12° 15.807'W	1810	
End deployment (winch)	15:42	57° 28.239'N	12° 17.116'W	1808	
Anchor drop	16:36:40	57.47016	-12.31289	1805	

Deployment comments:
1500 m to go @ end of dep/winch. Increased ship speed to 1kn.
Had to get the drop reel down after anchor drop, couldn't range on it right away.

Acoustic tracking of descent	
Time (UTC)	Range (m)
1759 16:56:50	—
2329 16:58:20	1825 / 1815
16:58:50	1815 / 1826
1759 17:00:00	1828

Acoustic release S/N: 2329 / 1759
ARM code:
DIAG code:
Vertical

Mooring on seabed time: before 16:56:50
Trilaterated latitude:
Trilaterated longitude:
Corrected depth: m
Fallback distance: m

Cruise DY181

Mooring deployment metadata log

11064

Mooring: WB1

Date: 12.07.2024

Arrival on site time: ~~13~~ 12:00 Setup distance: 1.5 nm Fallback 150m

	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
Start deployment	13:03:30	57°27.026'N	012°40.486'W	1654m	
End deployment (winch)	14:33:19	57°28.019	012°41.976	1605	
Anchor drop	15:11:29	57°28.281	12°42.368	1591	

Deployment comments:

1.5 nm → too short when no current, no wind

Acoustic tracking of descent	
Time (UTC)	Range (m)
15:13:30	437.1
15:13:45	456.6
15:14:30	688.0
15:14:40	(237)
15:15:30	806.2
15:15:40	819.6
15:16:30	985.7
15:16:40	1003.4
15:17:30	1159.7
15:17:40	1177.9
15:18:30	1334.9
15:18:40	1351.8
15:19:30	1499.6
15:19:40	1516.5
15:20:00	1579.8
15:20:10	1596.0
15:20:30	1608.7
15:20:40	1609.5
15:21:00	1608.5
15:21:10	1610.0

Acoustic release S/N: 1614 1135

ARM code:

DIAG code:

Mooring on seabed time: 15:20:30

Trilaterated latitude:

Trilaterated longitude:

Corrected depth: m

Fallback distance: m

Cruise DY181

Mooring deployment metadata log

Mooring: RH ADCP
Date: 14.07.2024

Arrival on site time:

Setup distance: 0 nm fallback 80m

	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
Start deployment	12:40	57.61446	-15.40066	1060	
End deployment (winch)	12:43	57.61427	-15.40125	1061	
Anchor drop	12:45	57.61411	-15.40476	1061	

Deployment comments:

Acoustic tracking of descent	
Time (UTC)	Range (m)
12:47:20	410.7
12:47:30	430.2
12:47:50	510
12:48:00	530
12:48:30	633
12:48:40	653
12:49:00	728
12:49:10	746
12:49:30	827
12:49:40	845
12:50:00	915
12:50:10	935
12:51:30	1049.9
12:51:40	1050
12:52:00	1050
12:52:00	1049.8

Acoustic release S/N: 1750

ARM code:

DIAG code:

Mooring on seabed time: 12:51
Trilaterated latitude: 57.6144
Trilaterated longitude: -15.4010
Corrected depth: 1058 m
Fallback distance: 52 m

Cruise DY181 Mooring deployment metadata log

Mooring: IB5
Date: 15.07.2024

Arrival on site time: lunch Setup distance: 1.5 nm Planned Fallback distance: 125m

	Time (UTC)	Latitude	Longitude	Uncorrected depth (m)	Corrected depth (m)
Start deployment	1200	57° 49.121	019° 12.442	973m	
End deployment (winch)	1254	57° 48.426	019° 10.596	949m	
Anchor drop	1329	57° 48.029	019° 10.169	945m	

Deployment comments: It's a lovely, sunny day :) Tiago was late so we didn't start in time ;) ← meta data to the meta data
No swivel for upper 4-pack of glasspheres

Acoustic tracking of descent	
Time (UTC)	Range (m)
13:32:00	561.6
13:32:30	602.4
13:32:40	621.0
13:33:00	686.2
13:33:10	704.0
13:33:30	770
13:33:40	787
13:34:00	850
13:34:10	866.5
13:34:30	935.3
13:34:40	945.0
13:35:00	944.3
13:35:10	944.2
13:35:30	945.3
13:35:40	944.6

Acoustic release S/N: 1765 2331
ARM code:
DIAG code:

Mooring on seabed time: 13:35
Trilaterated latitude: 57.8010
Trilaterated longitude: -19.1709
Corrected depth: 942 m
Fallback distance: 90 m

Cruise DY181 Mooring deployment metadata log

Mooring: IB4
Date: 17/07/24

Arrival on site time: overnight Setup distance: 3 nm Planned fallback: 250m

	Time (UTC)	Latitude	Longitude	Uncorrected depth (m)	Corrected depth (m)
Start deployment	07:47	58°00.839'N	21°03.738'W	2759	
End deployment (winch)	09:47	57°59.702N	21° 07.640W	2910	
Anchor drop	10:45:10	57°59.335'N	21° 09.015'W	2931	

Deployment comments:
After winch issue after end of deployment / before anchor drop (hydraulic oil bursting out). Slowed ship down @ ~09:55 to sort it out.

Acoustic tracking of descent	
Time (UTC)	Range (m)
10:47:15	423
10:48:00	564
10:48:30	655
10:49:30	838
10:50:30	1014
10:51:30	1186
10:52:30	1357
10:53:30	1527
10:54:30	1696
10:55:30	1862
10:56:30	2022
10:57:30	2181
10:58:30	2335
10:59:30	2483
11:00:30	2624
11:01:30	2762
11:02:30	2898
11:03:00	2918 / 2918

Acoustic release S/N: 1752

ARM code:

DIAG code:

Mooring on seabed time: 11:03
Trilaterated latitude: 57°59.30 N
Trilaterated longitude: 21° 08.78 W
Corrected depth: 2922 m
Fallback distance: 249 m

Cruise DY181 Mooring deployment metadata log

Mooring: IB4L

Date: 16/07/24

Arrival on site time: / Setup distance: 0 nm

	Time (UTC)	Latitude	Longitude	Uncorrected depth (m)	Corrected depth (m)
Start deployment	12:40	57.99232 N	-21.13147	2908	/
End deployment (winch)	/	/	/	/	/
Anchor drop	14:21	57.99219	-21.13190	2909	

Deployment comments: (Fetch-AZA lander)
Comms OK after lowering in the water. Issue with instrument setup, release delayed by ~1.5h. Took lander back to the surface to check bridle hadn't got tangled during that time (no swivel above A/R) – all OK. Released OK and tracked to the bottom in Ranger 2 / via USBL.

Acoustic tracking of descent	
Time (UTC)	Range (m)

Acoustic release S/N: 1755

ARM code:

DIAG code:

From USBL not trilateration

Mooring on seabed time: 14:54

~~**Trilaterated**~~ **latitude:** 57° 59.496'N

~~**Trilaterated**~~ **longitude:** 21° 07.943'W

Corrected depth: 2910.6 m

Fallback distance: 84 m

Cruise [redacted] DY181

Mooring deployment metadata log

Mooring: EB1 cdr telemetry
Date: 08/07/24

Arrival on site time: ~06:00 Setup distance: 400 m ~~nm~~

	Time (UTC)	Latitude	Longitude	Uncorrected depth (m)	Corrected depth (m)
Start deployment	07:44	57° 08.247'N	9° 35.327'W	1819	
End deployment (winch)	08:02	57° 08.163'N	9° 35.598'W	1826	
Anchor drop	08:05	57° 08.148'N	9° 35.646'W	1827	1821

Deployment comments:
started steaming after anchor drop (miscommunication!)
stopped steaming 08:23:00 @ 57° 07.974N
009° 36.277W

Acoustic tracking of descent	
Time (UTC)	Range (m)
08:09:00	326/332
08:10:00	380/385
08:11:00	433/438
08:24:00	1348/1353
08:25:00	1395/1399
08:29:00	1605/1611
08:30:00	1660/1666
08:32:00	1770/1776
08:34:00	1871/1876
08:35:00	1921/1926
08:36:00	1974/1979
08:38:00	1989/1989
08:38:40	1989/1989

Acoustic release S/N: 1999

ARM code:

DIAG code:

Mooring on seabed time: 08:38
Trilaterated latitude: 57°08.31 N
Trilaterated longitude: 09° 35.63 W
Corrected depth: 1821 m
Fallback distance: 293 m

Cruise DY181 Mooring deployment metadata log

Mooring: Tele test 2
Date: 20.07.2024

Arrival on site time: ~~07:15~~ → re location 08:00 Setup distance: 0 nm

	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
Start deployment	08:05	57°57.488	21°04.637	2681	
End deployment (winch)	08:18	57°57.493	21°04.639	2691	
Anchor drop	08:22	57°57.529	21°04.639	2695	

Deployment comments:

fall rate ~ 45m/min

Acoustic tracking of descent	
Time (UTC)	Range (m)
08:24:50	199.7/205.1
08:25:30	228.2/232.1
08:26:00	247.6/252.1
08:26:30	268.8/273.4
08:27:00	292.1/296.8
08:28:00	336.4/341.9
08:29:00	383.2/388.3
08:31:00	471/475
08:36:05	713/717
08:41:05	945/949
08:46:10	1179/1184
08:51:10	1404/1409
08:56:05	1637/1643
09:01:05	1861/1866
09:06:05	2092/2097
09:11:05	2314/2318
09:15:00	2491/2496
09:16:00	2536/2541
09:17:00	2580/2586
09:18:00	2626/2629

Acoustic release S/N: 1764

ARM code:

DIAG code:

Mooring on seabed time: 09:19:30
Trilaterated latitude: 57.9581°N
Trilaterated longitude: 21.0753°W
Corrected depth: 2685 m
Fallback distance: 138 m

09:19:00	2669/2674
09:19:30	2688/2688 ✓
09:20:00	2687/2687 ✓

APPENDIX BB META DATA FROM AZA-FETCH DEPLOYMENT

SAMS Fetch AZA logsheet Version 1

Date	16/07/24	Serial Number	007BE8
Cruise	DY181	Acoustic ID	2311
Operators	SJ & VB	Job file name	~~IB4L1~~

IB4L1_deployment_160724_Fetch_MF_job

Pre-test

Job file name ~~(n/a if test only)~~ ✓

Magnet removed? ✓ → 10:14

Check internal pressure gauge (green = OK)? ✓

Comms check? (get status) Test serial comms ✓ Link test ✓

→ ~~get AZA status~~

Stop logging and Set time (if not using PC time) Resync DAS time ✓

Set Transponder to job configuration? (Device tab) ✓

~~Clear memory?~~

Check configuration and generate report? ✓

Get AZA status > set launch/Recovery mode

(This should only be done < 6 hours prior to deployment)

Get AZA status ✓

└ AZA Mode → Seabed ✓

↳ Adv [Set Depl. Fm ✓

Run Singl. AZA Oper. ✓

Get AZA Status ✓

Lat		Lon	
Depth		Weather	

Comments
(e.g. time over rail, in water, out of water)

Seabed mode ✓ Releaser: pic on phone Estelle

Start AZA logging ✓

check tabs ✓✓✓ SAM_Test report_240716_time
(3 tabs)

– deploy from CTD wire start work on deck ~12:30
– bridle 12:41
– in water : 12 47 UTC

SAMS Fetch AZA logsheet **Version 1**

Freefall acoustic tracking log table

Time UTC	Depth	Lat	Lon	Comment
14:21	release			track in Ranger2 fr. port side USBL
14:22	120			
14:23	210			
14:24	296			
14:25	383			
14:30	834.1			
14:35	1373.			
14:40	1730.			
14:45.	2135			
14:50	2590			
14:54	2910			@bottom
15:01	good comms sensor check			in SAM softw.

AZA-Fetch Download scanned ✓

- 17/07/24 1B4L1 - 2311
- DY181 007BEB range from ship ~155 m

12:39 1B4L1 located in R2, port

12:39 1B4L1 contact succ. in SAM

12:40 Gain increased to 40 dB

Pow. 193 dB
Tel Pwr. 190 dB } good comms
Gain 46 dB

12:43 Set Telemetry to receive data @ 9000 bps

- get bookmarks ; 35 - 43 pages

12:44 retrieve data (took 20 sec)

range from ship:

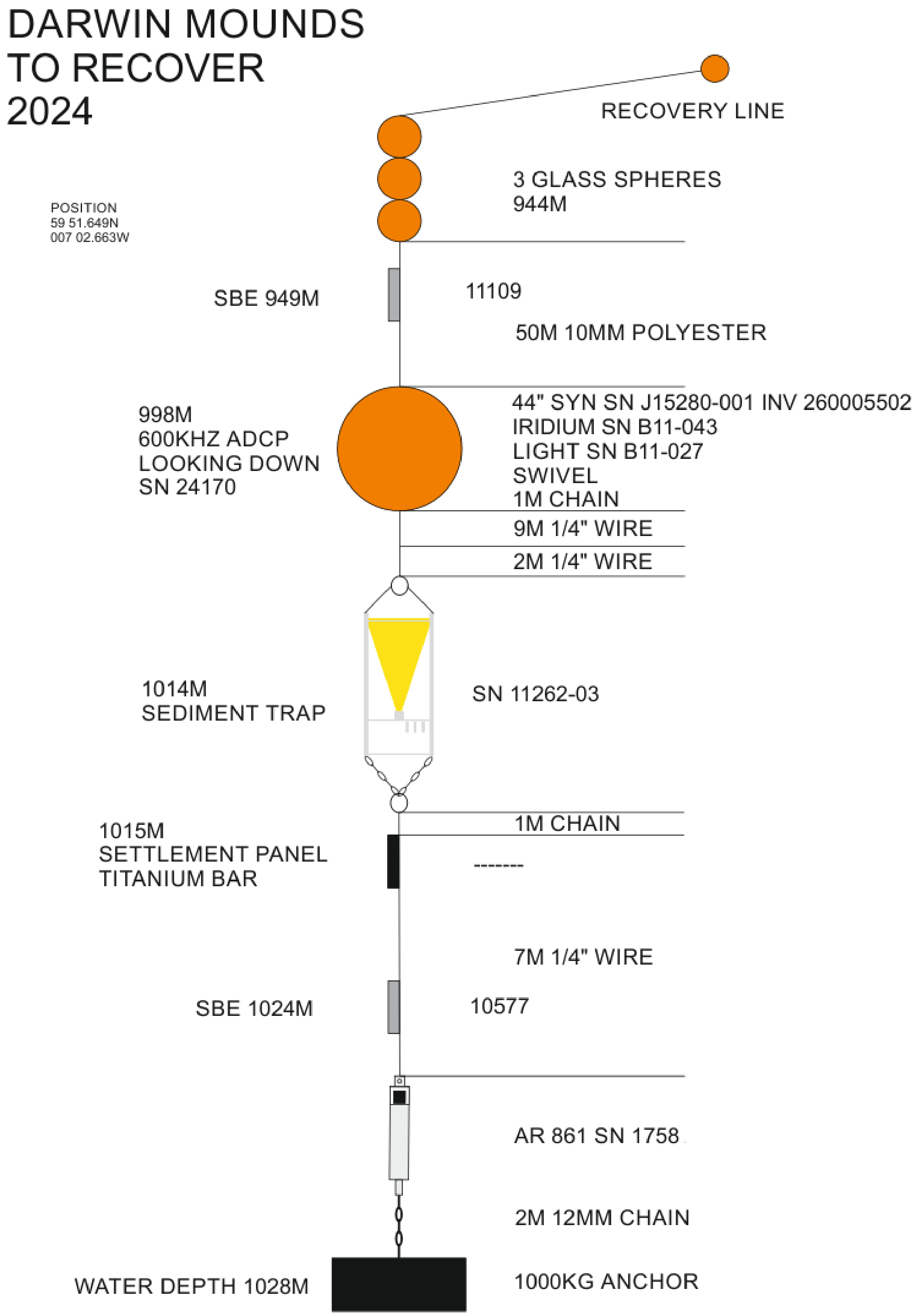
Tools > Options > General

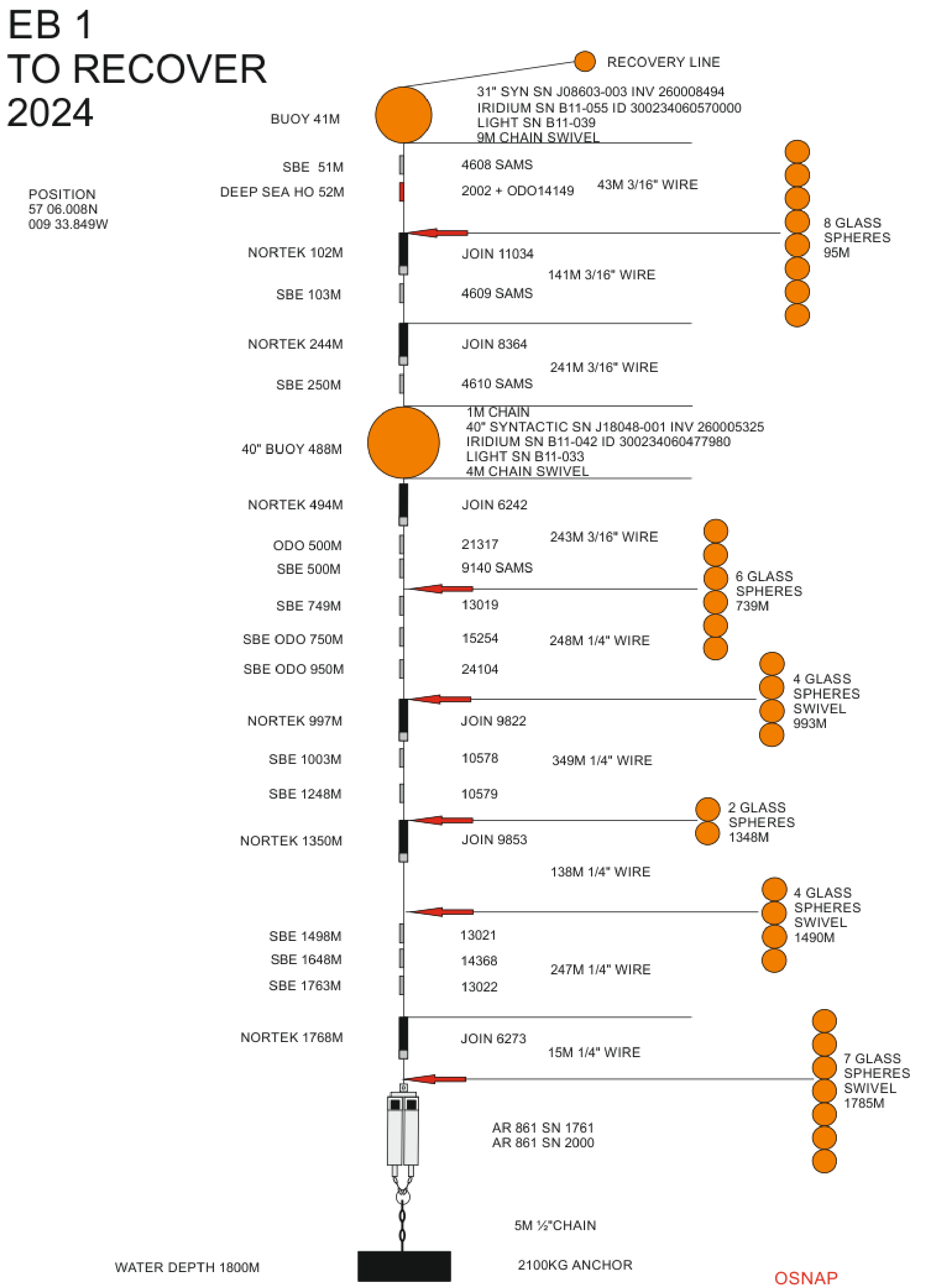
↳ position & display Formats sect.

~~Geo~~ Relative Frame

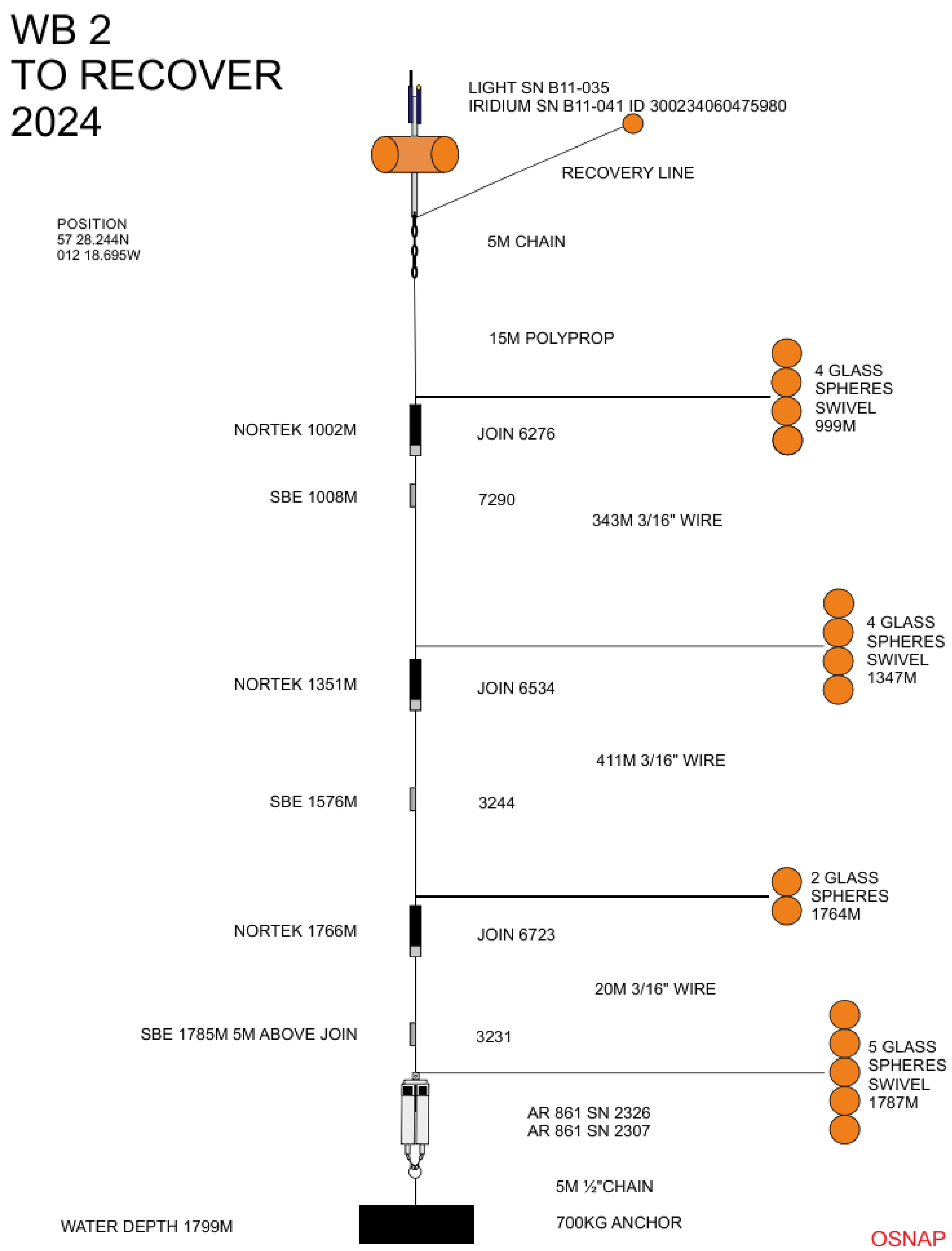
→ Screenshot 1.15:01

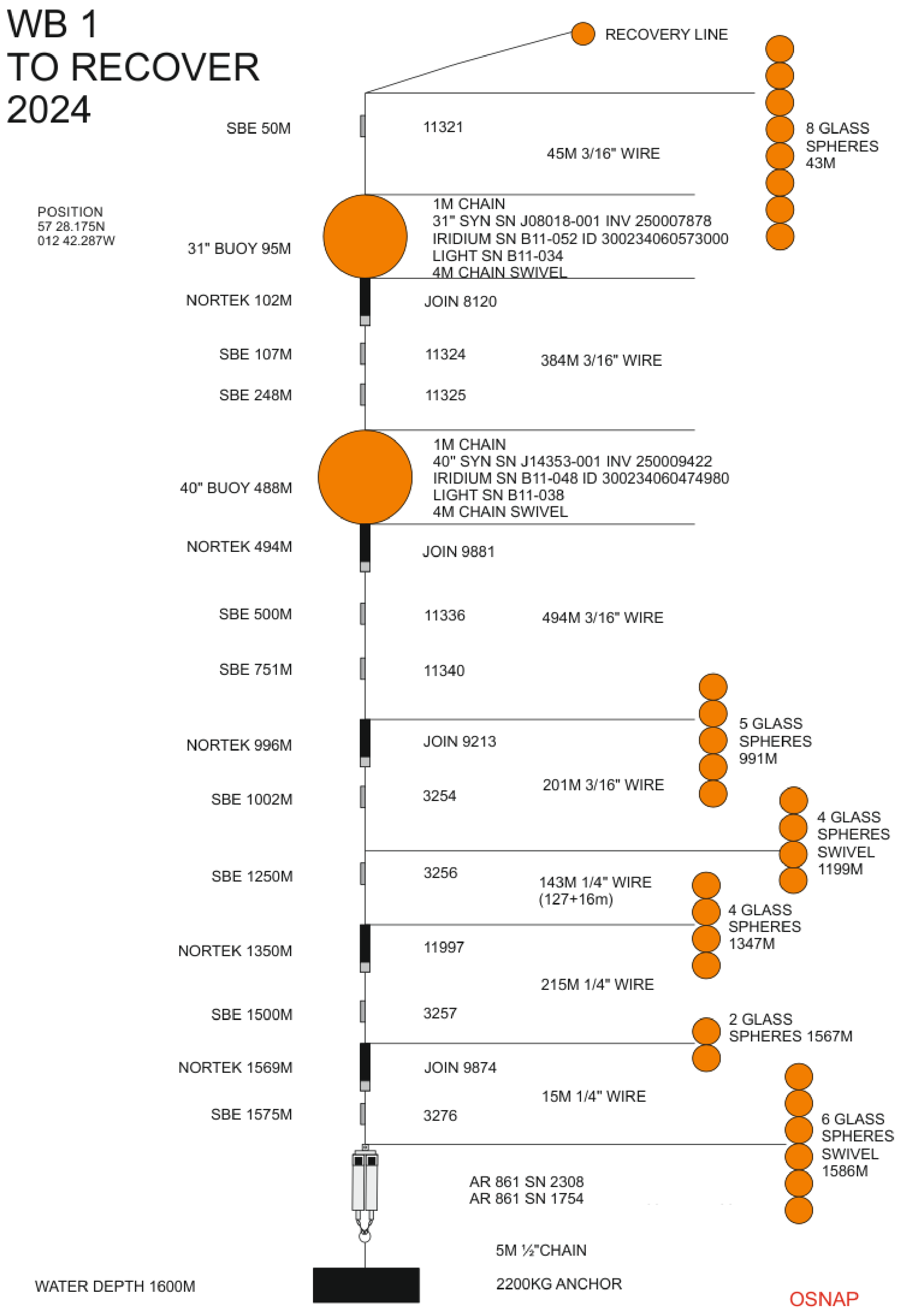
APPENDIX CC DIAGRAMS OF RECOVERED MOORINGS

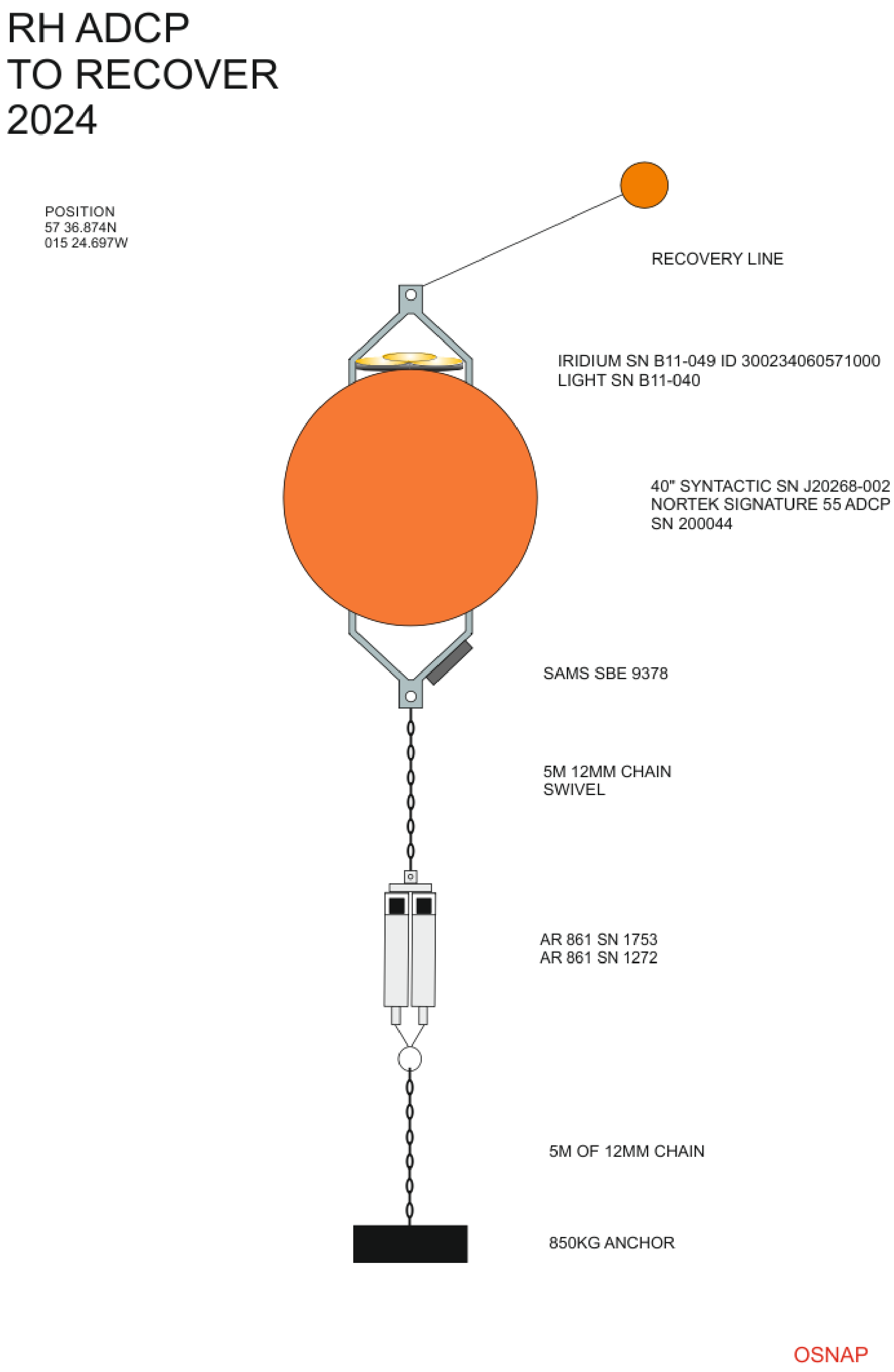


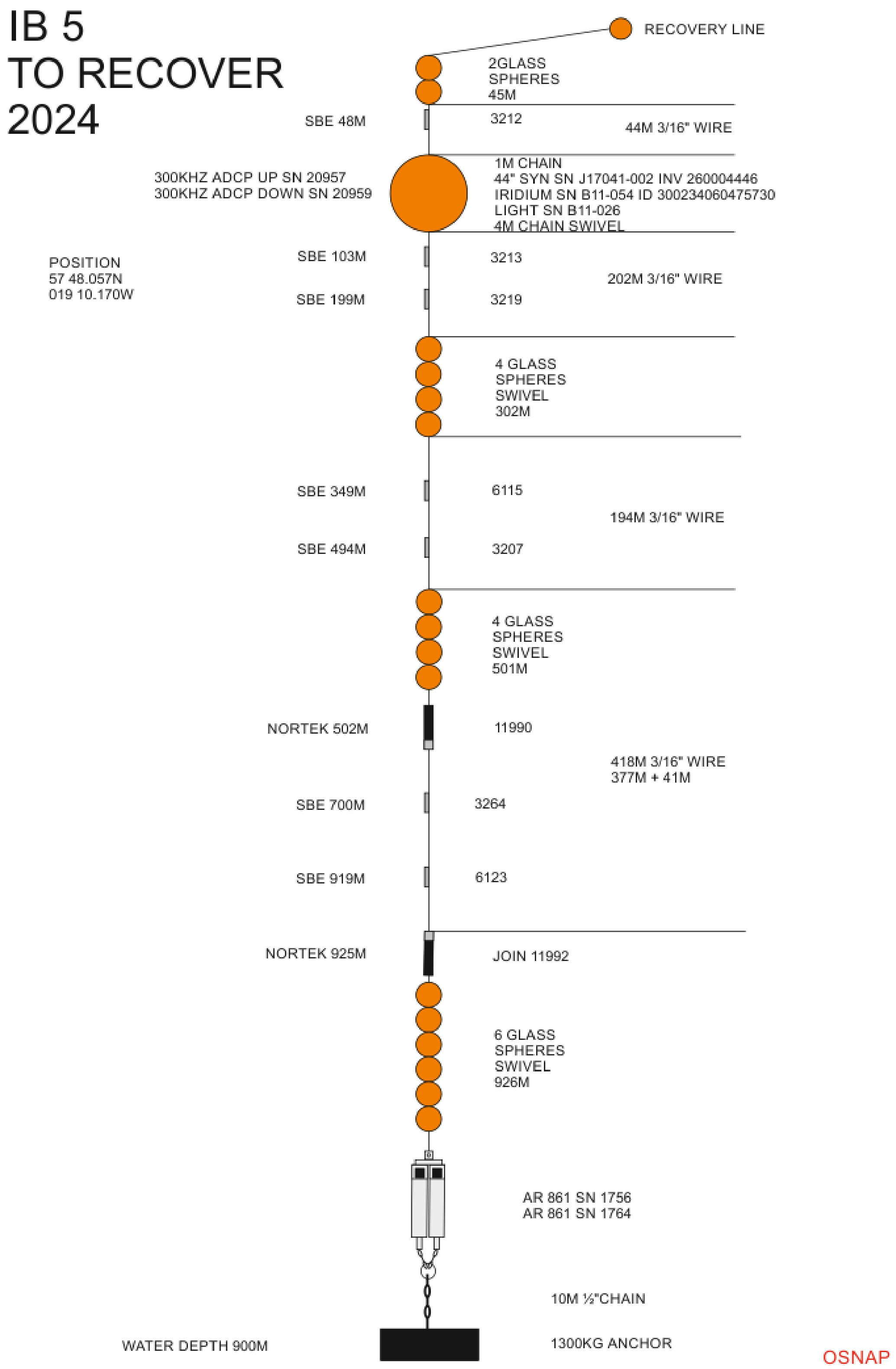


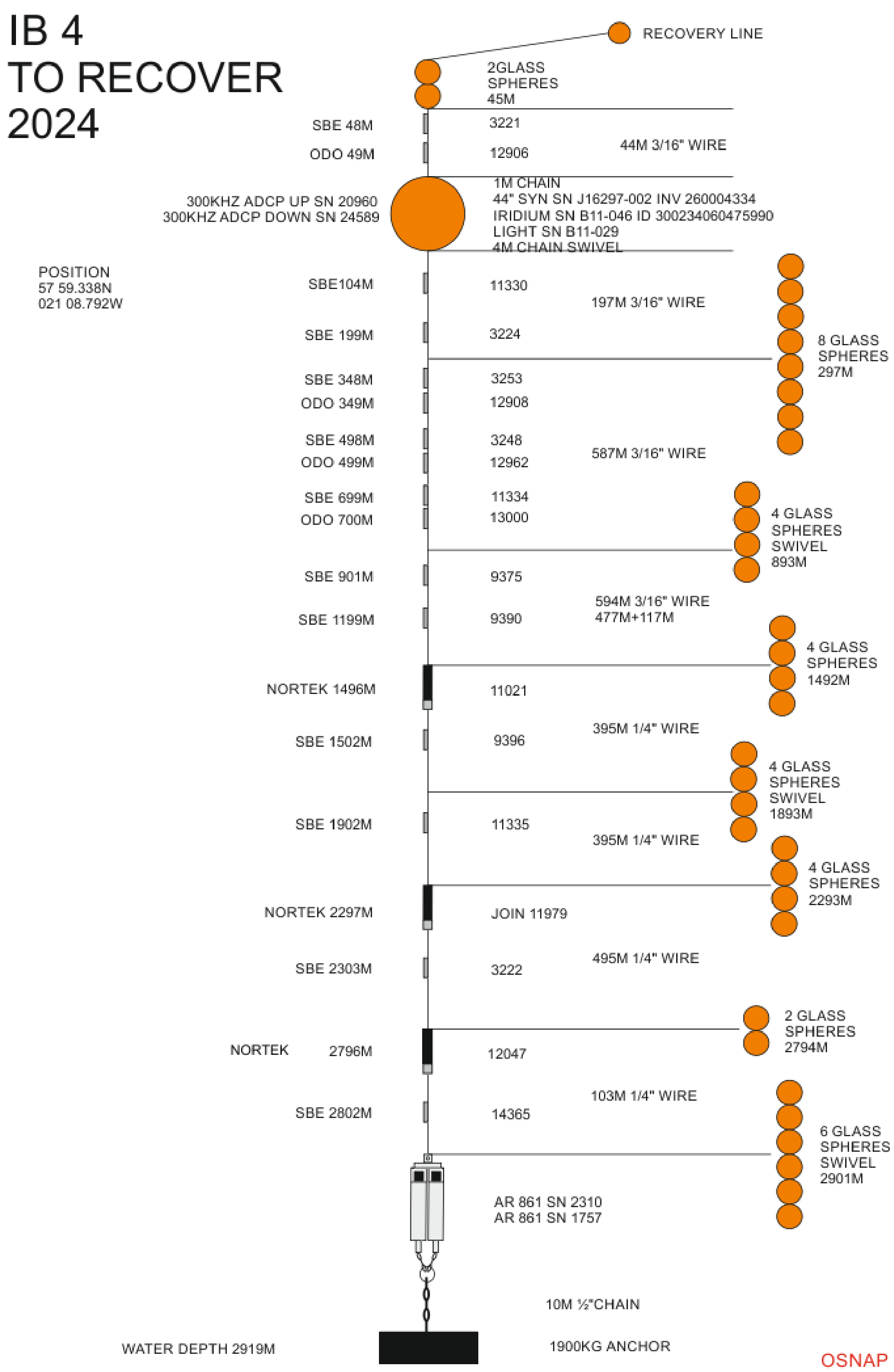
EB 1
TO RECOVER
2024
POSITION
57 06.008N
009 33.849W
RECOVERY LINE
BUOY 41M
31" SYN SN J08603-003 INV 260008494
IRIDIUM SN B11-055 ID 300234060570000
LIGHT SN B11-039
9M CHAIN SWIVEL
SBE 51M
4608 SAMS
DEEP SEA HO 52M
2002 + ODO14149
43M 3/16" WIRE
8 GLASS
SPHERES
95M
NORTEK 102M
JOIN 11034
141M 3/16" WIRE
SBE 103M
4609 SAMS
NORTEK 244M
JOIN 8364
241M 3/16" WIRE
SBE 250M
4610 SAMS
1M CHAIN
40" SYNTACTIC SN J18048-001 INV 260005325
IRIDIUM SN B11-042 ID 300234060477980
LIGHT SN B11-033
4M CHAIN SWIVEL
40" BUOY 488M
NORTEK 494M
JOIN 6242
ODO 500M
21317
243M 3/16" WIRE
SBE 500M
9140 SAMS
6 GLASS
SPHERES
739M
SBE 749M
13019
SBE ODO 750M
15254
248M 1/4" WIRE
SBE ODO 950M
24104
4 GLASS
SPHERES
SWIVEL
993M
NORTEK 997M
JOIN 9822
SBE 1003M
10578
349M 1/4" WIRE
SBE 1248M
10579
2 GLASS
SPHERES
1348M
NORTEK 1350M
JOIN 9853
138M 1/4" WIRE
4 GLASS
SPHERES
SWIVEL
1490M
SBE 1498M
13021
SBE 1648M
14368
247M 1/4" WIRE
SBE 1763M
13022
NORTEK 1768M
JOIN 6273
15M 1/4" WIRE
7 GLASS
SPHERES
SWIVEL
1785M
AR 861 SN 1761
AR 861 SN 2000
5M ½"CHAIN
WATER DEPTH 1800M
2100KG ANCHOR
OSNAP


WB 2
TO RECOVER
2024
LIGHT SN B11-035
IRIDIUM SN B11-041 ID 300234060475980
RECOVERY LINE
POSITION
57 28.244N
012 18.695W
5M CHAIN
15M POLYPROP
4 GLASS
SPHERES
SWIVEL
999M
NORTEK 1002M
JOIN 6276
SBE 1008M
7290
343M 3/16" WIRE
4 GLASS
SPHERES
SWIVEL
1347M
NORTEK 1351M
JOIN 6534
411M 3/16" WIRE
SBE 1576M
3244
2 GLASS
SPHERES
1764M
NORTEK 1766M
JOIN 6723
20M 3/16" WIRE
SBE 1785M 5M ABOVE JOIN
3231
5 GLASS
SPHERES
SWIVEL
1787M
AR 861 SN 2326
AR 861 SN 2307
5M ½"CHAIN
WATER DEPTH 1799M
700KG ANCHOR
OSNAP


WB 1
TO RECOVER
2024
RECOVERY LINE
8 GLASS
SPHERES
43M
SBE 50M
11321
45M 3/16" WIRE
POSITION
57 28.175N
012 42.287W
31" BUOY 95M
1M CHAIN
31" SYN SN J08018-001 INV 250007878
IRIDIUM SN B11-052 ID 300234060573000
LIGHT SN B11-034
4M CHAIN SWIVEL
NORTEK 102M
JOIN 8120
SBE 107M
11324
384M 3/16" WIRE
SBE 248M
11325
40" BUOY 488M
1M CHAIN
40" SYN SN J14353-001 INV 250009422
IRIDIUM SN B11-048 ID 300234060474980
LIGHT SN B11-038
4M CHAIN SWIVEL
NORTEK 494M
JOIN 9881
SBE 500M
11336
494M 3/16" WIRE
SBE 751M
11340
5 GLASS
SPHERES
991M
NORTEK 996M
JOIN 9213
SBE 1002M
3254
201M 3/16" WIRE
4 GLASS
SPHERES
SWIVEL
1199M
SBE 1250M
3256
143M 1/4" WIRE
(127+16m)
4 GLASS
SPHERES
1347M
NORTEK 1350M
11997
215M 1/4" WIRE
SBE 1500M
3257
2 GLASS
SPHERES 1567M
NORTEK 1569M
JOIN 9874
15M 1/4" WIRE
SBE 1575M
3276
6 GLASS
SPHERES
SWIVEL
1586M
AR 861 SN 2308
AR 861 SN 1754
5M ½"CHAIN
WATER DEPTH 1600M
2200KG ANCHOR
OSNAP

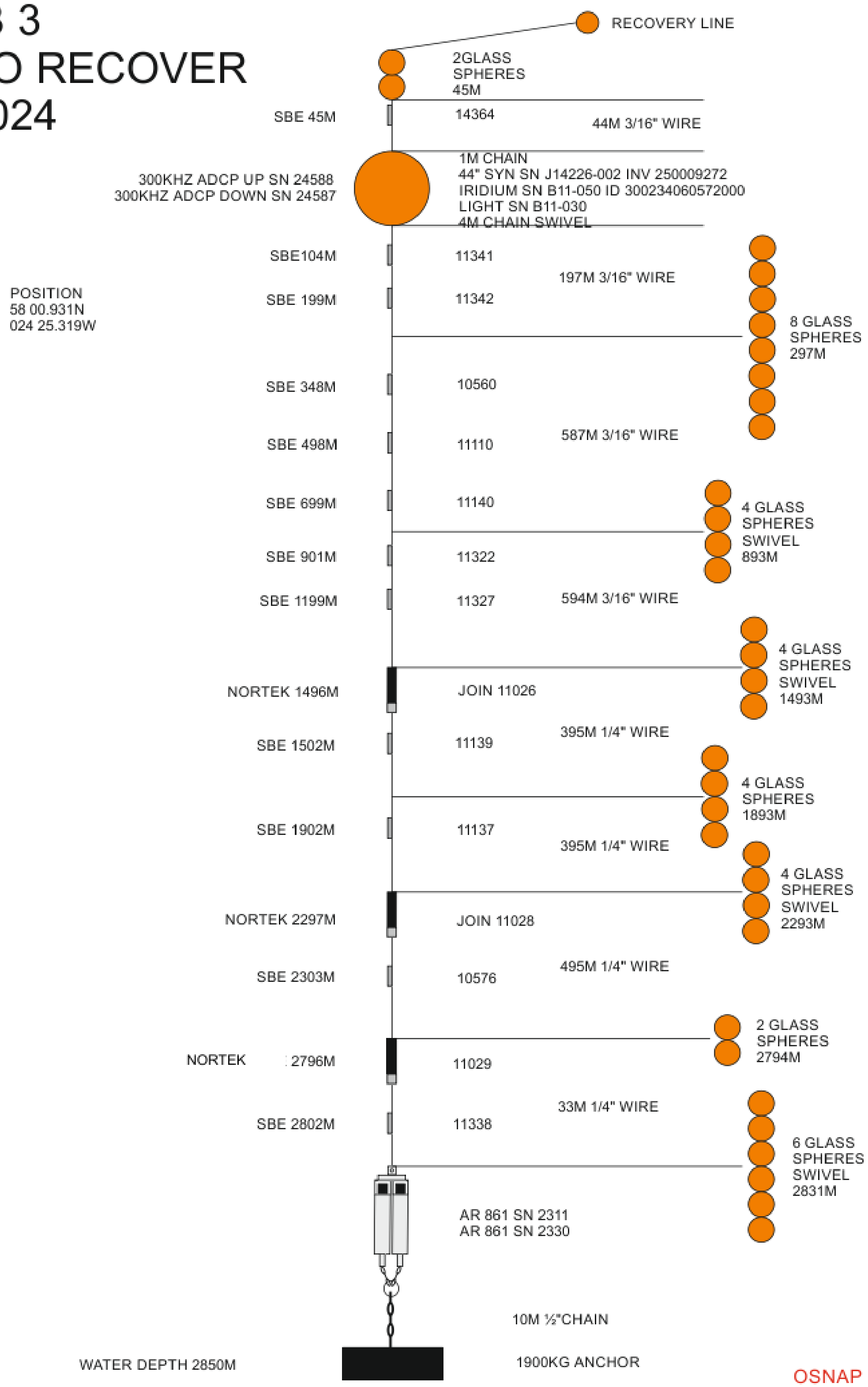

RH ADCP
TO RECOVER
2024
POSITION
57 36.874N
015 24.697W
RECOVERY LINE
IRIDIUM SN B11-049 ID 300234060571000
LIGHT SN B11-040
40" SYNTACTIC SN J20268-002
NORTEK SIGNATURE 55 ADCP
SN 200044
SAMS SBE 9378
5M 12MM CHAIN
SWIVEL
AR 861 SN 1753
AR 861 SN 1272
5M OF 12MM CHAIN
850KG ANCHOR
OSNAP


IB 5
TO RECOVER
2024
RECOVERY LINE
2GLASS
SPHERES
45M
SBE 48M
3212
44M 3/16" WIRE
300KHZ ADCP UP SN 20957
300KHZ ADCP DOWN SN 20959
1M CHAIN
44" SYN SN J17041-002 INV 260004446
IRIDIUM SN B11-054 ID 300234060475730
LIGHT SN B11-026
4M CHAIN SWIVEL
POSITION
57 48.057N
019 10.170W
SBE 103M
3213
202M 3/16" WIRE
SBE 199M
3219
4 GLASS
SPHERES
SWIVEL
302M
SBE 349M
6115
194M 3/16" WIRE
SBE 494M
3207
4 GLASS
SPHERES
SWIVEL
501M
NORTEK 502M
11990
418M 3/16" WIRE
377M + 41M
SBE 700M
3264
SBE 919M
6123
NORTEK 925M
JOIN 11992
6 GLASS
SPHERES
SWIVEL
926M
AR 861 SN 1756
AR 861 SN 1764
10M ½"CHAIN
WATER DEPTH 900M
1300KG ANCHOR
OSNAP

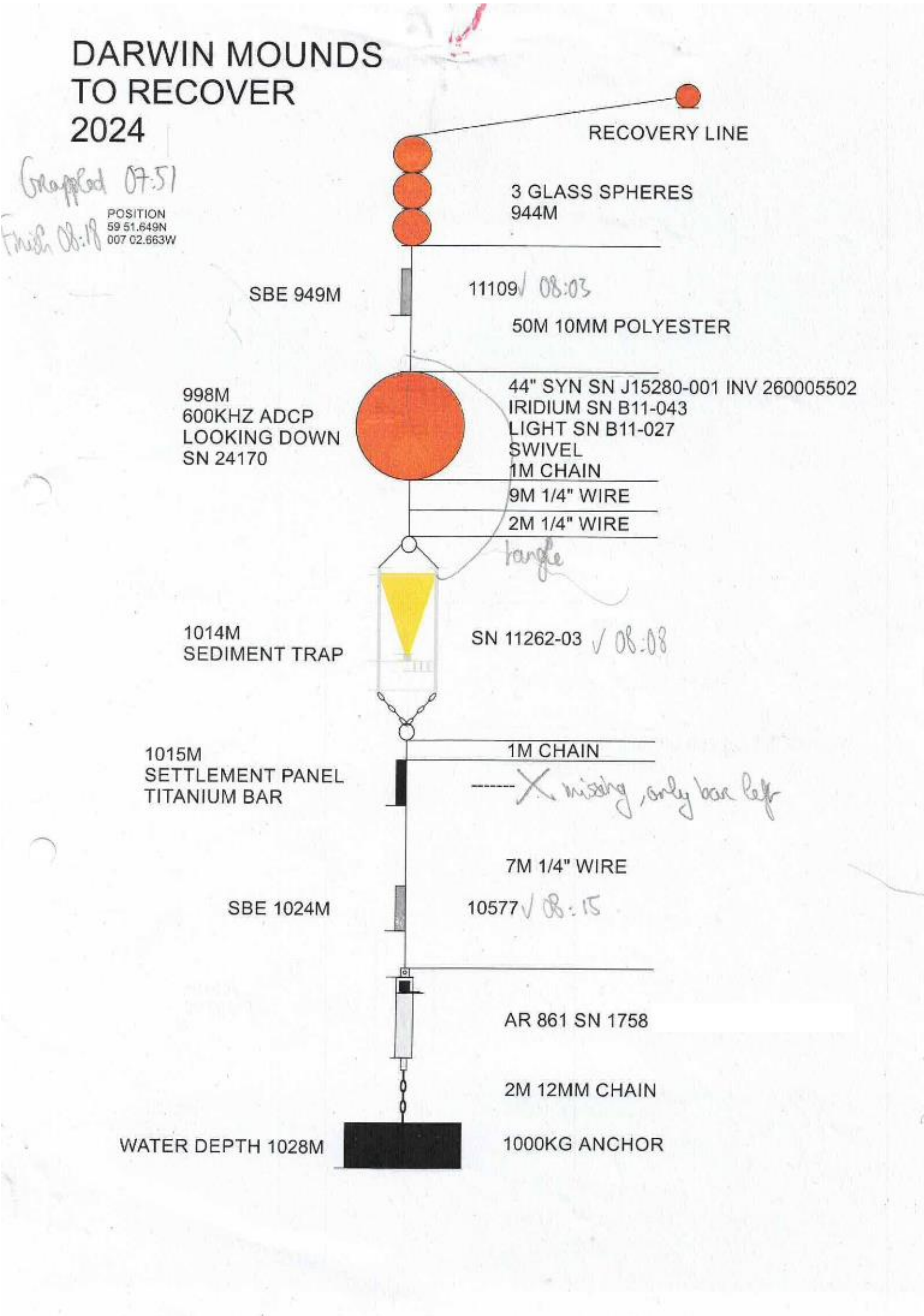


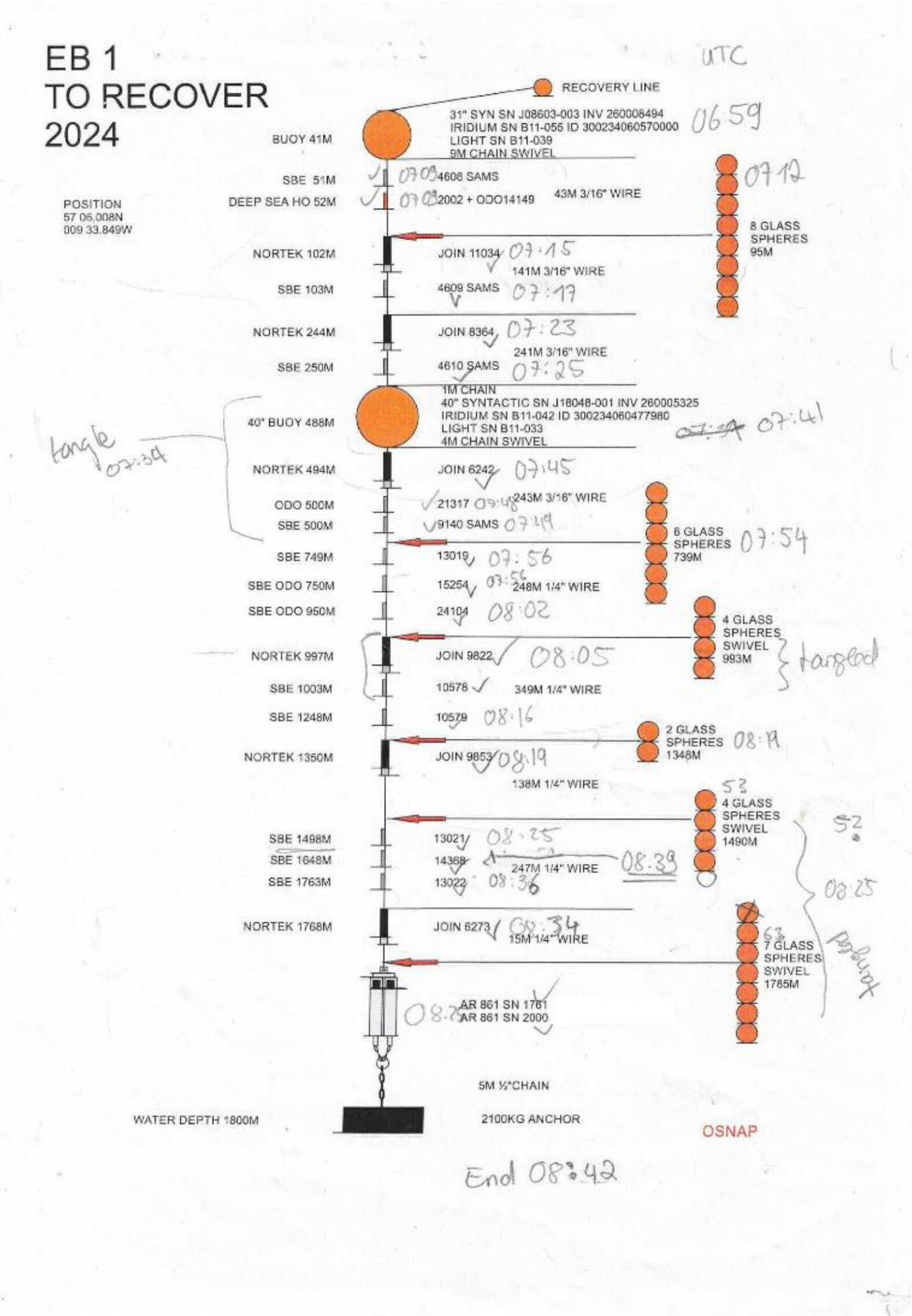
IB 4
TO RECOVER
2024
RECOVERY LINE
2GLASS SPHERES 45M
SBE 48M
ODO 49M
3221
12906
44M 3/16" WIRE
300KHZ ADCP UP SN 20960
300KHZ ADCP DOWN SN 24589
1M CHAIN
44" SYN SN J16297-002 INV 260004334
IRIDIUM SN B11-046 ID 300234060475990
LIGHT SN B11-029
4M CHAIN SWIVEL
POSITION
57 59.338N
021 08.792W
SBE104M
11330
197M 3/16" WIRE
SBE 199M
3224
8 GLASS SPHERES 297M
SBE 348M
ODO 349M
3253
12908
SBE 498M
ODO 499M
3248
12962
587M 3/16" WIRE
SBE 699M
ODO 700M
11334
13000
4 GLASS SPHERES SWIVEL 893M
SBE 901M
9375
594M 3/16" WIRE
477M+117M
SBE 1199M
9390
4 GLASS SPHERES 1492M
NORTEK 1496M
11021
395M 1/4" WIRE
SBE 1502M
9396
4 GLASS SPHERES SWIVEL 1893M
SBE 1902M
11335
395M 1/4" WIRE
4 GLASS SPHERES 2293M
NORTEK 2297M
JOIN 11979
495M 1/4" WIRE
SBE 2303M
3222
2 GLASS SPHERES 2794M
NORTEK 2796M
12047
103M 1/4" WIRE
SBE 2802M
14365
6 GLASS SPHERES SWIVEL 2901M
AR 861 SN 2310
AR 861 SN 1757
10M ½"CHAIN
WATER DEPTH 2919M
1900KG ANCHOR
OSNAP

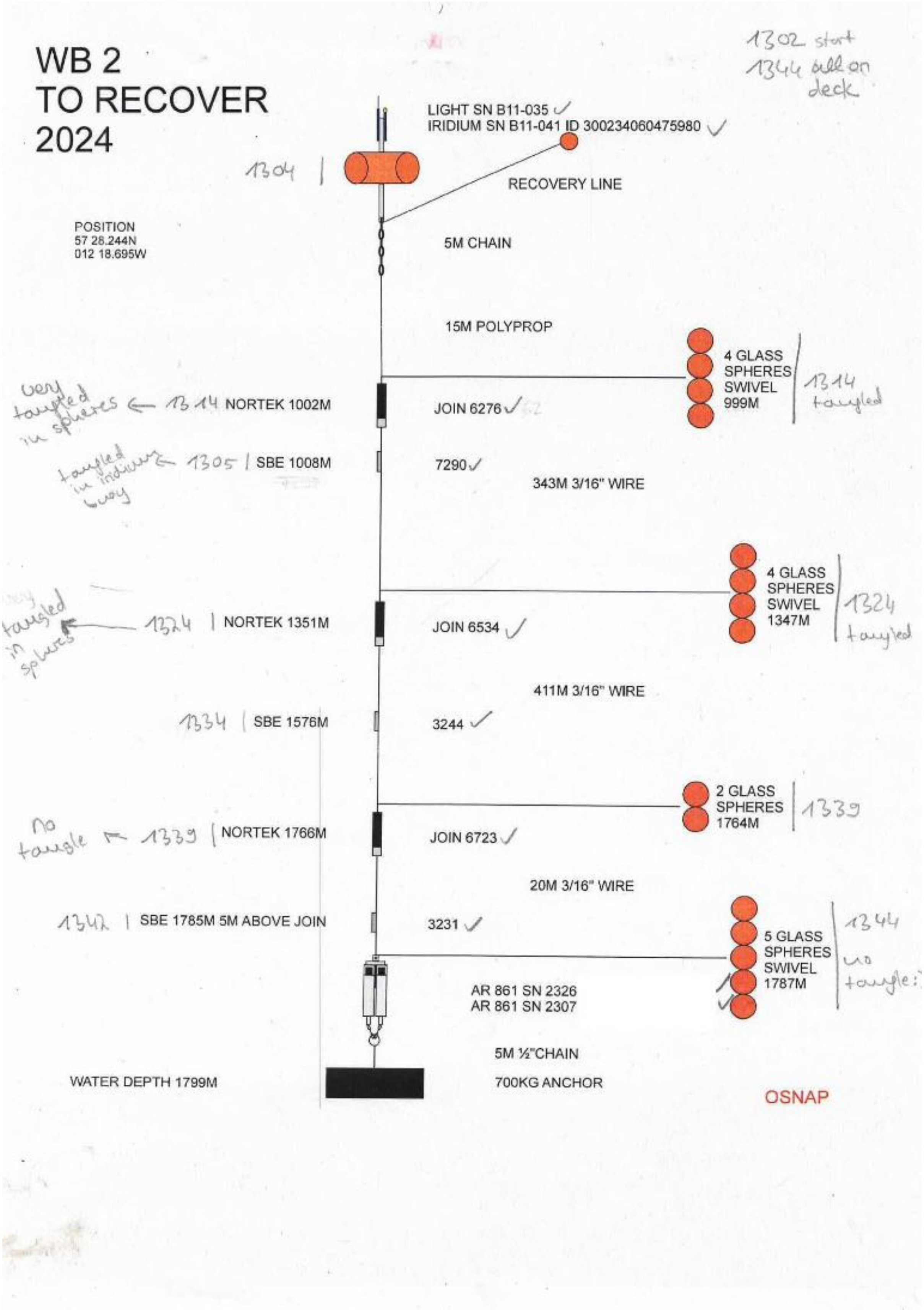
IB 3
TO RECOVER
2024



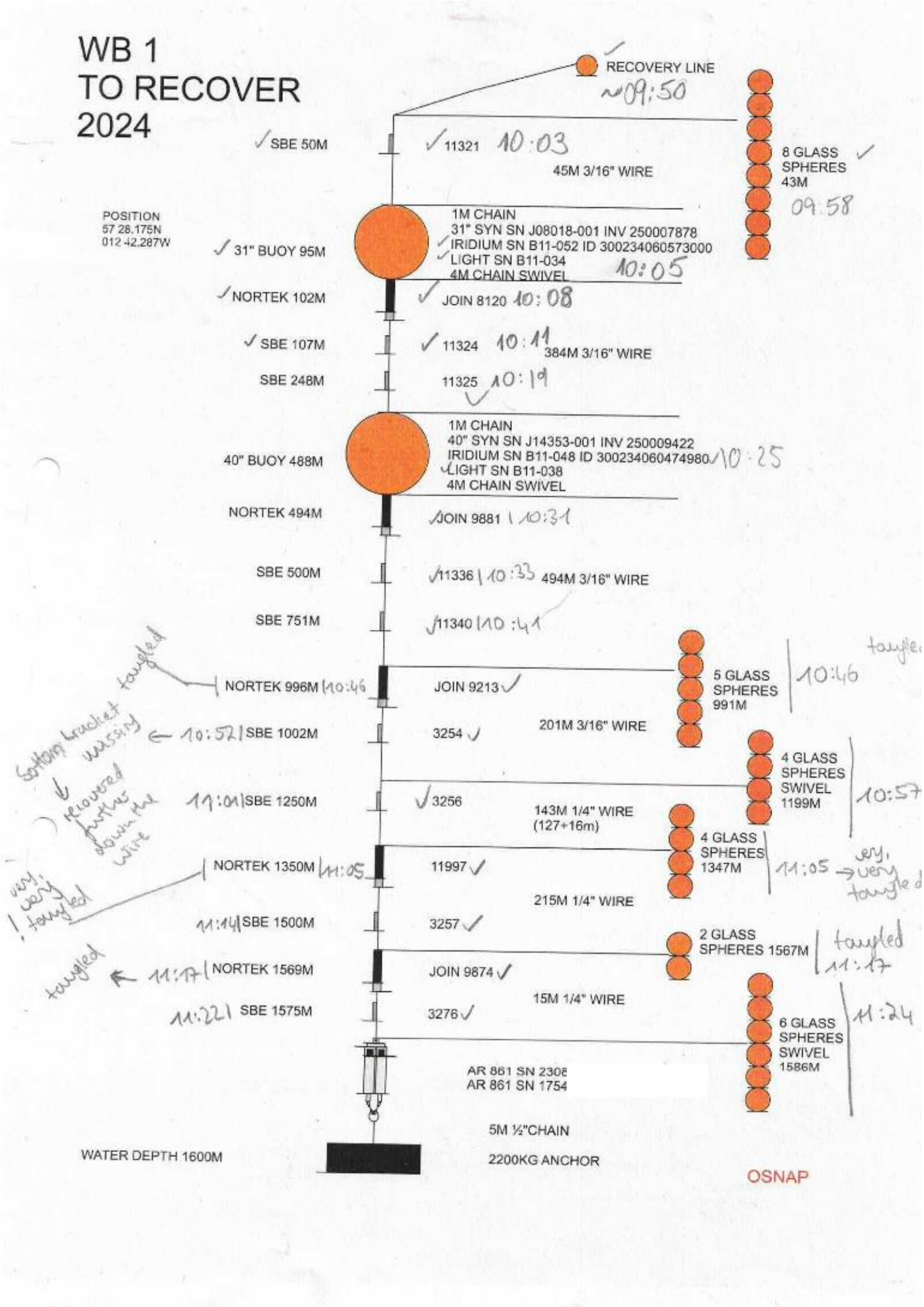
APPENDIX DD DECK LOGS OF RECOVERED MOORINGS

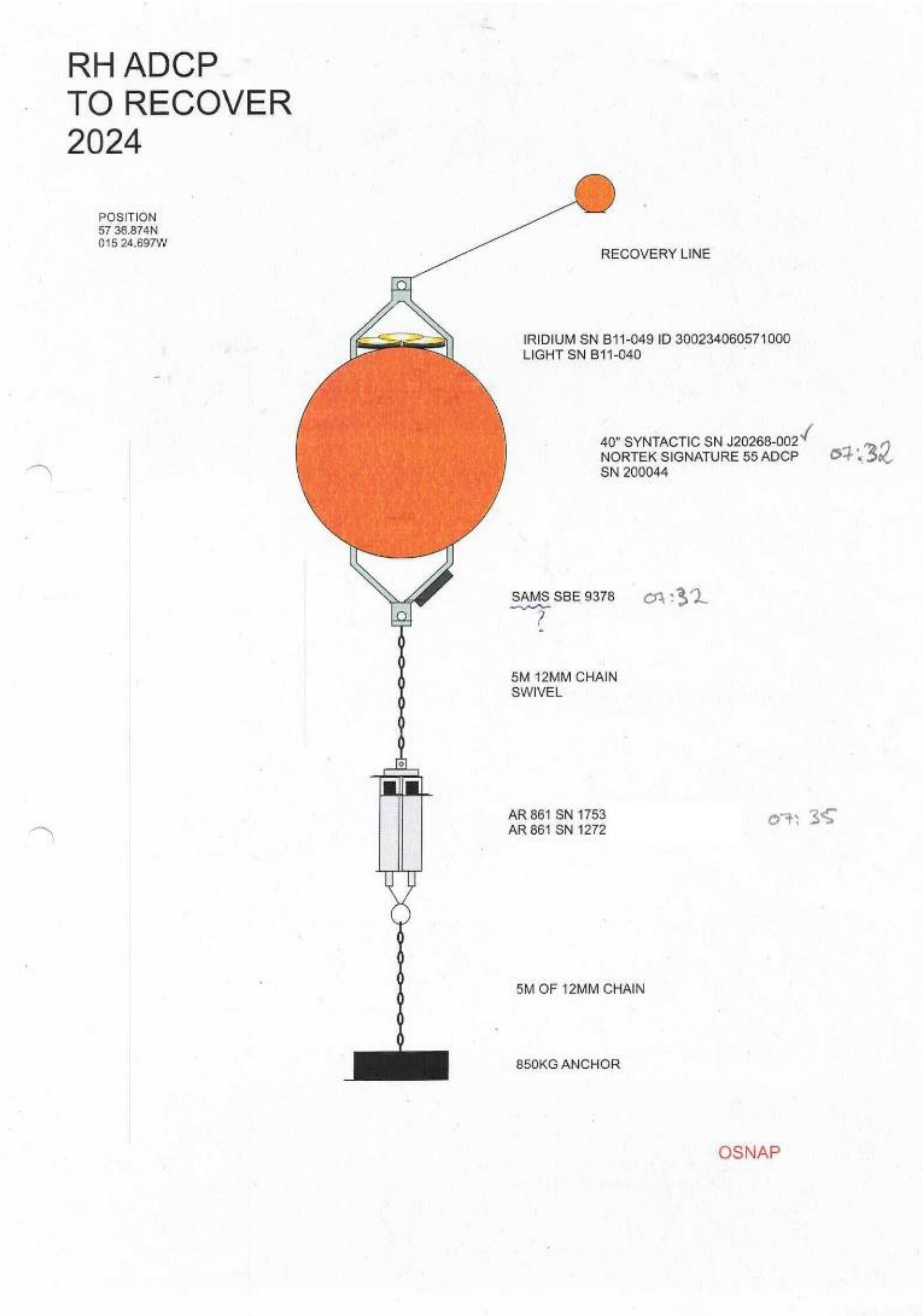


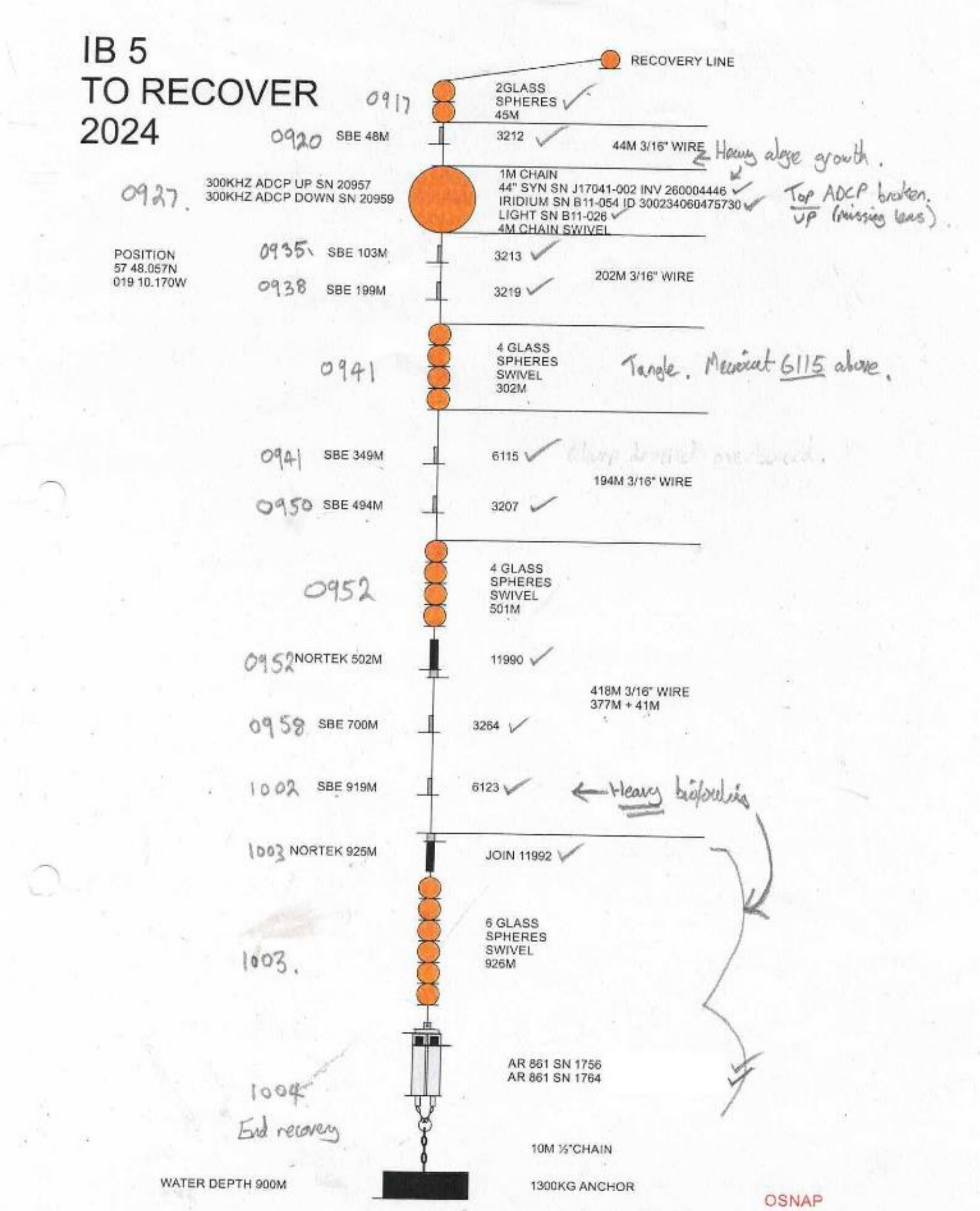

EB 1
TO RECOVER
2024
UTC
RECOVERY LINE
BUOY 41M
31" SYN SN J08603-003 INV 260008494
IRIDIUM SN B11-055 ID 300234060570000
LIGHT SN B11-039
9M CHAIN SWIVEL
06:59
SBE 51M
4608 SAMS
DEEP SEA HO 52M
2002 + ODO14149
43M 3/16" WIRE
07:12
POSITION
57 06.008N
009 33.849W
8 GLASS
SPHERES
95M
NORTEK 102M
JOIN 11034
07:15
141M 3/16" WIRE
SBE 103M
4609 SAMS
07:17
NORTEK 244M
JOIN 8364
07:23
241M 3/16" WIRE
SBE 250M
4610 SAMS
07:25
1M CHAIN
40" BUOY 488M
40" SYNTACTIC SN J18048-001 INV 260005325
IRIDIUM SN B11-042 ID 300234060477980
LIGHT SN B11-033
4M CHAIN SWIVEL
07:41
tangle
07:34
NORTEK 494M
JOIN 6242
07:45
ODO 500M
21317
243M 3/16" WIRE
SBE 500M
9140 SAMS
6 GLASS
SPHERES
739M
07:54
SBE 749M
13019
07:56
SBE ODO 750M
15254
248M 1/4" WIRE
SBE ODO 950M
24104
08:02
4 GLASS
SPHERES
SWIVEL
993M
tangled
NORTEK 997M
JOIN 9822
08:05
SBE 1003M
10578
349M 1/4" WIRE
SBE 1248M
10579
08:16
2 GLASS
SPHERES
1348M
08:19
NORTEK 1350M
JOIN 9853
08:19
138M 1/4" WIRE
53
4 GLASS
SPHERES
SWIVEL
1490M
52
SBE 1498M
13021
08:25
SBE 1648M
14368
247M 1/4" WIRE
08:39
SBE 1763M
13022
08:36
08:25
NORTEK 1768M
JOIN 6273
08:34
15M 1/4" WIRE
63
7 GLASS
SPHERES
SWIVEL
1785M
AR 861 SN 1761
AR 861 SN 2000
5M ½"CHAIN
WATER DEPTH 1800M
2100KG ANCHOR
OSNAP
End 08:42

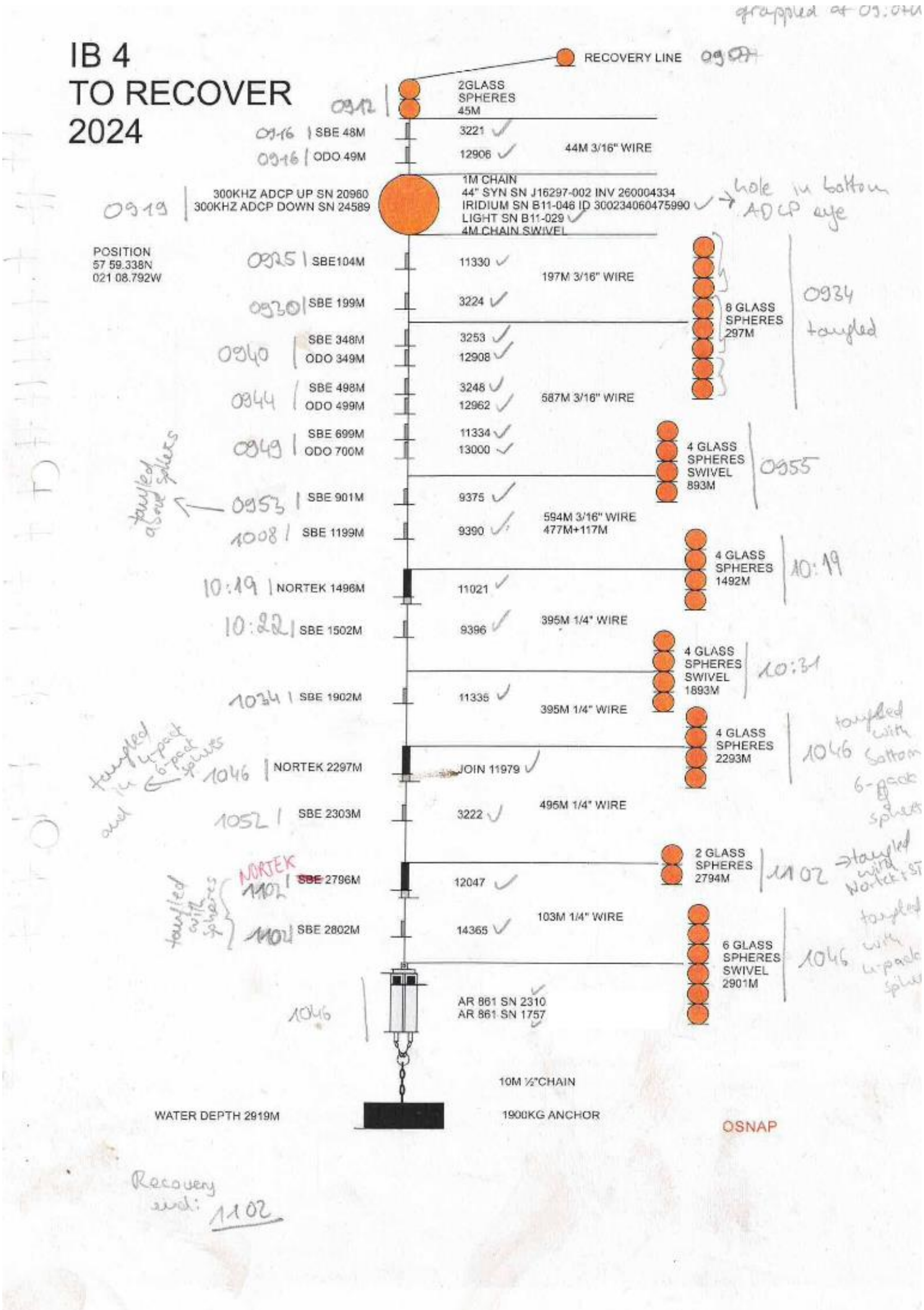


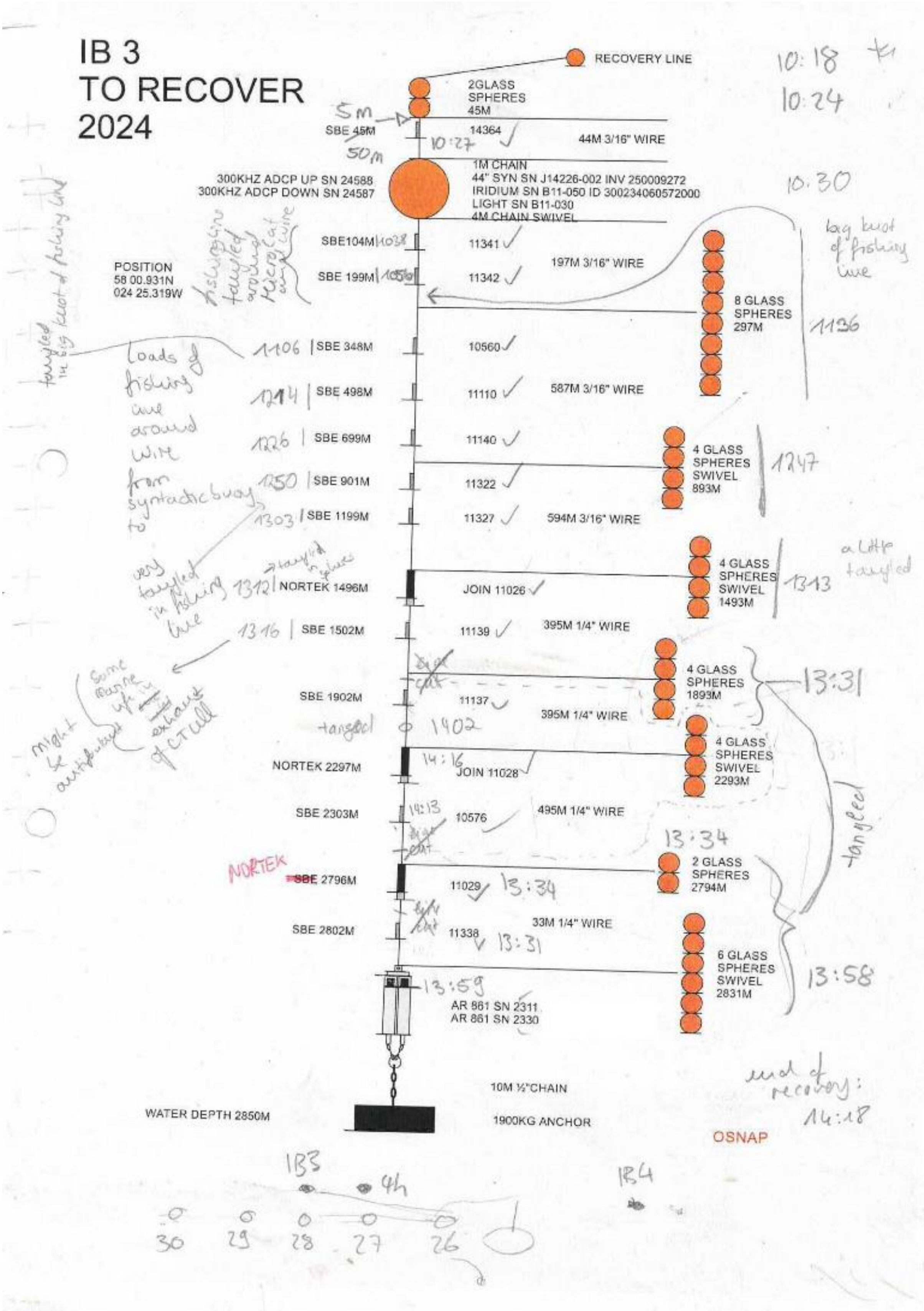
WB 2
TO RECOVER
2024
1302 start
1344 all on deck
LIGHT SN B11-035
IRIDIUM SN B11-041 ID 300234060475980
1304
RECOVERY LINE
POSITION
57 28.244N
012 18.695W
5M CHAIN
15M POLYPROP
4 GLASS
SPHERES
SWIVEL
999M
1314
tangled
very tangled in spheres
1314 NORTEK 1002M
JOIN 6276
tangled in Iridium buoy
1305 SBE 1008M
7290
343M 3/16" WIRE
4 GLASS
SPHERES
SWIVEL
1347M
1324
tangled
very tangled in spheres
1324 NORTEK 1351M
JOIN 6534
411M 3/16" WIRE
1334 SBE 1576M
3244
2 GLASS
SPHERES
1764M
1339
no tangle
1339 NORTEK 1766M
JOIN 6723
20M 3/16" WIRE
1342 SBE 1785M 5M ABOVE JOIN
3231
1344
5 GLASS
SPHERES
SWIVEL
1787M
no tangle
AR 861 SN 2326
AR 861 SN 2307
5M ½"CHAIN
WATER DEPTH 1799M
700KG ANCHOR
OSNAP

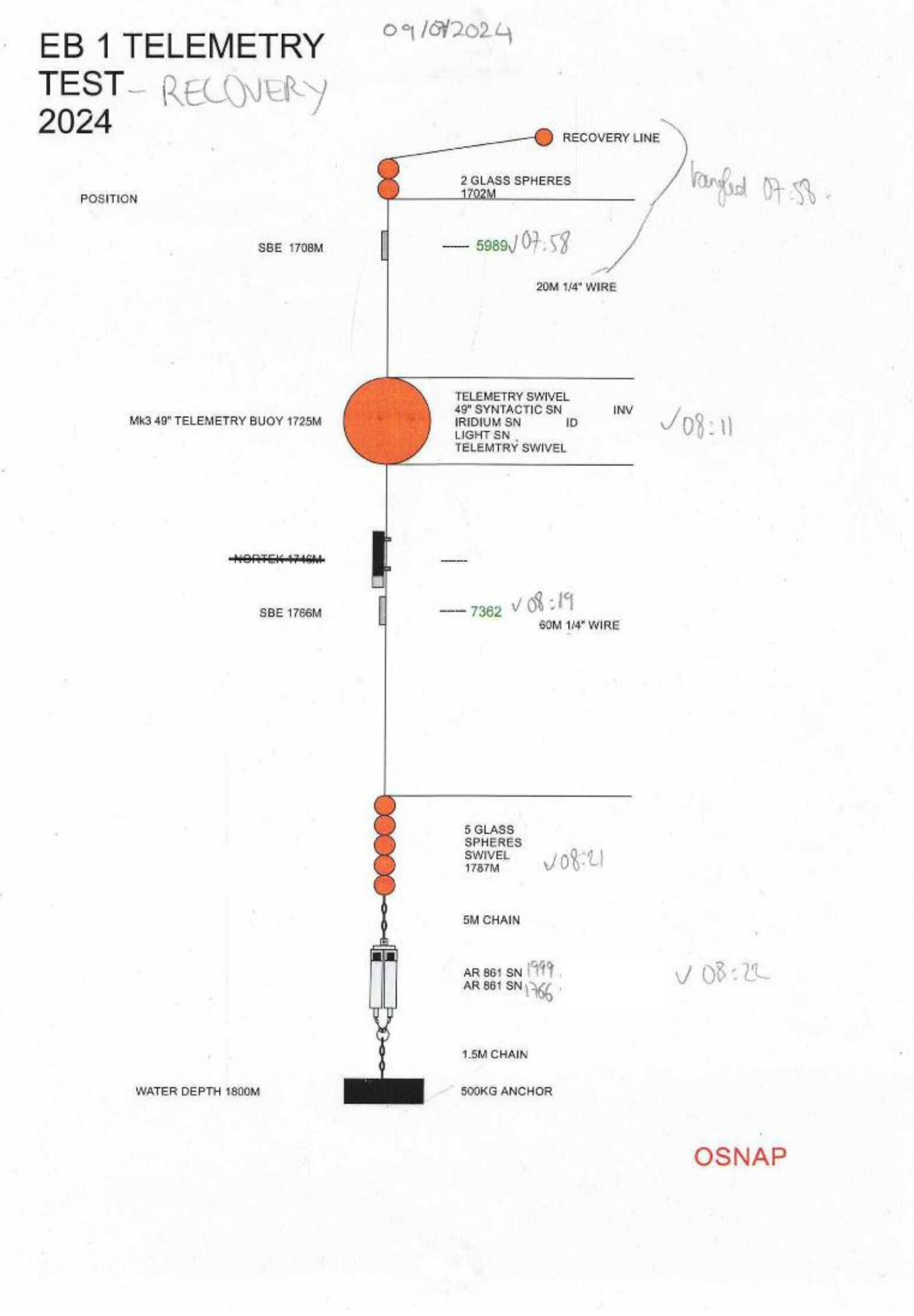

WB 1
TO RECOVER
2024
RECOVERY LINE
~09:50
8 GLASS SPHERES 43M
09:58
SBE 50M
11321 10:03
45M 3/16" WIRE
POSITION
57 28.175N
012 42.287W
31" BUOY 95M
1M CHAIN
31" SYN SN J08018-001 INV 250007878
IRIDIUM SN B11-052 ID 300234060573000
LIGHT SN B11-034
4M CHAIN SWIVEL
10:05
NORTEK 102M
JOIN 8120 10:08
SBE 107M
11324 10:11
384M 3/16" WIRE
SBE 248M
11325 10:19
40" BUOY 488M
1M CHAIN
40" SYN SN J14353-001 INV 250009422
IRIDIUM SN B11-048 ID 300234060474980
LIGHT SN B11-038
4M CHAIN SWIVEL
10:25
NORTEK 494M
JOIN 9881 10:31
SBE 500M
11336 10:33
494M 3/16" WIRE
SBE 751M
11340 10:41
tangled
NORTEK 996M 10:46
JOIN 9213
5 GLASS SPHERES 991M
10:46
tangled
bottom bracket missing
10:52 SBE 1002M
3254
201M 3/16" WIRE
4 GLASS SPHERES SWIVEL 1199M
10:57
recovered further down the wire
11:01 SBE 1250M
3256
143M 1/4" WIRE (127+16m)
4 GLASS SPHERES 1347M
very, very tangled
NORTEK 1350M 11:05
11997
11:05
very, very tangled
215M 1/4" WIRE
11:14 SBE 1500M
3257
2 GLASS SPHERES 1567M
tangled 11:17
tangled
11:17 NORTEK 1569M
JOIN 9874
15M 1/4" WIRE
11:22 SBE 1575M
3276
6 GLASS SPHERES SWIVEL 1586M
11:24
AR 861 SN 2308
AR 861 SN 1754
5M ½"CHAIN
WATER DEPTH 1600M
2200KG ANCHOR
OSNAP


RH ADCP
TO RECOVER
2024
POSITION
57 36.874N
015 24.697W
RECOVERY LINE
IRIDIUM SN B11-049 ID 300234060571000
LIGHT SN B11-040
40" SYNTACTIC SN J20268-002
NORTEK SIGNATURE 55 ADCP
SN 200044
07:32
SAMS SBE 9378
?
07:32
5M 12MM CHAIN
SWIVEL
AR 861 SN 1753
AR 861 SN 1272
07:35
5M OF 12MM CHAIN
850KG ANCHOR
OSNAP

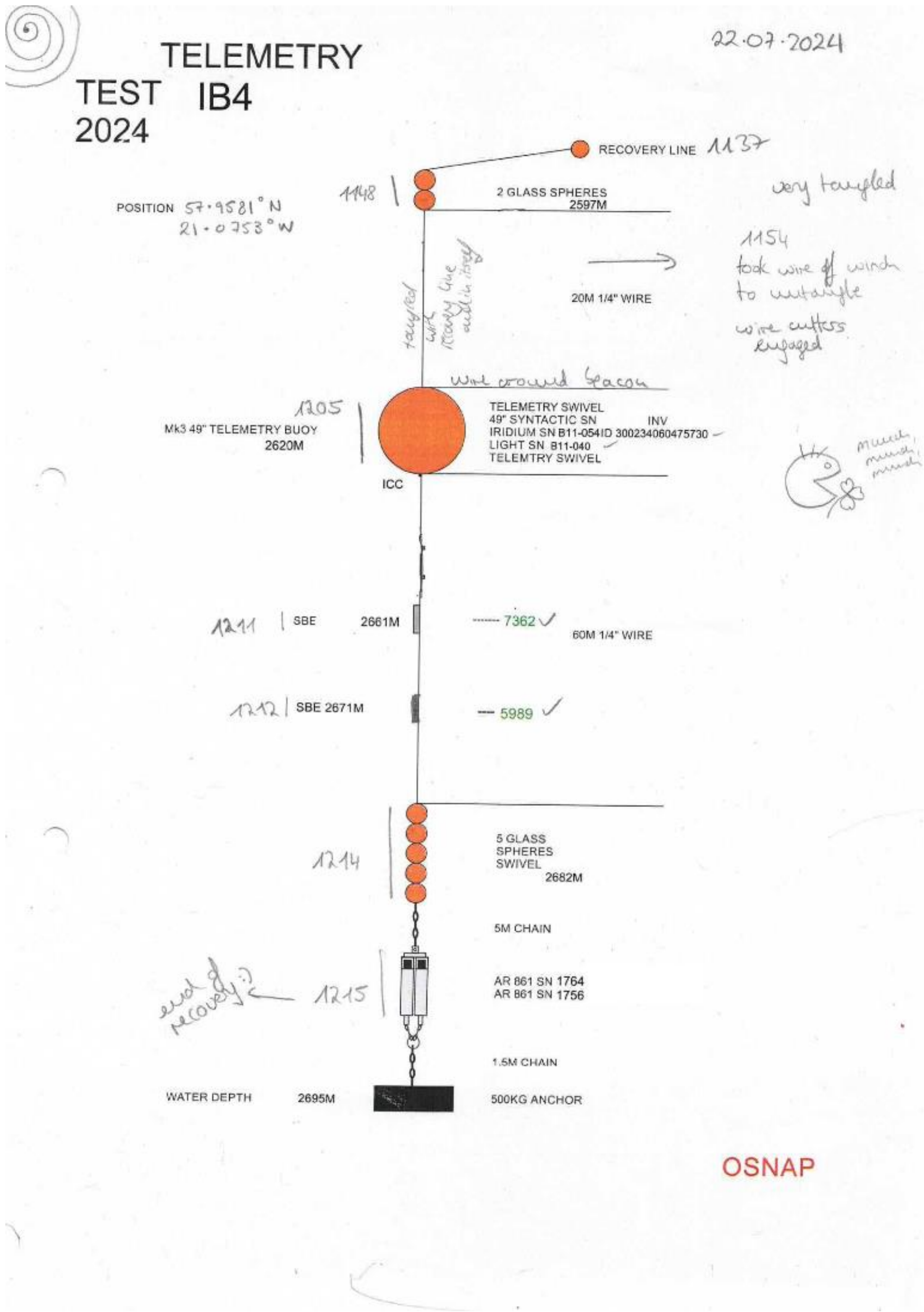

IB 5
TO RECOVER
2024
RECOVERY LINE
0917
2GLASS
SPHERES
45M
0920
SBE 48M
3212
44M 3/16" WIRE
Heavy algae growth.
0927.
300KHZ ADCP UP SN 20957
300KHZ ADCP DOWN SN 20959
1M CHAIN
44" SYN SN J17041-002 INV 260004446
IRIDIUM SN B11-054 ID 300234060475730
LIGHT SN B11-026
4M CHAIN SWIVEL
Top ADCP broken.
UP (missing lens)
POSITION
57 48.057N
019 10.170W
0935
SBE 103M
3213
0938
SBE 199M
3219
202M 3/16" WIRE
0941
4 GLASS
SPHERES
SWIVEL
302M
Tangle. Microcat 6115 above.
0941
SBE 349M
6115
194M 3/16" WIRE
0950
SBE 494M
3207
0952
4 GLASS
SPHERES
SWIVEL
501M
0952
NORTEK 502M
11990
418M 3/16" WIRE
377M + 41M
0958
SBE 700M
3264
1002
SBE 919M
6123
Heavy biofouling
1003
NORTEK 925M
JOIN 11992
1003.
6 GLASS
SPHERES
SWIVEL
926M
AR 861 SN 1756
AR 861 SN 1764
1004
End recovery
10M ½"CHAIN
WATER DEPTH 900M
1300KG ANCHOR
OSNAP


grappled at 09:04
IB 4
TO RECOVER
2024
RECOVERY LINE
2GLASS
SPHERES
45M
SBE 48M
ODO 49M
3221
12906
44M 3/16" WIRE
1M CHAIN
44" SYN SN J16297-002 INV 260004334
IRIDIUM SN B11-046 ID 300234060475990
LIGHT SN B11-029
4M CHAIN SWIVEL
300KHZ ADCP UP SN 20960
300KHZ ADCP DOWN SN 24589
hole in bottom ADCP eye
POSITION
57 59.338N
021 08.792W
SBE104M
11330
197M 3/16" WIRE
SBE 199M
3224
8 GLASS
SPHERES
297M
tangled
SBE 348M
ODO 349M
3253
12908
SBE 498M
ODO 499M
3248
12962
587M 3/16" WIRE
SBE 699M
ODO 700M
11334
13000
4 GLASS
SPHERES
SWIVEL
893M
tangled above spheres
SBE 901M
9375
SBE 1199M
9390
594M 3/16" WIRE
477M+117M
4 GLASS
SPHERES
1492M
NORTEK 1496M
11021
SBE 1502M
9396
395M 1/4" WIRE
4 GLASS
SPHERES
SWIVEL
1893M
SBE 1902M
11335
395M 1/4" WIRE
4 GLASS
SPHERES
2293M
tangled with bottom 6-pack spheres
tangled in 4-pack and 6-pack spheres
NORTEK 2297M
JOIN 11979
SBE 2303M
3222
495M 1/4" WIRE
2 GLASS
SPHERES
2794M
tangled with Nortek + ST
NORTEK
~~SBE~~ 2796M
12047
tangled with spheres
SBE 2802M
14365
103M 1/4" WIRE
6 GLASS
SPHERES
SWIVEL
2901M
tangled with 4-pack spheres
AR 861 SN 2310
AR 861 SN 1757
10M ½"CHAIN
WATER DEPTH 2919M
1900KG ANCHOR
OSNAP
Recovery end: 1102


IB 3
TO RECOVER
2024
RECOVERY LINE
2GLASS SPHERES 45M
SBE 45M
14364
44M 3/16" WIRE
1M CHAIN
300KHZ ADCP UP SN 24588
300KHZ ADCP DOWN SN 24587
44" SYN SN J14226-002 INV 250009272
IRIDIUM SN B11-050 ID 300234060572000
LIGHT SN B11-030
4M CHAIN SWIVEL
SBE104M
11341
197M 3/16" WIRE
POSITION
58 00.931N
024 25.319W
SBE 199M
11342
8 GLASS SPHERES 297M
SBE 348M
10560
SBE 498M
11110
587M 3/16" WIRE
SBE 699M
11140
4 GLASS SPHERES SWIVEL 893M
SBE 901M
11322
SBE 1199M
11327
594M 3/16" WIRE
4 GLASS SPHERES SWIVEL 1493M
NORTEK 1496M
JOIN 11026
SBE 1502M
11139
395M 1/4" WIRE
4 GLASS SPHERES 1893M
SBE 1902M
11137
395M 1/4" WIRE
4 GLASS SPHERES SWIVEL 2293M
NORTEK 2297M
JOIN 11028
SBE 2303M
10576
495M 1/4" WIRE
2 GLASS SPHERES 2794M
SBE 2796M
11029
SBE 2802M
11338
33M 1/4" WIRE
6 GLASS SPHERES SWIVEL 2831M
AR 861 SN 2311
AR 861 SN 2330
10M ½"CHAIN
WATER DEPTH 2850M
1900KG ANCHOR
OSNAP



EB 1 TELEMETRY TEST - RECOVERY 2024
09/07/2024
RECOVERY LINE
2 GLASS SPHERES 1702M
POSITION
SBE 1708M
5989 √07:58
20M 1/4" WIRE
TELEMETRY SWIVEL
49" SYNTACTIC SN INV
IRIDIUM SN ID
LIGHT SN
TELEMTRY SWIVEL
Mk3 49" TELEMETRY BUOY 1725M
√08:11
~~NORTEK 1746M~~
SBE 1766M
7362 √08:19
60M 1/4" WIRE
5 GLASS SPHERES SWIVEL 1787M
√08:21
5M CHAIN
AR 861 SN 1999
AR 861 SN 1766
√08:22
1.5M CHAIN
WATER DEPTH 1800M
500KG ANCHOR
OSNAP


TELEMETRY
TEST IB4
2024
22.07.2024
RECOVERY LINE 1137
POSITION 57·9581°N 21·0753°W
1148
2 GLASS SPHERES
2597M
very tangled
1154
took wire off winch to untangle
wire cutters engaged
20M 1/4" WIRE
Wire around beacon
1205
Mk3 49" TELEMETRY BUOY
2620M
TELEMETRY SWIVEL
49" SYNTACTIC SN
INV
IRIDIUM SN B11-054ID 300234060475730
LIGHT SN B11-040
TELEMTRY SWIVEL
ICC
1211
SBE
2661M
7362
60M 1/4" WIRE
1212
SBE 2671M
5989
1214
5 GLASS SPHERES SWIVEL
2682M
5M CHAIN
end of recovery :)
1215
AR 861 SN 1764
AR 861 SN 1756
1.5M CHAIN
WATER DEPTH
2695M
500KG ANCHOR
OSNAP

APPENDIX EE META DATA FROM RECOVERED MOORINGS

Cruise DY181

Mooring recovery metadata log

Mooring: DMLTM

Date: 05/07/2024

Trilaterated latitude: 59° 51.205'N

Trilaterated longitude: 7° 03.360'W

Corrected depth: 1026.7 m

Acoustic release S/N: 1758

ARM code:

DIAG code:

RELEASE code:

Arrival on site time (UTC): overnight

Ship location relative to mooring (distance + direction): 458 m, 271°

	Time (UTC)	Latitude	Longitude	Uncorrected depth (m)	Corrected depth (m)
Anchor release	0708				
Surface (acoustic tracking)	0720 est	---	---	---	---
Surface (spotted)	0718	---	---	---	---
Start recovery	0751				
End recovery	0918				

Recovery comments:

range UTC
0706 1103
~~0707~~
0720
0708 1104, 1103, REL OK
0709 1032, 1023
0710 941, 931
0712 764, 756

Cruise DY181 Mooring recovery metadata log

Mooring: EB1

Date: 10/07/2024

Trilaterated latitude: 57° 10013 N

Trilaterated longitude: 09.56415 W

Corrected depth: 1800 m

Acoustic release S/N: 1761

ARM code:

DIAG code:

RELEASE code:

Arrival on site time (UTC): 05:55

Ship location relative to mooring (distance + direction): 600m 20° to starboard

	Time (UTC)	Latitude	Longitude	Uncorrected depth (m)	Corrected depth (m)
Anchor release	06:02:23	57° 5.72040	09 3418374		
Surface (acoustic tracking)		---	---	---	---
Surface (spotted)	06:06	---	---	---	---
Start recovery	06:50	57° 5.928	09° 34.261		
End recovery	08:39	57° 05.651'N	009° 36.345'W	1856	

Recovery comments:

range 06:00:00 1891 m
06:02:00 1891
release sent 06:02:11 1891
06:03:00 1816m 06:03:12 1805m
06:04:04 1724m 06:04:11 1716m ~20min → surface

Cruise DY181 Mooring recovery metadata log

Mooring: WB2
Date: 11.07.2024

Trilaterated latitude: 57.47073
Trilaterated longitude: -12.31159
Corrected depth: 1789 m

Acoustic release S/N: 2326
ARM code:
DIAG code:
RELEASE code:

Arrival on site time (UTC): 11:33

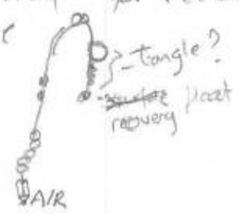
Ship location relative to mooring (distance + direction): 500m

	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
Anchor release	11:44:00	57° 28.3972~~4~~	12° 16.25152		
Surface (acoustic tracking)	—	---	---	---	---
Surface (spotted)	12:00	---	---	---	---
Start recovery	12:57	57° 28.57878	12° 18.41490	1805.8	
End recovery	13:44	57.47584	-12.29000	1807	

Recovery comments:

range 11:34: 1852m
11:44:00 1862m / 1862 release OK
11:45:00 1790/1782
11:46:00 1704/1698 ~85m/min

~~surface to~~ Iridium float sitting just below surface
- long time to manoeuvre into position for recovery, awkward configuration on surface



Cruise DY181

Mooring recovery metadata log

Mooring: WB1

Date: 12.07.2024

Trilaterated latitude: 57.469580 N

Trilaterated longitude: 12.704789 W

Corrected depth: 1581.2 m

Acoustic release S/N: 1754 2308 ✓

ARM code:

DIAG code:

RELEASE code:

Arrival on site time (UTC): ~~09:02~~ 09:15

Ship location relative to mooring (distance + direction): 500 m SE of position

	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
Anchor release	09:20:30	57°28.02756	12°41.82150		
Surface (acoustic tracking)		---	---	---	---
Surface (spotted)	09:21	---	---	---	---
Start recovery	09:53	57°27.761	12°42.193	1605 m	
End recovery	11:25	57°26.951	12°43.262	1582 m	

Recovery comments:

range 09:16 – no answer (wrong release type / code selected)

s/n 2308 09:19 – ~~no answer~~ 1669 m

releas 09:20:50 1669 / 1670 ~104 m/min

09:21:50 1578.8 / 1566.2

Cruise ~~JC238~~ DY181

Mooring recovery metadata log

Mooring: RH ADCP

Date: 14.07.2024

Trilaterated latitude: 57.614558N

Trilaterated longitude: 15.411617 W

Corrected depth: 1083 m

Acoustic release S/N: 1753 1272

ARM code:

DIAG code:

RELEASE code:

Arrival on site time (UTC): overnight

Ship location relative to mooring (distance + direction): 300m NE of location

	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
Anchor release	07:02:06	57°37.016	15°24.4610	1217	
Surface (acoustic tracking)		---	---	---	---
Surface (spotted)	07:12	---	---	---	---
Start recovery	07:25	57°36.897	15°24.493	1080	
End recovery	07:36	57°36.858'N	15°24.614'W	1081	

Recovery comments:

range 07:00:20 - 1218.5

release 07:02:06 - 1219 / 1219

~~07~~:03:00 - 1150 / 1140

07:04:00 - 1059 / 1050 ~90 m/min

Cruise DY181 Mooring recovery metadata log

Mooring: IB5
Date: 15.07.2024

Trilaterated latitude: 57.800956 N
Trilaterated longitude: 19.169497 W
Corrected depth: 936.1 m

Acoustic release S/N: 1756 / 1764
ARM code:
DIAG code:
RELEASE code:

Arrival on site time (UTC): 08:30
Ship location relative to mooring (distance + direction): 500 m SW of mooring

	Time (UTC)	Latitude	Longitude	Uncorrected depth (m)	Corrected depth (m)
Anchor release	08:38:30	57° 47.89014' N	19°.10-64886' W	954	
Surface (acoustic tracking)		---	---	---	---
Surface (spotted)	08:39	---	---	---	---
Start recovery	09:13	57° 48.021	19° 10.147	944	
End recovery	10:05	57.80429	-19.15766	935	

Recovery comments:
range check 08:38 1076 m, vertical
Release OK wsy 08:38:50

Cruise DY181

Mooring recovery metadata log

Mooring: IB4

Date: 16.07.2024

Trilaterated latitude: 57.98860 N

Trilaterated longitude: 21.146539 W

Corrected depth: 2898.2 m

Acoustic release S/N: 2310 1757

ARM code:

DIAG code:

RELEASE code:

Arrival on site time (UTC): 07:23

Ship location relative to mooring (distance + direction): 500m ship WNW of mooring

	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
Anchor release	07:27:30	57°59.42634	21° 9.55136	2940	
Surface (acoustic tracking)		---	---	---	---
Surface (spotted)	07:29	---	---	---	---
Start recovery	09:07	57° 59.063N	21° 10.218	2931m	
End recovery	11:03	57° 59.197N	21° 09.461'	2941	2966

Recovery comments:

range 07:25 - 2967.5m
2968.2

release OK
07:28:00 2855/2845

winch sort-out
(10:42) → start
(10:44) → end

dislodged drum

Cruise DY181

Mooring recovery metadata log

Mooring: IB3

Date: 18.07.2024

Trilaterated latitude: 58° 01.5508 N

Trilaterated longitude: 24.421989 W

Corrected depth: 2821.6 m

Acoustic release S/N: ✓ 2330, 2311

ARM code:

DIAG code:

RELEASE code:

Arrival on site time (UTC): 08:45

Ship location relative to mooring (distance + direction): 500m

	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
Anchor release	08:49:30	58° 1.19730	24° 25.03866	2851	
Surface (acoustic tracking)		---	---	---	---
Surface (spotted)	08:53	---	---	---	---
Start recovery	10:18	58° 00.712	24° 24.705	2853	
End recovery	~~14:48~~	~~57° 58.666~~	~~24° 23.801~~	~~2855m~~	~~→ all instruments onboard~~
	14:33	57° 58.381'N	24° 23.336'W	2855m	→ end Recovery

Recovery comments:

range 08:46:30 6647m ?

08:47:45 2883.4 / 2883.4 V

08:48:15 2883.2 / 2884.4

08:51:10 2760

51:40 ~~2956~~ 2694

drop keel not down → comms flaky

all on surface @ 09:29

→ end possibly tangled...

- changed drum at 13:47 UTC
- fishing line caught in mooring for top ~1200m / 300m. Took ~2 hrs to recover.
- tangle loop at the end — 6+2 end glass spheres tangled with 1900m package.

Cruise DY181

Mooring recovery metadata log

Mooring: EB1 test telemetry
Date: 09/07/2024

Trilaterated latitude: 57° 08·31 N
Trilaterated longitude: 09° 35·63 W
Corrected depth: 1821 m

Acoustic release S/N: 1999
ARM code:
DIAG code:
RELEASE code:

Arrival on site time (UTC): 07:05

Ship location relative to mooring (distance + direction): 200m

	Time (UTC)	Latitude °N	Longitude °W	Uncorrected depth (m)	Corrected depth (m)
Anchor release from pos.mv	07:11:30	57.13594	9.59818	1827.5	
Surface (acoustic tracking)	~~07:21~~	---	---	---	---
Surface (spotted)	07:24	---	---	---	---
Start recovery	07:50				
End recovery	08:22	57° 8·368	09° 36 312	1840	

Recovery comments:

ping @ 07:06 1839m
07:10:00 1832m, 1832, release
07:11:30 1765 1749
07:12:00 1711, 1696
07:13:00 1574, 1560
07:14:00 1439, 1425 135 m/min

tangled line below top glass spheres
successful detangle

Anchor release @ 57° 8·1564 N 09° 35·8908 W

Cruise DY181 Mooring recovery metadata log

Mooring: tele test 2
Date: 22.07.2024

Trilaterated latitude: 57.9581° N
Trilaterated longitude: 21.0753° W
Corrected depth: m

Acoustic release S/N: 1764
ARM code:
DIAG code:
RELEASE code:

Arrival on site time (UTC): 10:45
Ship location relative to mooring (distance + direction): 500m ship south of location

	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
Anchor release	10:47:30	57° 57.2224	21° 4.46100	2214	
Surface (acoustic tracking)		---	---	---	---
Surface (spotted)	11:05	---	---	---	---
Start recovery	11:37	57° 57.416	21° 04.528	2672	
End recovery	12:15	57° (N) 57.483	021° (W) 04.734	2700m	

Recovery comments:
range 10:46 2727 2728 vertical
release sent 10:47:30 2728 2728 release OK
range check 10:48:30 2617 2604 on its way up
10:49:30 2482 / no reply ~130 m/min

many tangles in mooring
syntactic buoy floated on its side (not upright)

APPENDIX FF DECK LOGS OF SURFACE TELEMETRY BUOY DEPLOYMENT & RECOVERIES

Cruise DY181

Drifting telemetry buoy metadata log

Surface buoy ID: Floaty

Telemetry mooring: TeleTest 2

Date: 20/07/24

Acoustic ID:

Acoustic ID:

	Activity	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
#1	Buoy Release	09:44:56	57° 57.588'N	21° 04.640'W	2701	
	Grapple/start recovery	12:34	57° 56.616	021° 05.159	2623	
	Floaty on deck	12:41	57° 56.725	021° 05.174	—	
	Sea anchor on deck	12:43	–	—	—	
#2	Buoy release	13:21	57° 58.567	21° 04.354	2711	
	anchor release	13:23	57° 58.590	21° 04.374	2712	
	Grapple/start recovery	15:52	57° 58.527	21° 04.420	2716	
	Buoy out water	16:00	57° 58.602	21° 04.490	—	
	anchor on deck	16:02	—	—	—	

Deployment comments:

Ship drifting with floaty to maintain visual contact
recovery #1 due to distance from mooring @comms limit
dep #2 → 1.5 nmi upwind of mooring site, drift with floaty again.

Cruise DY181

Drifting telemetry buoy metadata log

Surface buoy ID: Floaty

Acoustic ID:

Telemetry mooring: Teletest 2

Acoustic ID:

Date: 21·07·2024

	Activity	Time (UTC)	Latitude N	Longitude W	Uncorrected depth (m)	Corrected depth (m)
#1	Buoy deployed	08:26	57° 57.518 'N	21° 04.504'W	2693	
	Buoy Recovered	11:34	57°57.114 'N	21° 04.324 'W	2628	
#2	Buoy deployed	13:56	57° 57.564	021° 04.615	2702	
	Buoy recovered	17:16	57°57.270	021° 04.549	2650	

Deployment comments:

APPENDIX GG NORTEK S55 LOGS

Cruise DY181 OSNAP S55 Data Recovery

Operator sa03 hs **Laptop** SA-L0096 **Date** 14-07-2024 **Mooring** RH ADCP

Instrument S/N: 200044

External power applied? ☑ **Time** 08:02

Connect to Signature Deployment software? ☑ **Time** 08:04 stop @ 08:05

Start Data Retrieval? ☑ **Time** ~~08:05~~ 08:07

Data Retrieval:

File size /name	Data download files	Data download ok?	Conversion ok?	Data check
279MB S200044A002_RHAD2-TC138	AD2CP - 257 MB Avg - 28 MB	complete ✓ 08:10	→ MATLAB AD2CP ✓ AVG ✓	✓

Data including raw data (grey arrow). The raw data downloads all single ping data. The file will be saved by default in the folder named Users\User\Documents\Nortek\Deployment\Downloads

Comments:

Data check – pitch – ✓
roll – ✓
heading – ✓
plotted in signature viewer
– Amplitude – ✓
velocity – N ✓
E ✓

Cruise DY181
Setup Log

OSNAP S55 Pre-deployment

Operator S.O3h.s **Laptop** L-0096 **Date** 14-07-2024 **Mooring** RHADCP_03_2024

Instrument S/N: 200044

Functionality check

External power applied? ☑

Test deployment filename: test_RHADCP LED blink ✓
Settings: avg interval = 6s, measurement interval = 6s

Sensors check:

in hangar on ship

Temp	Press	Tilt					Compass				Amplitude – air (dB)			Amplitude – rub (dB)		
		level	left	right	fwd	bwd	N	E	S	W	Beam1	Beam2	Beam3	Beam1	Beam2	Beam3
11.64	0.242	✓	✓	✓ –	✓ –18	✓ +8	37°		186		53 ✓	49 ✓	45 ✓	68 ✓	68 ✓	72 ✓

P – -14
r – -1.76

Data check:

Start recorder deployment	Data download ok?	Conversion ok?	Data check
07:40 end 09:47	48KB S200044 AUG_test.adcp	-> MATLAB ✓ avg file created	✓

Comments:

All testing in hangar on Discovery

Cruise DY181
Setup Log

OSNAP S55 Pre-deployment

Deployment

Memory cleared? ☑ 14-07-2024 10:50

Deployment settings:

Instrument
Deployment length: 730 days
Battery type: Lithium
internal =
external = 3600 Wh (confirmed by NMF)

Application
☐ Fine
☑ Coarse
☐ Alternating: ratio ....

Environment
Sound velocity:
☑ Fixed = 1500 m/s
☐ Measured - salinity = ...
Orientation:
☑ Up
☐ Down
Depth = 1000 m
Mounting:
☐ Fixed frame
☑ Subsurface buoy
☐ Surface buoy

Profile
Range:
Start = 2 m
End = 1022 m
Cell size = 20 m
Power level = -2.0 db
Sampling:
Avg interval = 60 s
Measurement interval = 1800 s
Measurement load = 100% Auto
Coord system = ENU
Telemetry format = –
Enable serial output? ☐ NO

Deployment
Filename = DY181 RH ADCP
Start date + time = ~~14-07-2024 10:55:00~~ → 11:55:00
PC clock synchronized to GPS ☑
Clock synchronized to PC ☑
LED: ☑ On for 24 hours
☐ Off
Deploy ☑ Time: ~~10:57:00~~ → 11:52:00

Performance estimates:
Estimated max length = 976 days
Power Usage = 2691.3 Wh
Memory Usage = 281.6 MB
Horizontal prec = 2.09 cm/s
Vertical prec = 0.54 cm/s

Dummy plugs in ☑ External battery pack plugged in ☑ LED blinking at startup time ☑ 11:55:00

Did not start blinking @ set time
→ external battery not working → 0V
→ wires crimped somehow
→ old battery pack did work

check ext batt pack = disconnect from software
plug in batt
plug in LAN connect 2 software.

APPENDIX HH SET-UP FILES FOR DEPLOYED INSTRUMENTS (ELLETT ARRAY MOORINGS)

SBE37-IM set up example

```
S>pwron
sending wake up tone, wait 4 seconds
S>id?
id = 46
S>#46DS
SBE37-IM V 2.3a  SERIAL NO. 4460    09 Jul 2024  12:03:50
not logging: received stop command
sample interval = 10 seconds
samplenumber = 944, free = 189706
store time with each sample
do not transmit sample number
A/D cycles to average = 1
internal pump is installed
temperature = 20.38 deg C
S>#46DDMMYY=090724
S>S>#46HHMMSS=120420
S>#46DS
SBE37-IM V 2.3a  SERIAL NO. 4460    09 Jul 2024  12:04:31
not logging: received stop command
sample interval = 10 seconds
samplenumber = 944, free = 189706
store time with each sample
do not transmit sample number
A/D cycles to average = 1
internal pump is installed
temperature = 20.38 deg C
S>#46SAMPLENUM=0
S>#46STORETIME=Y
S>#46OUTPUTSAL=N
S>#46NAVG=1
S>#46INTERVAL=3600
S>#46PUMPINSTALLED=Y
S>#46OUTPUTSV=N
S>#46SYNCMODE=N
S>#46TXREALTIME=N
S>#46ADAPTIVEPUMPCONTROL=Y
S>#46SAMPLEINTERVAL=3600
 04460,   7.6083,  3.13144,  936.637, 06 Jul 2024, 12:47:11, 944
S>#46OUTPUTFORMAT=1
S>#46FORMAT=1
S>#46STARTDDMMYY=100724
S>#46STARTHHMMSS=060000
start time = 10 Jul 2024  06:00:00
S>#46SAMPLENUM=0
S>#46STARTLATER
start time = 10 Jul 2024  06:00:00
#46DSno reply from acquisition CPU
S>
SBE37-IM V 2.3a  SERIAL NO. 4460    09 Jul 2024  12:10:27
not logging: waiting to start at  10 Jul 2024  06:00:00
sample interval = 3600 seconds
samplenumber = 0, free = 190650
```

```
store time with each sample
do not transmit sample number
A/D cycles to average = 1
internal pump is installed
temperature = 20.43 deg C
```

SBE37SM setup example

```
OutputExecutedTag=n
S>Outputformat=3
S>DS
SBE37SM-RS232 v4.1  SERIAL NO. 10562  12 Jul 2024 08:20:47
vMain = 13.53, vLith =  3.18
samplenumber = 1184, free = 558056
not logging, stop command
sample interval = 10 seconds
data format = converted engineering alternate
transmit real-time = no
sync mode = no
pump installed = yes, minimum conductivity frequency = 3069.0
S>Datetime=07122024082054
S>SAMPLENUMBER=0
this command will modify memory pointers
repeat the command to confirm
SAMPLENUMBER=0
S>OUTPUTSAL=N
S>SAMPLEINTERVAL=3600
S>BAUDRATE=38400
repeat the command at 38400 baud to confirm
BAUDRATE=38400
baud rate change is confirmed
S>OUTPUTSV=N
S>SYNCMODE=N
S>TXREALTIME=N
S>ADAPTIVEPUMPCONTROL=Y
<Error type='INVALID COMMAND' msg='cmd not recognized'/>
S>SAMPLEINTERVAL=1800
S>STARTDATETIME=07122024120000
<start dateTime = 12 Jul 2024 12:00:00/>
S>SAMPLENUMBER=0
this command will modify memory pointers
repeat the command to confirm
SAMPLENUMBER=0
S>STARTLATER
<!--start logging at = 12 Jul 2024 12:00:00, sample interval = 1800 seconds-
->
S>DS
SBE37SM-RS232 v4.1  SERIAL NO. 10562  12 Jul 2024 08:22:17
vMain = 13.50, vLith =  3.19
samplenumber = 0, free = 559240
not logging, waiting to start at 12 Jul 2024 12:00:00
sample interval = 1800 seconds
data format = converted engineering alternate
transmit real-time = no
sync mode = no
```

```
pump installed = yes, minimum conductivity frequency = 3069.0
```

SBE37SMP-ODO-RS232 setup example

```
SBE37SMP-ODO-RS232 v2.3.1  SERIAL NO. 14987  09 Jul 2024 18:13:41
vMain = 13.50, vLith =  2.98
samplenumber = 642, free = 398815
not logging, stop command
sample interval = 15 seconds
data format = converted engineering
output temperature, Celsius
output conductivity, S/m
output pressure, Decibar
output oxygen, mg/L
output salinity, PSU
transmit real time data = no
sync mode = no
minimum conductivity frequency = 3230.1
adaptive pump control disabled, pump on time 1.0 * 7.0 = 7.0 sec
<Executed/>
outputexecutedtag=n
S>outputformat=1
S>outputtemp=1
S>outputcond=1
S>outputpress=1
S>outputox=1
S>outputsal=1
S>adaptivepumpcontrol=y
S>OxNTau=7
S>OxTau20=5.5
S>DateTime=07092024181530
S>ds
SBE37SMP-ODO-RS232 v2.3.1  SERIAL NO. 14987  09 Jul 2024 18:15:35
vMain = 13.48, vLith =  2.98
samplenumber = 642, free = 398815
not logging, stop command
sample interval = 15 seconds
data format = converted engineering
output temperature, Celsius
output conductivity, S/m
output pressure, Decibar
output oxygen, mg/L
output salinity, PSU
transmit real time data = no
sync mode = no
minimum conductivity frequency = 3230.1
adaptive pump control enabled
S>sampleinterval=4500
S>txrealtime=n
S>samplenumber=0
memory pointers will be modified
repeat command to confirm:
samplenumber=0
S>startdatetime=07102902411000
<start dateTime = 10 Jul 2024 11:00:00/>
S>startlater
```

```
<!--start logging at = 10 Jul 2024 11:00:00, sample interval = 4500 seconds-
->
S>ds
SBE37SMP-ODO-RS232 v2.3.1  SERIAL NO. 14987  09 Jul 2024 18:16:31
vMain = 13.45, vLith =  2.98
samplenumber = 0, free = 399457
not logging, start at 10 Jul 2024 11:00:00
sample interval = 4500 seconds
data format = converted engineering
output temperature, Celsius
output conductivity, S/m
output pressure, Decibar
output oxygen, mg/L
output salinity, PSU
transmit real time data = no
sync mode = no
minimum conductivity frequency = 3230.1
adaptive pump control enabled
S>
```

SBE37SM – caldip setup example

```
OutputExecutedTag=n
S>Outputformat=3
S>DS
SBE37SM-RS232 v4.1  SERIAL NO. 9377  04 Jul 2024 18:49:34
vMain = 13.16, vLith =  3.15
samplenumber = 31910, free = 527330
not logging, stop command
sample interval = 10 seconds
data format = converted engineering alternate
transmit real-time = no
sync mode = no
pump installed = yes, minimum conductivity frequency = 3324.7
S>Datetime=07042024184930
S>OUTPUTSAL=N
S>SAMPLEINTERVAL=10
S>BAUDRATE=38400
repeat the command at 38400 baud to confirm
BAUDRATE=38400
baud rate change is confirmed
S>OUTPUTSV=N
S>SYNCMODE=N
S>TXREALTIME=N
S>ADAPTIVEPUMPCONTROL=N
S>DS
SBE37SM-RS232 v4.1  SERIAL NO. 9377  04 Jul 2024 18:50:35
vMain = 13.15, vLith =  3.15
samplenumber = 31910, free = 527330
not logging, stop command
sample interval = 10 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = yes, minimum conductivity frequency = 3324.7
```

```
S>DC
SBE37SM-RS232 v4.1  9377
temperature:  25-Oct-23
    TA0 = -1.109253e-04
    TA1 = 3.107165e-04
    TA2 = -4.893657e-06
    TA3 = 2.111845e-07
conductivity:  25-Oct-23
    G = -9.891503e-01
    H = 1.247377e-01
    I = -3.842623e-04
    J = 4.240254e-05
    CPCOR = -9.570000e-08
    CTCOR = 3.250000e-06
    WBOTC = 6.785500e-07
pressure S/N 2096514, range = 10153 psia  09 nov 2023
    PA0 = 1.499899e+01
    PA1 = 3.383283e-02
    PA2 = 2.361294e-09
    PTCA0 = 5.254097e+05
    PTCA1 = -6.036257e+00
    PTCA2 = 2.076820e-01
    PTCB0 = 1.008716e+02
    PTCB1 = -9.724248e-03
    PTCB2 = 0.000000e+00
    PTEMPA0 = -9.598757e+01
    PTEMPA1 = 4.073120e-02
    PTEMPA2 = 9.199326e-07
    POFFSET = 0.000000e+00
S>STARTDATETIME=07042024210000
<start dateTime = 04 Jul 2024 21:00:00/>
S>STARTLATER
<!--start logging at = 04 Jul 2024 21:00:00, sample interval = 10 seconds--
>
S>DS
SBE37SM-RS232 v4.1  SERIAL NO. 9377  04 Jul 2024 18:50:59
vMain = 13.16, vLith =  3.15
samplenumber = 31910, free = 527330
not logging, waiting to start at 04 Jul 2024 21:00:00
sample interval = 10 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = yes, minimum conductivity frequency = 3324.7
S>
```

DeepSeaPHox setup

Configuration

Deep SeapHox2 Summary Report

Serial Number:	0002061	Firmware Rev:	6.1.4
Operator:	SA01ED		
Comment:	Setup SeapHOx EB1 50m, deployment 10 July 2024		

Ancillary	Value	Setting	Value
Recorded Events	12	Baud Rate	19200
Stored Samples	1	CTD Power	false
Free Samples	883010	Temperature Units	Celsius
Power Supply Voltage	12.4	Pressure Units	Decibar
Main Battery Voltage	12.8	Conductivity Units	S/m
Clock Battery Voltage	3.3	Oxygen Units	ml/L
Isolated Circuit Voltage	6.4	Transmit Data Realtime	false
Clock Time	09 Jul 2024 17:54:13 UTC	Sample Interval (seconds)	3600
		Pump Time (s)	65

7/9/24 6:54 PM Page 1 of 4

Calibration Coefficients

Sensor	Coefficient	Value
pH	F1	7.345427E-6
pH	F2	-6.654979E-9
pH	F3	4.728646E-12
pH	F4	-2.300883E-15
pH	F5	7.24722E-19
pH	F6	-1.030522E-22
pH	K0	-1.49153
pH	K2	-9.380058E-4
temperature	A0	-2.721089E-4
temperature	A1	3.410228E-4
temperature	A2	-6.943564E-6
temperature	A3	2.660811E-7
conductivity	G	-1.00693
conductivity	H	0.1387207
conductivity	I	-7.693422E-5
conductivity	J	2.470632E-5
conductivity	PCOR	-9.57E-8
conductivity	TCOR	3.25E-6
conductivity	WBOTC	2.164826E-7
conductivity	Z	0.0
pressure	PA0	-0.2125723
pressure	PA1	0.03124667
pressure	PA2	2.449185E-9
pressure	PTCA0	524817.9
pressure	PTCA1	-5.11733
pressure	PTCA2	0.2050017
pressure	PTCB0	100.6468
pressure	PTCB1	-0.005938254

Sensor	Coefficient	Value
pressure	PTCB2	0.0
pressure	PTEMPA0	-95.71543
pressure	PTEMPA1	0.04013217
pressure	PTEMPA2	1.109323E-6
pressure	POFFSET	0.0
pressure	PRANGE	10153.0
oxygen	TAU20	7.0
oxygen	OXA0	1.0513
oxygen	OXA1	-0.0015
oxygen	OXA2	0.371001
oxygen	OXB0	-0.246985
oxygen	OXB1	1.60047
oxygen	OXC0	0.105919
oxygen	OXC1	0.00453504
oxygen	OXC2	6.48092E-5
oxygen	OXTA0	6.9031E-4
oxygen	OXTA1	2.54384E-4
oxygen	OXTA2	3.70558E-7
oxygen	OXTA3	1.1015E-7
oxygen	OXE	0.011

CTD Settings Report

Setting	Value
Device Type	SBE37SMP-ODO-RS232
Serial Number	03721320
Pressure Installed	true
Output Format	raw decimal
Sample Interval (seconds)	3600
Transmit Data Realtime	false
Min Conductivity Frequency (Hz)	3194.6
Adaptive Pump Control	false
Pump Time Multiplier (OxNTau)	1.0
Pump On Time (seconds)	7.0

7/9/24 6:54 PM

Page 4 of 4

Start command

```
<Executed/>
StartDateTime=07102024110000
<Executed/>
<Executed/>
StartLater
<!--Checking Logging Parameters-->
<!--start logging at 10 Jul 2024 11:00:00, sample interval = 3600 seconds--
>
<Executed/>
<Executed/>
ds
[InstrumentInfo]
  DeviceType      = Deep SeapHox2
  SerialNumber    = 0002061
  FirmwareVersion = 6.1.4 b30014
  FirmwareDate    = Jun 08 2018, 10:10:57
  FrameSync       = DSPHOX
[Status]
  DateTime        = 09 Jul 2024 17:56:43
  AutoSampling    = Not logging, start at 10 Jul 2024 11:00:00
  EventsCount     = 12
  PowerSrc        = Internal
  SystemVolts     = 12.46V
  BatteryVolts    = 12.82V
  IsoBattery      = 6.36V
  RTCBattery      = 3.27V
  [Status.Memory]
  SamplesStored   = 1
  SamplesFree     = 883010
  SampleLength    = 38
  BytesUsed       = 38
[Config]
  SampleInterval  = 3600
  PumpOnTime      = 65.0
  TxRealTime      = no
  CTDPower        = no
  [Config.Measurands]
  Format          = converted engineering
  pH              = pH
  Temperature     = Celsius
  Conductivity    = S/m
  Salinity        = PSU
  Pressure        = Decibar
  Oxygen          = ml/L
<Executed/>
```

SBE16+ setup (integrated with SUNA)

```
SBE 16plus V 3.2.0  SERIAL NO. 50388    09 Jul 2024 18:19:58
vbatt = 13.6, vlith =  8.5, ioper =  49.4 ma, ipump =  11.3 ma,
iext01 =   0.2 ma
status = not logging
samples = 0, free = 3870479
sample interval = 7200 seconds, number of measurements per sample = 4
Paros integration time = 1.0 seconds
pump = run pump for 0.5 sec, delay before sampling = 30.0 seconds, delay
after sampling = 0.0 seconds
transmit real-time = yes
battery cutoff =  7.5 volts
pressure sensor = quartz with temp comp, range = 870.0
SBE 38 = no, SBE 50 = no, WETLABS = no, OPTODE = no, SBE63 = no, SeaFET =
no, Gas Tension Device = no
Ext Volt 0 = yes, Ext Volt 1 = no
Ext Volt 2 = no, Ext Volt 3 = no
Ext Volt 4 = no, Ext Volt 5 = no
echo characters = yes
output format = converted decimal
output salinity = yes, output sound velocity = no
serial sync mode disabled
<Executed/>startlater
ds
start logging at = 10 Jul 2024 12:00:00, sample interval = 7200 seconds
SBE 16plus V 3.2.0  SERIAL NO. 50388    09 Jul 2024 18:33:31
vbatt = 13.8, vlith =  8.5, ioper =  49.5 ma, ipump =  11.5 ma,
iext01 =   0.2 ma
waiting to start at  10 Jul 2024 12:00:00
samples = 0, free = 3870479
sample interval = 7200 seconds, number of measurements per sample = 4
Paros integration time = 1.0 seconds
pump = run pump for 0.5 sec, delay before sampling = 30.0 seconds, delay
after sampling = 0.0 seconds
transmit real-time = yes
battery cutoff =  7.5 volts
pressure sensor = quartz with temp comp, range = 870.0
SBE 38 = no, SBE 50 = no, WETLABS = no, OPTODE = no, SBE63 = no, SeaFET =
no, Gas Tension Device = no
Ext Volt 0 = yes, Ext Volt 1 = no
Ext Volt 2 = no, Ext Volt 3 = no
Ext Volt 4 = no, Ext Volt 5 = no
echo characters = yes
output format = converted decimal
output salinity = yes, output sound velocity = no
serial sync mode disabled
<Executed/>
```

Nortek setup example

```
===============================================================
Deployment    : 11023
Current time : 04/07/2024 09:51:12
Start at      : 04/07/2024 18:00:00
Comment:
RTEB1 OSNAP 2024
---------------------------------------------------------------
Measurement interval  (s) : 3600
Average interval      (s) : 60
Blanking distance     (m) : 0.50
Measurement load      (%) : 4
Power level               : HIGH
Diagnostics interval(min) : 720:00
Diagnostics samples       : 20
Compass upd. rate     (s) : 1
Coordinate System         : ENU
Speed of sound      (m/s) : 1500
Salinity            (ppt) : N/A
Analog input 1            : NONE
Analog input 2            : NONE
Analog input power out    : DISABLED
Raw magnetometer out      : OFF
File wrapping             : OFF
TellTale                  : OFF
AcousticModem             : OFF
Serial output             : OFF
Baud rate                 : 9600
---------------------------------------------------------------
Assumed duration   (days) : 730.0
Battery utilization   (%) : 79.0
Battery level         (V) : 13.8
Recorder size        (MB) : 9
Recorder free space  (MB) : 8.973
Memory required      (MB) : 1.9
Vertical vel. prec (cm/s) : 1.4
Horizon. vel. prec (cm/s) : 0.9
---------------------------------------------------------------
Instrument ID             : AQD11023
Head ID                   : A6L 6003
Firmware version          : 3.37
---------------------------------------------------------------
Aquadopp Deep Water Version 1.40.14
Copyright (C) Nortek AS
===============================================================
```

Workhorse 300 kHz ADCP setup

```
CR1
CF11101
EA0
EB0
ED10000
ES35
EX11111
EZ1111101
WA50
WB0
WD111100000
WF88
WN29
WP10
WS100
WV175
TE00:03:00.00
CK
CS
;
;Instrument          = Workhorse Sentinel
;Frequency           = 614400
;Water Profile       = YES
;Bottom Track        = NO
;High Res. Modes     = NO
;High Rate Pinging   = NO
;Shallow Bottom Mode= NO
;Wave Gauge          = NO
;Lowered ADCP        = YES
;Ice Track           = NO
;Surface Track       = NO
;Beam angle          = 20
;Temperature         = 5.00
;Deployment hours    = 17760.00
;Battery packs       = 3
;Automatic TP        = YES
;Memory size [MB]    = 256
;Saved Screen        = 3
;
;Consequences generated by PlanADCP version 2.06:
;First cell range    = 2.10 m
;Last cell range     = 30.10 m
;Max range           = 43.72 m
;Standard deviation = 2.21 cm/s
;Ensemble size       = 734 bytes
;Storage required    = 248.64 MB (260716800 bytes)
;Power usage         = 766.87 Wh
;Battery usage       = 1.7
;
; WARNINGS AND CAUTIONS:
; Advanced settings have been changed.
```

Signature 55 setup


```
#$DeployFileVersion,4,afde37876cf797ac4c189fc2e75cd1e5
#$SWSource,"Deployment-v4.6.19.1"
#$InstrumentId,{"InstrumentType":"Signature55","HeadFrequency":55,"IsDeepWater":fal
se,"IsLADCP":false,"FWVersion":"2214.12"}
#$DeploymentName,"DY181RHADCP"
#$Comment,null
#$ApplicationConfig,[{"Enabled":true,"Application":"AvgCoarse","Mounting":"Subsurfa
ceBuoy","Orientation":"UpLooking","Geography$C
#$":"OpenOcean","SoundVelocity":"Fixed","SoundVelocityValue":1500.0,"Salinity":35.0
,"StrongWaves":false,"ProfileRange":1000.0,"$C
#$InstrumentDepth":1000.0,"TidalRange":1.0,"BurstHR":false,"BurstHR5":false},{"Enab
led":false,"Application":"None","Mounting":"$C
#$SubsurfaceBuoy","Orientation":"UpLooking","Geography":"OpenOcean","SoundVelocity"
:"Fixed","SoundVelocityValue":1500.0,"Salini$C
#$ty":35.0,"StrongWaves":false,"ProfileRange":1000.0,"InstrumentDepth":1000.0,"Tida
lRange":1.0,"BurstHR":false,"BurstHR5":false$C
#$}]
#$AlternatingRatio,[3,1]
#$DeploymentConfigExtensions,[{"AvgDesiredRange":1022.0,"BurstDesiredRange":1000.0,
"BurstHrDesiredRange":1000.0,"EchoSounderDes$C
#$iredRange":1000.0,"AvgEndProfile":1124.2,"BurstEndProfile":1100.0,"BurstHrEndProf
ile":1100.0,"EchoSounderEndProfile":1100.0,"$C
#$AIStep":6,"RangeStep":1.0,"BurstMeasurementContinuous":false,"AvgMeasurementLoad"
:100.0,"MinAvgMeasurementLoad":10.0,"MaxAvgM$C
#$easurementLoad":100.0,"AvgAutoMeasurementLoad":true,"AvgMeasurementLoadTick":10.0
,"BurstMeasurementLoad":100.0,"BurstAutoMeas$C
#$urementLoad":true,"BurstMeasurementLoadTick":1.0,"PulseDistanceAutoOption":3,"Pul
seDistance":3,"DistanceToBottom":2.0,"Distan$C
#$ceToSurface":2.0,"DesiredVelocityRange":0.25,"ValidBurstIntervals":[],"Measuremen
tIntervalAlternate":6},{"AvgDesiredRange":10$C
#$00.0,"BurstDesiredRange":1000.0,"BurstHrDesiredRange":1000.0,"EchoSounderDesiredR
ange":1000.0,"AvgEndProfile":1100.0,"BurstEn$C
#$dProfile":1100.0,"BurstHrEndProfile":1100.0,"EchoSounderEndProfile":1100.0,"AISte
p":1,"RangeStep":0.1,"BurstMeasurementContin$C
#$uous":false,"AvgMeasurementLoad":100.0,"MinAvgMeasurementLoad":0.0,"MaxAvgMeasure
mentLoad":100.0,"AvgAutoMeasurementLoad":tru$C
#$e,"AvgMeasurementLoadTick":1.0,"BurstMeasurementLoad":100.0,"BurstAutoMeasurement
Load":true,"BurstMeasurementLoadTick":1.0,"P$C
#$ulseDistanceAutoOption":3,"PulseDistance":3,"DistanceToBottom":2.0,"DistanceToSur
face":2.0,"DesiredVelocityRange":0.25,"Valid$C
#$BurstIntervals":[],"MeasurementIntervalAlternate":0}]
#$BatteryItem,null
#$BatteryCombo,{"InternalBattery":{"Name":"None                                    0
Wh","Volume":0.0,"Voltage":0.0},"ExternalBattery":{"Name":"Lithium 3600 Wh","$C
#$Volume":3600.0,"Voltage":18.0},"Volume":3600.0,"Voltage":18.0}
#$RecorderItem,{"Name":"16 GB","Capacity":16000000000}
#$AhrsInstalled,false
#$DeploymentDays,730
SETDEFAULT,ALL
SETPLAN,MIAVG=1800,AVG=1,DIAVG=0,VD=0,MV=10,SA=35,BURST=0,MIBURST=120,DIBURST=0,SV=
1500,FN="DY181RHADCP.ad2cp",SO=0,FREQ=55,NSTT=0
SETAVG,NC=56,CS=20,BD=2,CY="ENU",PL=-
2,AI=60,VR=1,DF=3,NPING=10,NB=3,CH=0,MUX=1,BW="NARROW",ALTI=0,BT=0,ICE=0,ALTISTART=
0.5,ALTIEND=150,RAWALTI=1
SETTMAVG,EN=0,CD=1,PD=1,AVG=60,TV=1,TA=1,TC=1,CY="ENU",FO=0,SO=0,DF=100,DISTILT=0,T
PG=0,MAPBINS=0
SAVE,ALL
```

APPENDIX II REFERENCES

Armstrong, F.A. J., et al. 1967. The measurement of upwelling and subsequent biological process by means of the technicon Autoanalyser and associated equipment. Deep-Sea Res. Oceanogr. Abstr. 14:381 – 389. Doi:10.1016/0011-7471(67)90082-4.

Becker., S. et al., 2020. GO-SHIP Repeat Hydrography Nutrient Manual: The Precise and Accurate Determination of Dissolved Inorganic Nutrients in Seawater, Using Continuous Flow Analysis Methods. Front. Mar. Scie., 30 October 2020 Sec. Ocean Observations Volume 7 doi :10.3389/fmars.2020.581790.

Drummond and W. Maher, 1995. Re-examination of the optimum conditions for the analysis of phosphate. Analytical Chimica Acta 302: 69-74.

Holliday, P. N., Pollard, R. T., Read, J. F., & Leach, H. (2000). Water mass properties and fluxes in the Rockall Trough, 1975–1998. *Deep Sea Research Part I: Oceanographic Research Papers*, *47*(7), 1303–1332. https://doi.org/10.1016/S0967-0637(99)00109-0

Murphy and J.P. Riley, 1962. A modified single solution method for the determination of phosphate in natural waters. Analytica Chimica Acta 27:31-36. 2.

Pollard, R. T., Read, J. F., Holliday, N. P., & Leach, H. (2004). Water masses and circulation pathways through the Iceland Basin during Vivaldi 1996. *Journal of Geophysical Research: Oceans*, *109*(C4). https://doi.org/10.1029/2003JC002067

Rees, C., et al. 2019. Methods for reproducible shipboard SFA nutrient measurement using RMNS and automated data processing. *Limnol. Oceanogr.: Methods 17, 2019, 25-41 doi:10:1002/lom3.10294.*