National Oceanography Centre

RESEARCH EXPEDITION REPORT

RAPID 26N Report for *RRS Discovery* Research Expedition DY204

2nd - 10th February 2026

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Abstract

The purpose of *RRS Discovery* research expedition DY204 was to refurbish the Eastern Boundary of the RAPID 26°N array of moorings that span the Atlantic from the Bahamas to the Canary Islands. The expedition started in Santa Cruz de Tenerife on 2nd February 2026 and ended on 10th February 2026 at Santa Cruz de Tenerife.

The moorings are part of a purposeful Atlantic wide array that observes the Atlantic Meridional Overturning Circulation and the associated heat and freshwater transports. The RAPID-MOCHA-WBTS array is a joint UK-US programme.

During DY204 moorings were serviced at sites: EBH3, EBH3L, EBH2, EBH1, EBH1L. Sites with suffix 'L' denote landers fitted with bottom pressure recorders. Moorings were equipped with instruments to measure temperature, conductivity and pressure, and a number of moorings were also equipped with current meters and/or oxygen sensors.

CTD stations were conducted throughout the cruise for purposes of providing pre- and post-deployment calibrations for mooring instrumentation. Shipboard underway measurements were systematically logged, processed and calibrated, including : surface meteorology, 5m depth sea temperatures and salinities, water depth, and navigation. Water velocity profiles from 15 m to approximately 800m depth were obtained using two vessel mounted Acoustic Doppler Current Profilers (one 75 kHz and one 150 kHz).

Keywords

Atlantic Meridional Overturning Circulation, AMOC, RAPID, moorings, mooring array, North Atlantic

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1. Scientific and Ship Personnel

Name	Position	Affiliation
Antonio Gatti	Master	NOC
Thomas Williams	Chief Officer	NOC
Jonathan Brown	2nd Officer	NOC
Heather Smith	3rd Officer	NOC
James Bills	Chief Engineer	NOC
Daniel Evans	2nd Engineer	NOC
Elliot Draper	3rd Engineer	NOC
Marc Smith	3rd Engineer	NOC
David Pascoe	ETO	NOC
Paul Quenault	ERPO	NOC
Valerija Brown	Purser	NOC
Ryan Paris	CPOS	NOC
John Hopley	CPOD	NOC
Steven Duncan	POD	NOC
Andrew Whitehead	POS	NOC
Gary Crabb	SG1A	NOC
Steven Crickmore	SG1A	NOC
Piotr Grzesiak	SG1A	NOC
Vincent Puchalt	Head chef	NOC
Juan Bellanato Chapela	Chef	NOC
Carl Piper	Steward	NOC
Kevin Mason	A/Steward	NOC
Ben Moat	Chief Scientist	NOC
Tillys Petit	co- Chief Scientist	NOC
John Siddorn	Scientist	NOC
Yvonne Firing	Scientist	NOC
Adam Blaker	Scientist	NOC
Sarah Reynolds	Scientist	NOC
Vanessa Cavucci	PhD student	Univ. of Southampton
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Rhory Lester	Scientist	NOC
Dan Bourne	Videographer	NOC
Lloyd Gofton	Communications Manager	NOC
Peter Ware	Illustrator	NOC
Alexander Thompson	Chief correspondent	Channel 4
James Stevens	Camera	Channel 4
Paul Voosen		Science magazine
Christian Crowe	Senior Technical Officer	NOC/NMFSS
Josue Viera Rivero	ITO	NOC/NMFSS
Thomas Ballinger	Technician (Moorings)	NOC/NMFSS
Dave Childs	Technician (Moorings)	NOC/NMFSS
Timothy Powell	Technician (Engineering)	NOC/NMFSS
Richard Phipps	Technician (Engineering)	NOC/NMFSS
Andrew Cotmore	Technician (Moorings)	NOC/NMFSS
Jade Garner	Technician (Moorings)	NOC/NMFSS
John Clarke	Technician (Moorings)	NOC/NMFSS

2. Itinerary

The RAPID 26N expedition aboard the RRS Discovery DY204 departed Santa Cruz de Tenerife on Monday 2nd February 2026 and concluded on 10th February 2026 in Santa Cruz de Tenerife. A full itinerary is given in Table 2.1.

Table 2.1 Cruise Itinerary (time in GMT)

Date	Operation	Start time	End time	Durat. (hrs)	Latitude (°N)	Long. (°W)	Notes
Mon 2 Feb	Depart Santa Cruz	10:00					
	Test CTD1	16:14	17:36		27°33.97	16°34.51	1500m. 6 releases
	CTD2	18:35	21:58		27°33.97	16°34.52	Calibration cast. releases and MicroCATs
	CTD3	22:30	01:44		27°33.97	16°34.53	Calibration cast. Releases and MicroCATs
	Transit to EBH2						
Tue 3 Feb	CTD4	14:19	16:10		27°36.38	14°12.68	Pre Oxygen profile. 2000m
	Recover EBH2	17.24	17:55		27° 36.94	14° 12.69'	
	Transit to EBH3						
	CTD5	21:12	22:31		27°47.76	13°45.86	Pre Oxygen profile. 1400m
	CTD6	23:28	00:32		27°47.76	13°45.86	shallow
Wed 4 Feb	Recover EBH3	09:05	10:33		27° 48.49'	13° 44.86'	
	Deploy EBH3	12:15	14:17		27°48.55	13°44.71	
	Deploy EBH3L2	15:19	15:25		27°48.21	13°45.37	
	CTD7	16:12	17:27		27°47.77	13°45.84	Post Oxygen profile. 1400m
	CTD8	18:50	19:59		27°48.74	13°45.69	
	Transit EBH3B						
	CTD9	21:17	21:45		27°44.58	13°50.37	500m
	CTD10	22:46	23:13		27°44.55	13°50.31	

Thu 5 Feb	Recover EBH3B	09:05	10:04		27° 44.99'	13° 50.01'	
	Deploy EBH3B	12:01	13:52		27°45.00	13°50.00	
	Transit EBH2						
	CTD11	19:07	20:04		27° 36.51	14° 13.05	Pre Oxygen profile. 2000m
Fri 6 Feb	Deploy EBH2	08:57	09:24				
	Trilaterate						
	CTD12	12:08	14:01		27° 36.29	14° 00.00	Post Oxygen profile. 2000m
	CTD13	14:36	15:20		27° 36.29	14° 00.00	272m
	Transit EBH1						
	CTD14	22:12	00:19		27° 13.16	15° 25.82	Pre Oxygen profile. 3000m
Sat 7 Feb	Recover EBH1L15	08:53	08:58		27° 12.97’	15° 26.04	
	Recover EBH1	10:24	11:14		27° 13.37'	15° 25.29	
	Deploy EBH1	13:38	14:42		27°13.35	15°25.39	
	Deploy EBH1L17	15:33	15:34		27°13.05	15°25.97	
	CTD15	16:05	16:43		27° 13.17	15°27.11	shallow
	CTD16	17:49	20:06		27° 13.18	15°27.11	Post Oxygen profile. 3000m
	Deploy Argo float	20:16	20:16		27° 13.18	15°27.11	
	CTD17	20:51	21:24		27° 14.13	15°26.70	shallow
Sun 8 Feb	CTD18	09:40	12:58		26°48.13	16°15.74	Calibration cast
	CTD19	13:42	14:28		26°48.13	16°15.74	shallow
	CTD19	15:05	18:25		26°48.13	16°15.74	Calibration cast

	CTD20	09:40	12:58		26°48.13	16°15.74	Calibration cast
Mon 9 Feb	CTD21	08:25	09:40		27°25.68	14°46.15	shallow
	CTD22	10:26	12:00		27°25.68	14°46.15	Full depth. No bottle stops
	CTD23	14:17	16:26		27°19.01	15°08.18	
Tue 10 Feb	Santa Cruz de Tenerife	09:00					

3. Introduction

This cruise report is for cruise DY204 conducted aboard RRS *Discovery* in February 2026. The primary purpose of the cruise was to service the UK contribution to the RAPID-MOC/MOCHA mooring array. The RAPID-MOC/MOCHA array was first deployed in 2004 to measure the Atlantic Meridional Overturning Circulation (AMOC) at 26°N and has been maintained by regular service cruises since then. The array and associated observations are funded by NERC, NSF and NOAA. The NERC contribution to the first four years of measurements was funded under the directed programme "RAPID Climate Change". Following an international review NERC continued funding to 2014 under the programme "RAPID-WATCH". The servicing and redeployment of the UK moorings on this cruise are conducted under the "RAPID-AMOC" programme, which is funded until 2020. NSF and NOAA have also continued funding and commitments so that the system can continue operating at the same level of activity.

RAPID-AMOC continues the measurements at 26°N and extends these to include biological and chemical measurements in order to determine the variability of the AMOC and its links to climate and the ocean carbon sink on interannual-to-decadal time scales.

For further information on the RAPID-MOC/MOCHA array, please see previous cruise reports (detailed in Table 3.1).

As on previous cruises, we deployed an Argo floats supplied by the UK Met Office. All Argo data is freely available online - see https://argo.ucsd.edu/data/ for further details.

3.1 Results and Data Policy

All data and data products from the RAPID 26°N project are freely available. The NERC data policy may be found at http://www.bodc.ac.uk/projects/uk/rapid/data policy/. Access to data and data products can be obtained via https://rapid.ac.uk and https://mocha.earth.miami.edu/mocha/results/index.html). Data may also be obtained directly from http://www.bodc.ac.uk/.

A full list of published papers is available on the programme website at https://rapid.ac.uk/publications

3.2 Previous RAPID-MOC Cruises

Table 3.1 details the previous cruises completed as part of the RAPID-MOC project with information on the relevant cruise reports for reference, note this does not include all NOAA WBTS hydrography cruises.

Cruise	Vessel	Date	Objectives	Cruise Report
D277	RRS *Discovery*	Feb - Mar 2004	Initial Deployment of Eastern Boundary and Mid-Atlantic Ridge moorings.	Southampton Oceanography Centre Cruise Report, No 53, 2005
D278	RRS *Discovery*	Mar 2004	Initial Deployment of UK and US Western Boundary Moorings.	Southampton Oceanography Centre Cruise Report, No 53, 2005
D279	RRS *Discovery*	Apr –May 2004	Transatlantic hydrography (125 CTD stations).	Southampton Oceanography Centre, Cruise Report, No 54, 2005
P319	RV *Poseidon*	Dec 2004	Emergency deployment of replacement EB2 following loss.	Appendix in National Oceanography Centre Southampton Cruise Report, No. 2, 2006
CD170	RRS *Charles Darwin*	Apr 2005	Service and redeployment of Eastern Boundary and Mid-Atlantic Ridge moorings.	National Oceanography Centre Southampton Cruise Report, No. 2, 2006
KN182-2	RV *Knorr*	May 2005	Service and redeployment of UK and US Western Boundary Moorings and Western Boundary Time Series (WBTS) hydrography section.	National Oceanography Centre Southampton Cruise Report, No. 2, 2006
CD177	RRS *Charles Darwin*	Nov 2005	Service and redeployment of key Eastern Boundary moorings.	National Oceanography Centre Southampton Cruise Report, No. 5, 2006
WS05018	RV *F.G. Walton Smith*	Nov 2005	Emergency recovery of drifting WB1 mooring.	No report published
RB0602	RV *Ronald H. Brown*	Mar 2006	Service and redeployment of UK Western Boundary moorings and WBTS hydrography section.	National Oceanography Centre Southampton Cruise Report, No. 16, 2007
D304	RRS *Discovery*	May - Jun 2006	Service and redeployment of Eastern Boundary and Mid-Atlantic Ridge moorings.	National Oceanography Centre Southampton Cruise Report, No. 16, 2007
P343	RV *Poseidon*	Oct 2006	Service and redeployment of key Eastern Boundary moorings.	National Oceanography Centre Southampton Cruise Report No. 28, 2008.
P345	RV *Poseidon*	Nov – Dec 2006	Emergency redeployment of EB1 and EB2 following problems on P343.	National Oceanography Centre Southampton Cruise Report No. 28, 2008.
SJ-14-06	RV *Seward Johnson*	Sep – Oct 2006	Recovery and redeployment of WB2 and US Western Boundary moorings, and WBTS hydrography section.	Appendix G in National Oceanography Centre, Southampton Cruise Report, No 29
RB0701	RV *Ronald H. Brown*	Mar - Apr 2007	Service and redeployment of UK Western Boundary moorings and WBTS hydrography section.	National Oceanography Centre, Southampton Cruise Report, No 29

D324	RRS *Discovery*	Oct – Nov 2007	Service and redeployment of Eastern Boundary and Mid-Atlantic Ridge moorings.	National Oceanography Centre, Southampton Cruise Report, No 34
SJ0803	RV *Seward Johnson*	Apr 2008	Service and redeployment of the Western Boundary moorings.	National Oceanography Centre, Southampton Cruise Report, No 37
D334	RRS *Discovery*	Oct-Nov 2008	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings.	National Oceanography Centre, Southampton, Cruise Report No. 38, 2009
RB0901	RV *Ronald H. Brown*	Apr – May 2009	Service and redeployment of the UK and US Western Boundary moorings and the WBTS hydrography section.	National Oceanography Centre, Southampton Cruise Report, No 40, 2009
D344	RRS *Discovery*	Oct – Nov 2009	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings.	National Oceanography Centre, Southampton, Cruise Report No. 51, 2010
D345	RRS *Discovery*	Nov – Dec 2009	Recovery and redeployment of US Western Boundary moorings, and WBTS hydrography section.	RAPID/MOCHA Program Report (W. Johns, RSMAS).
D346	RRS *Discovery*	Jan – Feb 2010	Transatlantic hydrography (135 CTD stations).	National Oceanography Centre Cruise Report, No 16, 2012
OC459	RV *Oceanus*	Mar – Apr 2010	Service and redeployment of the Western Boundary moorings.	National Oceanography Centre Cruise Report, No 01, 2010
RB1009	RV *Ronald H. Brown*	Nov – Dec 2010	Recovery of WB4 and WB3L3. Redeployment of WB4.	Appendix in: National Oceanography Centre Cruise Report, No - 01, 2010
D359	RRS *Discovery*	Dec 2010 – Jan 2011	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings.	National Oceanography Centre Cruise Report, No. 09, 2011
KN200-4	RV *Knorr*	Apr – May 2011	Service and redeployment of Western Boundary Moorings and WBTS hydrography section.	National Oceanography Centre Cruise Report, No 07, 2011
JC064	RRS *James Cook*	Sep – Oct 2011	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings.	National Oceanography Cruise Report, No. 14, 2012
RB1201	RV *Ronald H. Brown*	Feb – Mar 2012	Service and redeployment of Western Boundary Moorings and WBTS hydrography section.	National Oceanography Centre, Cruise Report No. 19, 2012
EN517	RV *Endeavor*	Sep – Oct 2012	Service of US moorings in Western Boundary.	RV Endeavor Cruise EN-517 Cruise Report
D382	RRS *Discovery*	Oct – Nov 2012	Service and redeployment of full UK RAPID array.	National Oceanography Centre Cruise Report No. 21, 2012
AE1404	RV *Atlantic Explorer*	Mar 2014	Service of US moorings in Western Boundary.	RV Atlantic Explorer Cruise AE-1404 Cruise Report

JC103	RRS *James Cook*	Apr – Jun 2014	Service and redeployment of full UK RAPID array.	National Oceanography Centre Cruise Report No. 30, 2015
EN570	RV *Endeavor*	Oct 2015	Service of US moorings in Western Boundary.	RV Endeavor Cruise EN-570 Cruise Report
DY039	RRS *Discovery*	Oct – Dec 2015	Service and redeployment of full UK RAPID array.	National Oceanography Centre Cruise Report, 37
DY040	RRS *Discovery*	Dec 2015 – Jan 2016	Transatlantic hydrography.	National Oceanography Centre Cruise Report, XX
EN598	RV *Endeavor*	May 2017	Service of US moorings in Western Boundary.	RV Endeavor Cruise EN-598 Cruise Report
JC145	*RRS James Cook*	Feb – Apr 2017	Service and redeployment of full UK RAPID array.	National Oceanography Centre Cruise Report, 52
JC174	*RRS James Cook*	Oct – Nov 2018	Service and redeployment of full UK RAPID array.	National Oceanography Centre Cruise Report, 59
JC192	*RRS James Cook*	March 2020	Service and redeployment of eastern boundary of the UK RAPID array.	National Oceanography Centre Cruise Report, 71
DY129	RRS *Discovery*	December 2020 – January 2021	Recovery of RAPID MAR array and recovery and redeployment of RAPID western boundary array.	National Oceanography Centre Cruise Report, 72
DY146	RRS *Discovery*	Feb – Mar 2022	Recovery and redeployment of RAPID Eastern Boundary.	National Oceanography Centre Cruise Report, 76
EN697	RV *Endeavor*	Mar – Apr 2023	Recovery and redeployment of UK Western Boundary moorings	R/V Endeavor Cruise EN-697 Cruise Report
EN705	RV *Endeavor*	July 2023	Recovery and redeployment of UK Western Boundary moorings.	R/V Endeavor Cruise EN-705 Cruise Report
DY174	RRS *Discovery*	Mar – Apr 2024	Recovery and redeployment of RAPID Eastern Boundary.	National Oceanography Centre Cruise Report, 72
DY186	RRS *Discovery*	Dec 2024	Recovery and redeployment of UK Western Boundary moorings.	National Oceanography Centre Cruise Report, 85
DY204	RRS *Discovery*	Feb 2026	Recovery and redeployment of RAPID Eastern Boundary.	This report

Table 3.1 Cruises conducted as part of the RAPID 26°N project

4. Scientific Computing Systems and Data Processing

Yvonne Firing

4.1 Workstations and configuration

Three OOP Linux workstations were available on DY204, all running Ubuntu. The primary workstation, kolea, housed the primary directory structure for data processing, which was served as an NFS mount and mounted on the other two workstations, akeake and ulili. The data processing directories were also copied regularly to an external hard drive as well as to backup directories on the two secondary workstations by a script using rsync. Each workstation had a copy of MATLAB and of the CODAS ADCP processing library. User accounts were configured on each workstation using a script and skeleton directory structure to configure common settings for group permissions (umask) and to point to a common MATLAB startup file.

Access to ship systems and data via mounting shared drives or via the RVDAS postgresql data base was unchanged from DY186.

Shell scripts from the mexec_exec toolbox (git.noc.ac.uk/OCP/mexec_exec) from the dy204 branch were used to configure the cruise data processing directories before the cruise, to sync CTD and UHDAS data to the workstation and between workstations, and to back up data to external hard drives. These scripts were placed in /data/pstar/programs/repos_github/mexec_exec (and added to paths in bash, see above).

4.2 Data Processing Tools

Data processing and plotting used the MATLAB Gibbs Seawater (gsw) toolbox (v3_06_15), neutral density (gamma_n) code (v3_05_10), m_map, and Seawater (ver3_3_1, for sw_dist.m). We also used the pyIGRF package to estimate magnetic declination for Nortek current meter processing. The psql package was used to get data from the RVDAS database.

Shipboard ADCP data are acquired using UHDAS and processed automatically using CODAS installed on the UHDAS machine. Data were synced to kolea and a locally installed version of CODAS was used to review and (where necessary) reprocess and/or edit them.

Hydrographic data – CTD and bottle data, and underway navigation, bathymetry, meteorology and surface ocean time series -- were processed using MATLAB toolbox ocp_hydro_matlab (github.com/NOC-OCP/ocp_hydro_matlab), main branch. Because multiple users were running and modifying these scripts simultaneously, and because of past problems with MATLAB updating files open in multiple instances of the editor, each user had their own copy of the repository (/data/pstar/programs/repos_userbranched/ocp_hydro_matlab_${username}), and their own branch checked out within that copy. On a regular basis, changes to each user branch were committed within the user's copy of the repository; selected changes were checked out or merged into the main branch (copy in /data/pstar/programs/repos_github/ocp_hydro_matlab) and committed; and the updated main branch was fetched (from /data/pstar/programs/repos_github/ocp_hydro_matlab/) and merged back into each user branch. The main branch was also regularly pushed back up to github.

Moored data as well as cal-dip data were processed using MATLAB toolbox m_moorproc_toolbox (github.com/ScotMarPhys/m_moorproc_toolbox), dy186 branch, which was cloned into /data/pstar/programs/repos_github/m_moorproc_toolbox.

5. NMFSS Ship Systems Computing and Underway Instruments

Josue Viera Rivero

5.1 Overview

The information in this section has been taken from the NMF Scientific Ship Systems Cruise Report where full details can be found.
The ship-fitted instruments are listed in Table 5.1, the data were logged by the Techsas 5.11 data acquisition system. The system creates NetCDF and ASCII output data files. Data were additionally

logged onto the legacy RVS Level-C format and raw NEMA strings from the instruments were time stamped and logged.

Manufacturer	Model	Function/data types	Logged? (Y/N)	Comments
Meinberg		GPS network time server (NTP)	N	Not logged
Applanix	POS MV	Primary GPS and attitude	Y	
C-Nav	X3	Correction service for primary and secondary GPS and dynamic positioning.	Y	
Kongsberg Seatex	Seapath 330+	Primary GPS and attitude	N	Not operational
Sperry Marine		Ship gyrocompasses x 2	Y	
Chernikeef Instruments	Aquaprobe Mk5	Electromagnetic speed log	Y	Needs Calibration
Kongsberg Maritime	Simrad EA640	Single beam echo sounder (hull)	Y	
Kongsberg Maritime	Simrad EM122	Multibeam echo sounder (deep)	Y	
NMFSS	CLAM	CLAM system winch log	Y	
NMFSS	Surfmet	Meteorology suite	Y	
NMFSS	Surfmet	Surface hydrography suite	Y	
		Skipper log (ship's velocity)	Y	
OceanWaveS GmbH	WaMoS II	Wave Radar	N	
Teledyne RD Instruments	Ocean Observer 75 kHz	UHDAS	N	Not operational
Teledyne RD Instruments	Ocean Observer 150 kHz	UHDAS	Y	

Table 5.1 Ship-fitted instruments

There are several gaps in the data from the EA640 and EM122 due to isolation of the systems during release and ranging of moorings.

5.2 Position and Attitude

GPS and attitude measurement systems were run throughout the cruise.
The ***Applanix POSMV*** system is the vessel's primary GPS system, outputting the position of the ship's common reference point in the gravity meter room. The POSMV is available to be sent to all systems and is repeated around the vessel. The position fixes attitude and gyro data are logged to the Techsas system. True Heave is logged by the Kongsberg EM122 & EM710 systems.

The ***Kongsberg Seapath 330+*** system is the vessel's secondary GPS system. This was the position and attitude source that was used by the EM122 & EM710 due to its superior real-time heave data. Position fixes and attitude data are logged to the Techsas system.
The ***CNav 3050*** GPS system is the vessel's differential correction service. It provides the Applanix POSMV and Seapath330+ system with RTCM DGPS corrections (greater than 1m accuracy). The position fixes data are logged to the Techsas system.

5.3 Meteorology and Sea Surface Monitoring Package

The NMF Surfmet system was run throughout the cruise, excepting times for cleaning, entering and leaving port and whilst alongside (Table 5.2).
The Surfmet system is comprised of:

- Hull water inlet temperature probe (SBE38).
- Sampling board conductivity, temperature salinity sensor (SBE45).
- Sampling board transmissometer (CST).
- Sampling board fluorometer (WS3S)
- Met platform temperature and humidity probe (HMP45).
- Met platform port and starboard ambient light sensors (PAR, TIR).
- Met platform atmospheric pressure sensor (PTB110).
- Met platform anemometer (Windsonic).

Date	Start Time	Stop Time	Cleaned	Transmissivity (v)	
				High	Low
01/Feb/2026	18:00	19:30		Boards and sensors cleaned	
02/Feb/2026	08:01	08:02	Yes	4.631	0.006
02/Feb/2026	08:06	08:02		Fresh water flushed into the system. Data values are not valid.	
02/Feb/2026	16:10			Underway started after dip clear. Data valid now.	
10/Feb/2026	07:50			Underway turned off upon exit of international waters	

Table 5.2 Underway water logging events

5.4 Hydro-acoustic Systems

The EA640 single-beam echo-sounder was run throughout the cruise apart from during release and ranging of moorings when it was turned off to avoid interference. Both the 10 kHz and 12 kHz were run in active mode triggered by K-Sync. Pulse parameters were altered during the cruise in response to changing depth. It was used with a constant sound velocity of 1500 ms^{-1} throughout the water column to allow it to be corrected for sound velocity in post processing.
The EM122 multibeam echo sounder was run throughout the cruise apart from during release and ranging of moorings triggered by K-sync. The position and attitude data were supplied from the Seapath 330+ due to its superior real-time heave. Applanix PosMV position and attitude data is also logged to the .all files as the secondary source and True Heave *.ath file are logged to allow for inclusion during reprocessing. Sound velocity profiles were derived from a statistical model using SHOM & Ifremer's DORIS programme, derived from CTD data.
The surface Sound Velocity (SV) sensor (AML SmartSV) mounted on the drop keel was used throughout providing SV data to the EM122. The port drop keel remained flush with the hull for the duration of the cruise. Both the 75 and 150 kHz were run consistently during the cruise.

5.5 Other Systems

The single axis bridge Skipper Log and the dual axis Chernikeef science log were logged throughout the cruise.

6. Underway Data and Processing

Adam Blaker, Yvonne Firing, Ben Moat

6.1 Overview

Most underway streams are logged by two systems, Techsas and RVDAS, and latest data as well as recent time series are displayed in several formats viewable in the main laboratory as well as on the ship intranet. Vessel-mounted Acoustic Doppler Current Profiler (VMADCP) data acquired by UHDAS are also viewable both online and on dedicated displays, while multibeam (swath) bathymetry data from the EM122 are viewable on displays of the manufacturer data acquisition software in the main lab. These displays were used by watchkeepers to monitor incoming data on a regular basis (checking that data were updating with reasonable values) by watchkeepers. Bottle samples from the underway system were taken approximately every 4 hours between 0800 and 2000 local time.

6.2 Daily Processing of Underway Data Streams

Data were read from the RVDAS database and processed using the ocp_hydro_matlab (https://github.com/NOC-OCP/ocp_hydro_matlab) Matlab toolbox. Relative to past RAPID cruises the processing was simplified because the NMF-maintained scripts writing to the database had already applied any necessary conversions from engineering to scientific units by applying factory calibration coefficients, including for the radiative and optical streams. Data from the echosounders were corrected for transducer depth (multibeam) and speed of sound (singlebeam, using the Carter tables), automatically despiked, and averaged to 60 s. Based on inspection, data from the surface underway system (SBE45) were removed from times (at the start and end) when the pumps were off or water was just starting to circulate in the system, and these data along with drop keel temperature were averaged to 60 s. Navigation data (position, heading, and attitude) from the preferred instrument (posmv) were averaged to 30 s. Meterological data (PAR and total incident radiation, atmospheric temperature, pressure, and humidity, and wind) were averaged to 30 s and the 30-s position and heading were used to convert the ship-relative wind from the sonic anemometer to true wind by combining the vectors.

6.3 Navigation

The posmv instrument is typically the preferred navigation data source on the Discovery, and was used to reference the VMADCP as well as the wind data. Three sources of heading data are available, with small offsets between them (Figure 6.1). Two sources of attitude data, the posmv and the phins, reflect a difference in sign convention for pitch which may need to be documented in RVDAS as it is in TechSAS.

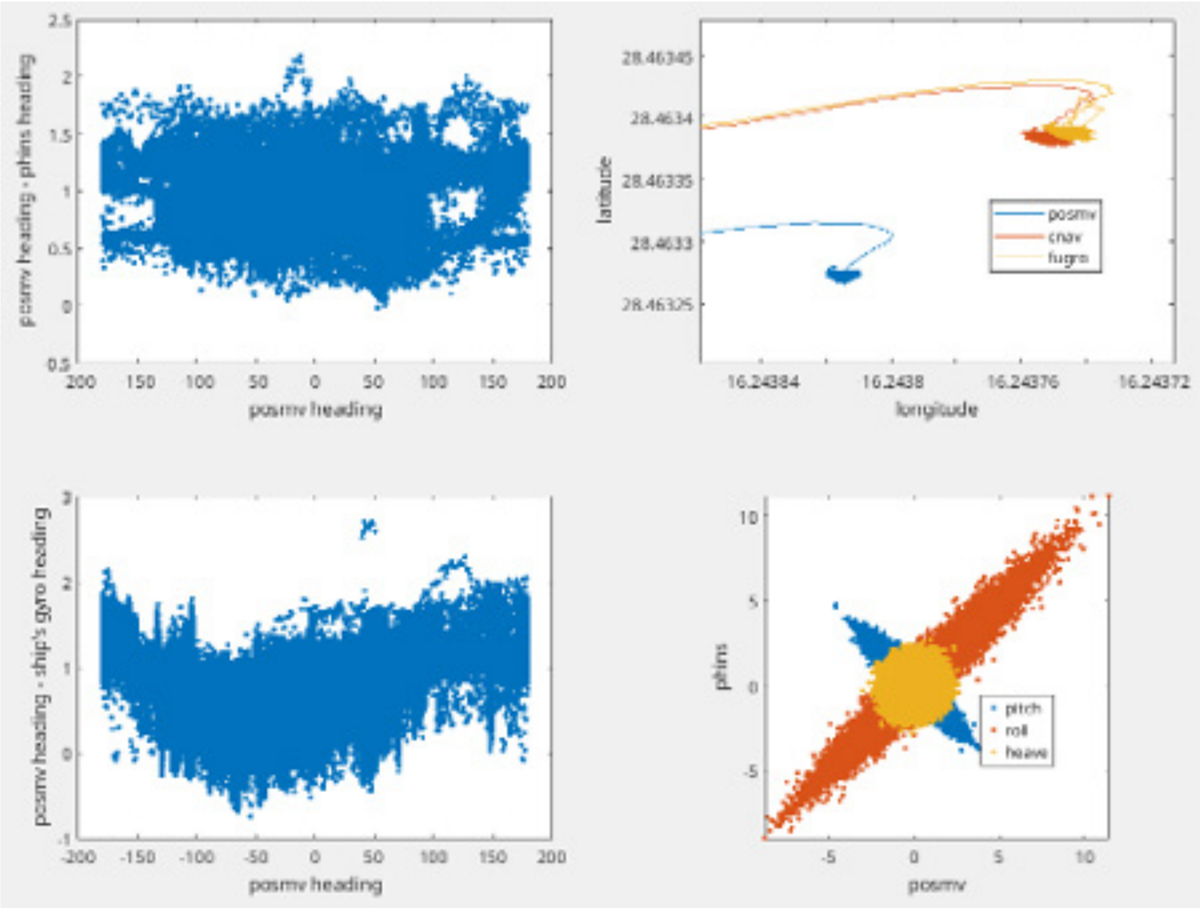


Figure 6.1 Comparisons of different sensors' heading (left), attitude (bottom right), and position while alongside (top right).

6.4 Bathymetry Data

Bathymetry data were collected through most of the cruise, with the singlebeam (EA640) switched on in port and the multibeam (EM122) given a soft start following observing with no evidence of marine mammals in the area. Bathymetric echosounder pinging was stopped for less than 10 minutes at a time (following the Environmental Impact Assessment) when required for mooring release communications (comprising testing on cal dips, pinging and release for recovery, and trilateration). Spikes were edited out of 1-Hz data using automatic despiking and range-editing (mostly removing bad singlebeam data reading as 0) before averaging to 60 s. EA640 data were corrected for regional speed of sound profile based on the Carter tables. The raw singlebeam data were quite noisy, but after despiking and averaging, the two sources generally agreed and had good data quality and coverage (Figure 6.2), with the averaged multibeam data being somewhat noisier.

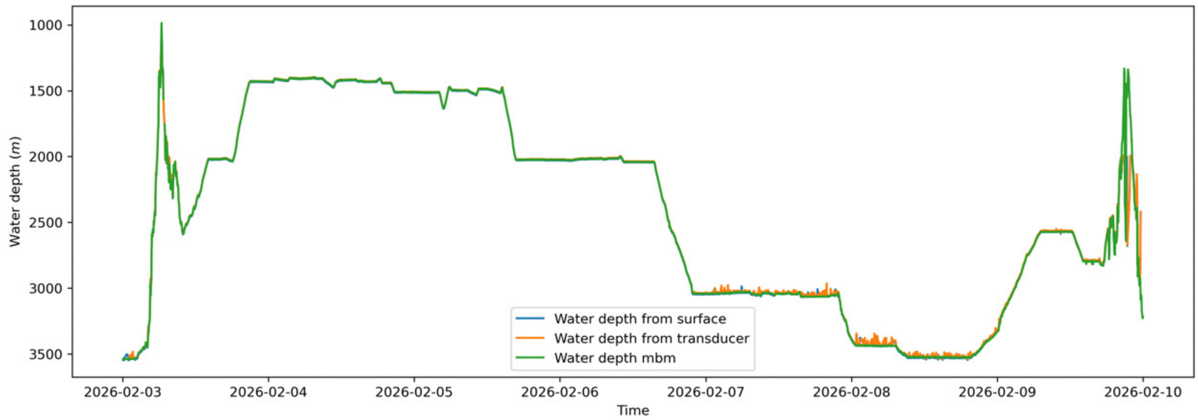


Figure 6.2 Water depth throughout DY204.

6.5 Meteorology and Ocean Surface

Relative wind data were combined with the posmv navigation data (interpolated from 30 s averages) to compute vector true wind (northwards and eastwards components) and corresponding true wind speed and direction (Figure 6.3). Total incident and photosynthetically active radiometer data were converted to W/m². The port-side PAR sensor tended to read about 5% lower than the starboard side sensor, while the two TIR sensors were consistent with each other.

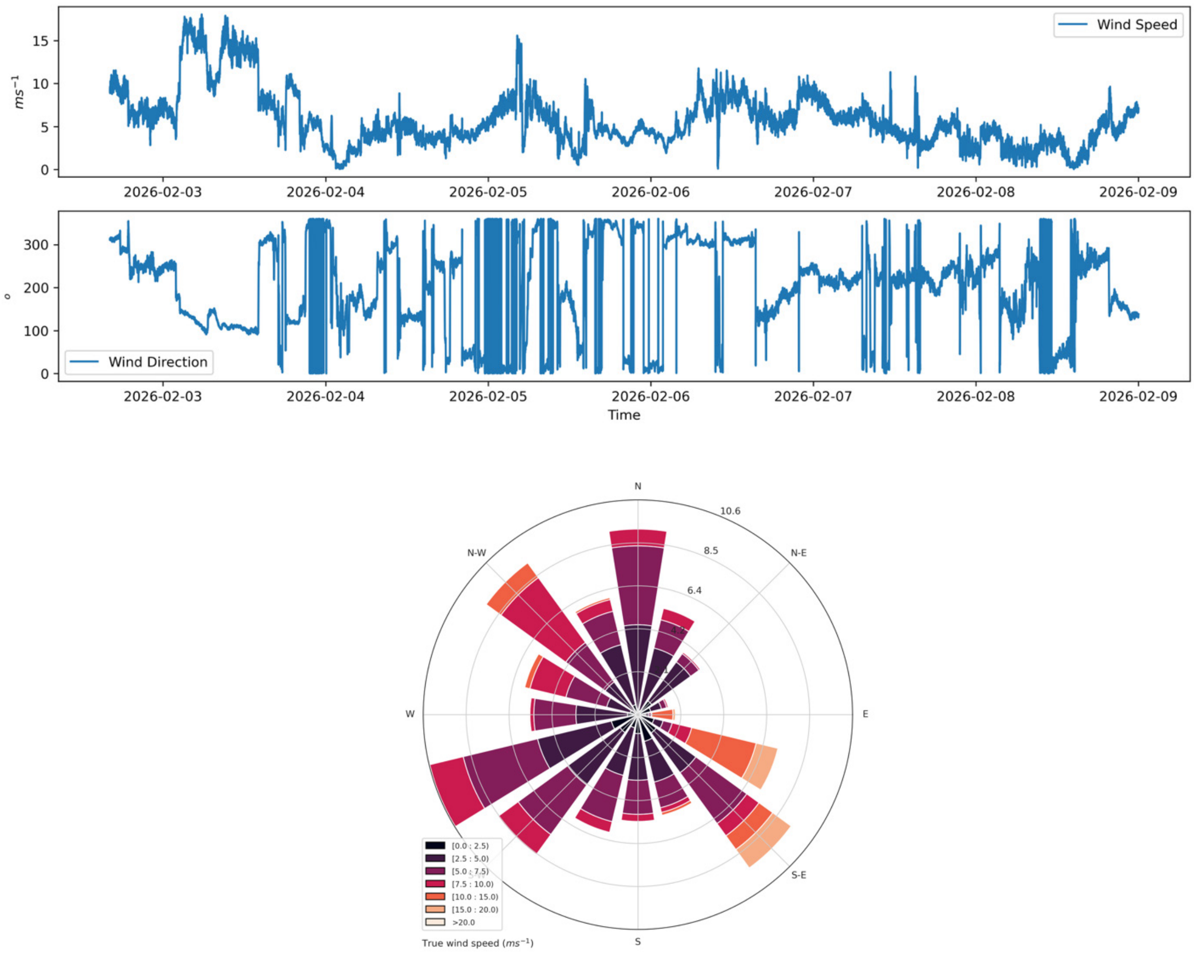


Figure 6.3 Wind data from DY204 as time series (top) and wind rose histogram (bottom).

TSG, fluorometer, and transmissometer data from the start of the cruise before the underway seawater supply was switched on (and the first few minutes while the system was flushing) were edited out before producing 60-s averages. Salinity data can be calibrated using bottle salinities. Samples for calibration of the TSG salinity were drawn from the underway uncontaminated seawater supply approximately every four hours during the day (3-4 samples per day). The 26 samples were analysed together at the end of the cruise. The offsets between bottle and sensor salinity showed no trend over time, and after smoothing the median offset of 0.0137 psu was added to TSG salinity as a scalar; remaining offsets are within +/- 0.0032 psu. The underway temperatures and the TSG salinity were also compared with CTD near-surface values, revealing good agreement between CTD and drop keel temperatures, with a mostly negligible increase from the drop keel to the inlet temperature.

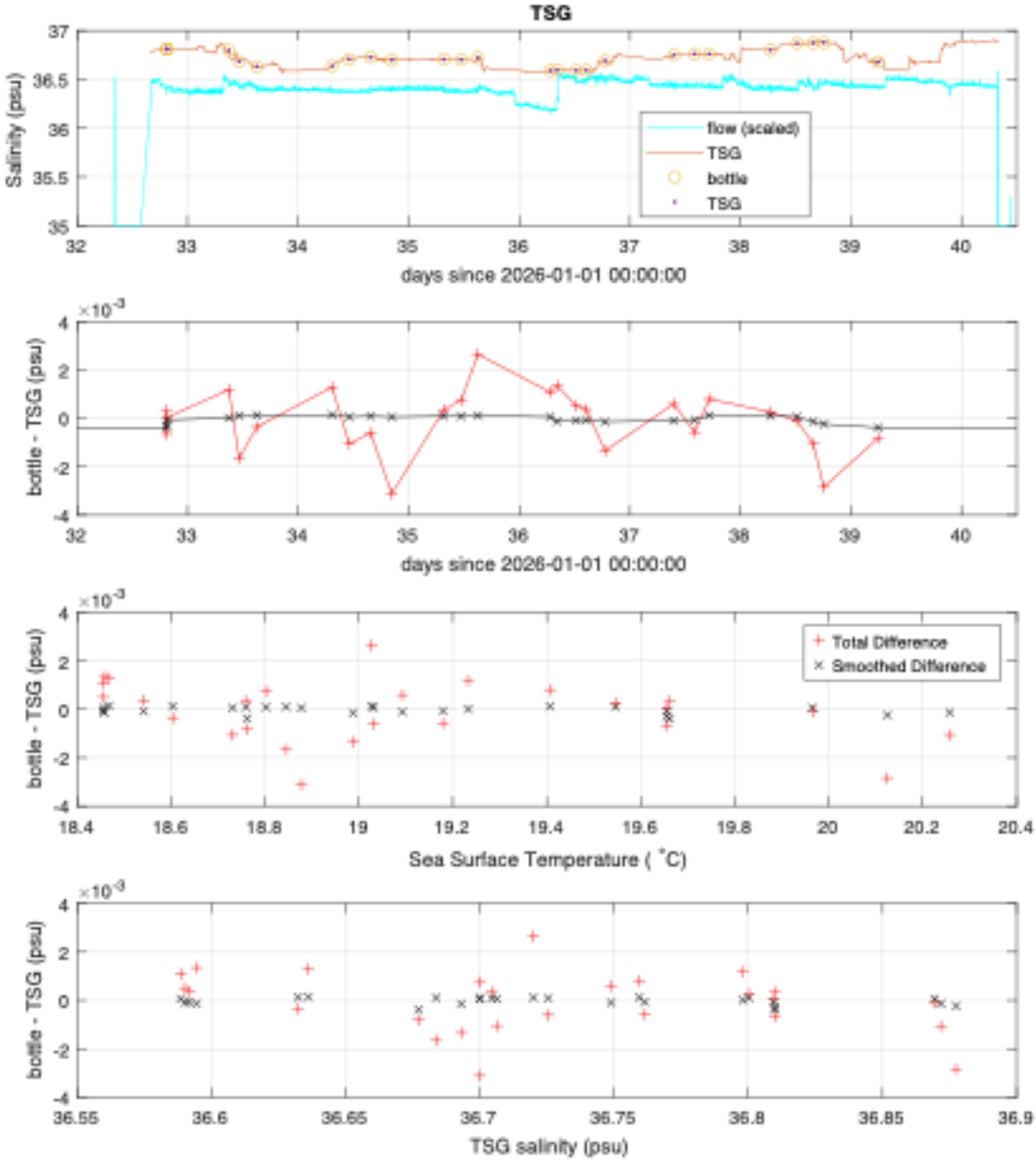


Figure 6.4 Post-calibration comparisons between TSG salinity and bottle salinity.

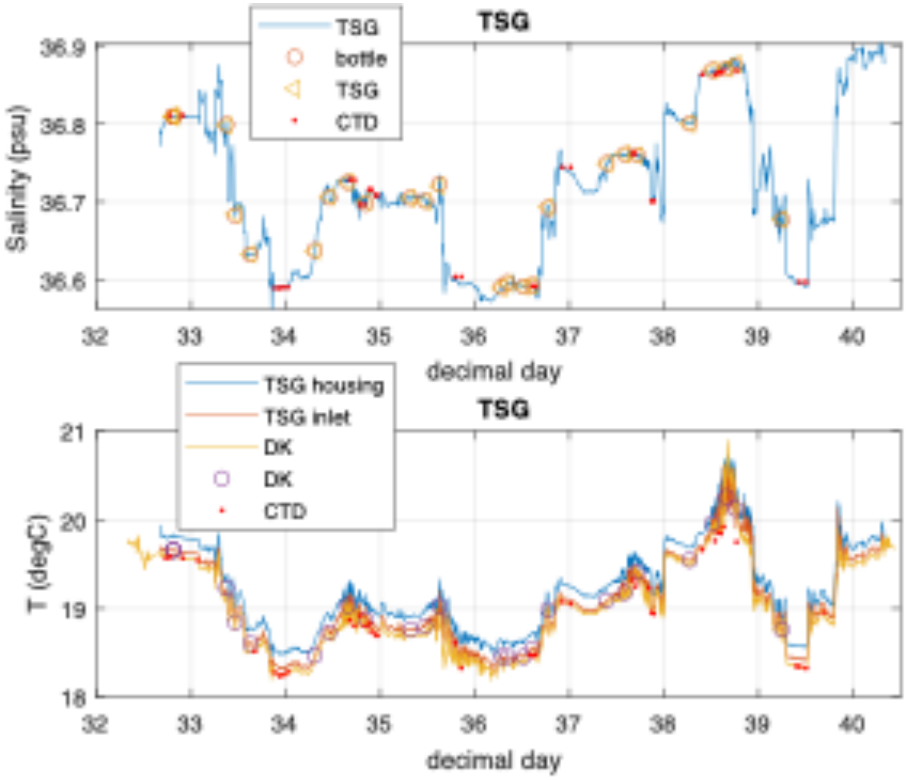


Figure 6.5 TSG temperature compared with CTD near-surface temperature (top) and calibrated TSG salinity compared with CTD near-surface salinity and bottle salinity (bottom).

6.6 Vessel-mounted Acoustic Doppler Current Profiler (ADCP)

6.6.1. Introduction

The *RRS Discovery* is fitted with 2 Teledyne RD Instruments Ocean Surveyor (OS) VMADCPs for measuring the horizontal velocity field: one at 150kHz (os150nb) and the other at 75kHz (os75nb). These are both mounted on the port drop keel. Problems with the 75kHz data meant that only the 150kHz instrument was run on this cruise. Data acquisition is done automatically by the University of Hawaii Data Acquisition system (UHDAS). The system was configured in narrowband (nb) mode with watertracking pings only, using calibrations derived by the UH currents group based on multiple past cruises. The 150kHz penetrates up to 400 m (depending on sea state and water properties).

6.6.2. Data Monitoring and Automatic Processing

The UHDAS interface displayed on a screen in the main lab has all the control and monitoring options. As part of the systems watchkeeping, the UHDAS monitor interface was checked for any errors or data acquisition problems. UHDAS/CODAS applies automatic quality control and automatically generates a series of contour and vector plots, which were also visually inspected for errors. Data quality of the 150kHz was good.

6.6.3. Data Processing

Throughout the cruise, several shell scripts on workstation akeake were used to sync data from the UHDAS server to a backup on the workstation, and then to a local processing directory. At the end of the cruise, CODAS utility dataviewer.py was used to inspect the 5-minute ensemble-averaged data from the two instruments separately and together. No additional edits or adjustments to the pre-configured angle and amplitude calibration and transducer offsets were made. A NetCDF file of processed 150kHz data was generated using adcp_nc.py.

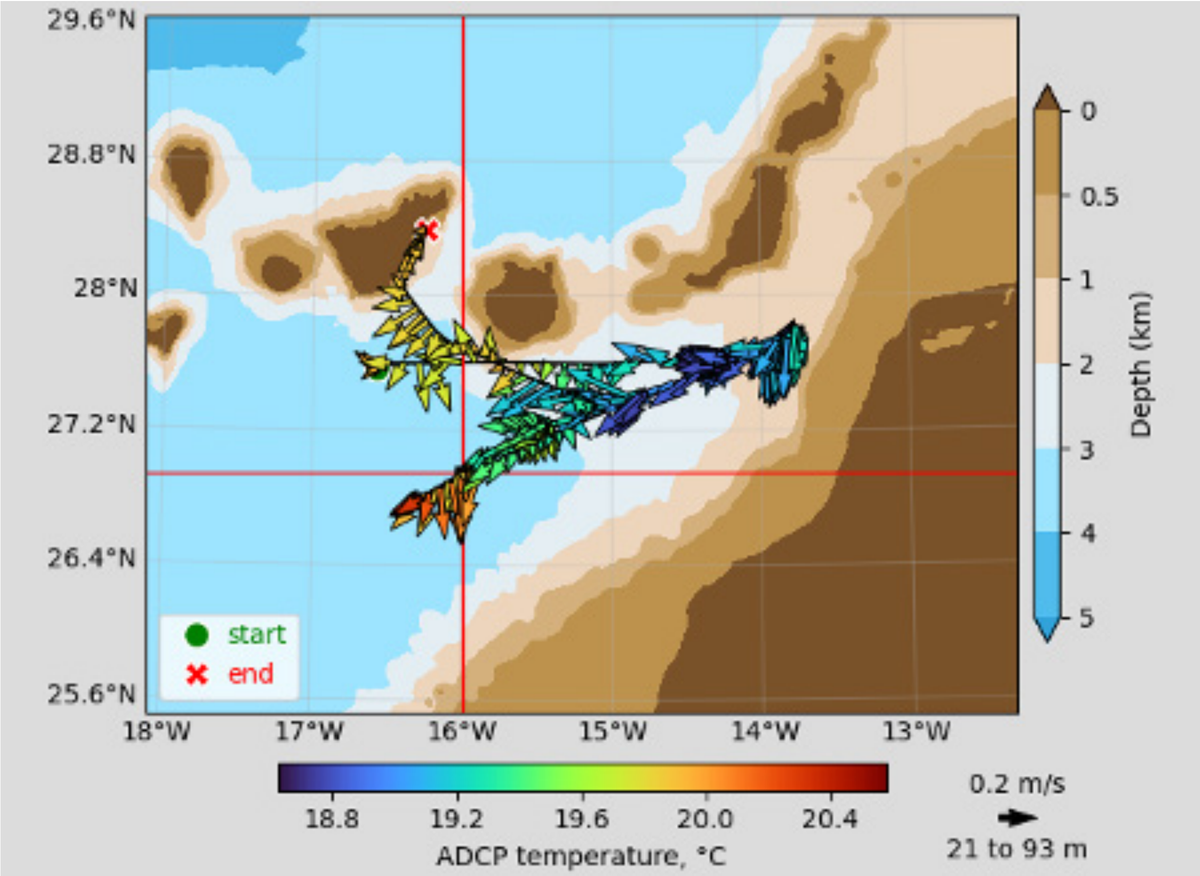


Figure 6.6 Currents over the cruise track, from dataviewer.py.

7. CTD Operations

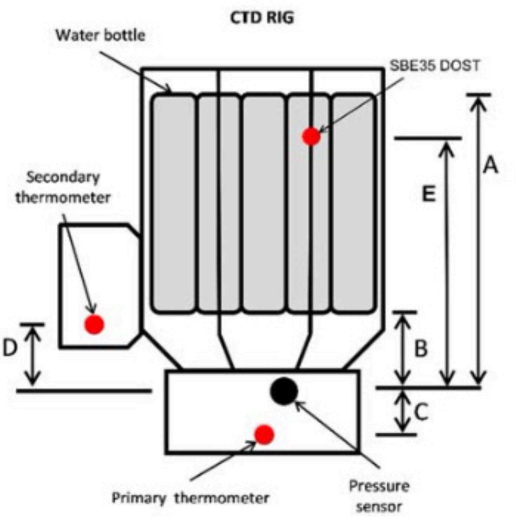
Jade Garner

7.1 CTD Operation

All casts were carried out using CTD1 wire. The CTD wire was electrically tested prior to sailing and had an insulation resistance of > 999 MΩ at 250V. The. Active heave compensator (AHC) was used for the majority of the CTD casts. 12 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 calibration dips. 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 temperature data. There were no major technical issues with the Stainless Steel CTD suite during the cruise and no sensors required changing. The Transmissometer was reading incorrectly on CTD006 and by CTD0008 due to a loose lens which was swapped. All bottles were leak tested before the start of science and again at the end of science, no issues noticed.

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Casts Used
Stainless steel 24-way frame	NOCS	SBE CTD 6	N/A	All casts
EM CTD Swivel	Machinery Development Services ST6003-2E2-Ti	1246-2	N/A	All casts
Primary CTD deck unit	SBE 11plus	11P-24680-0588	N/A	All casts
CTD Underwater Unit	SBE 9plus	09P-39607-0803	N/A	All casts
24-way Carousel	SBE 32	32-60380-0805	N/A	All casts
Primary Temperature Sensor	SBE 3P	3P -5494	F0	All casts
Primary Conductivity Sensor	SBE 4C	4C - 2165	F1	All casts
Digiquartz Pressure sensor	Paroscientific	93896	F2	All casts
Secondary Temperature Sensor	SBE 3P	3P - 4816	F3	All casts
Secondary Conductivity Sensor	SBE 4C	4C - 3873	F4	All casts
Primary Pump	SBE 5T	05T-6320	N/A	All casts
Secondary Pump	SBE 5T	05T-3085	N/A	All casts
Primary Dissolved Oxygen Sensor	SBE 43	43-2539	V6	All casts
Secondary Dissolved Oxygen Sensor	SBE 43	43-4580	V1	All casts
Altimeter	Valeport VA500	96098	V3	All casts
Transmissometer	WETLabs C-Star	CST-2150DR	V4	All casts
Fluorometer	CTG Aquatracka MKIII	088-244	V5	All casts
PAR sensor UWIRR	Santlantic	2356	V7	All casts
10L water samplers	Ocean Test Equipment	Set B	N/A	All casts
DOST	SBE 35	0037	N/A	All casts

Table 7.1 The sensors fitted to the CTD frame.



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 7.1 CTD frame geometry.

7.2 Salinity Measurement

A Guildline 8400B, s/n 71185 was installed in the Salinometer Room as the main Autosal for salinity analysis. The bath temperature was set to 21°C with the lab ambient temperature ranging between 18°C – 18.5°C. The salinometer was standardised during the mobilisation, then again prior to the start of analysis. Originally, autosal 68958 was prepped and ready to use, however upon standardisation it was noted that the Autosal was reading too low, this machine is being sent back to Southampton post cruise for calibration.

A standard (IAPSO Standard Seawater batch P165, K15 = 0.99986, 2xK15 = 1.99972) was analysed before starting to run samples on a given day, and after each crate of samples to monitor & record drift. Standards and samples were measured by first flushing and filling the conductivity cell three or more times (using up to half the bottle) then using NMF's software to record conductivity ratio readings from three successive fills of the conductivity cell.

8. CTD Data

Tillys Petit, Yvonne Firing

8.1 Introduction

A total of 23 CTD casts were completed during the cruise (Table 8.1). The majority of casts were for the purpose of calibration of the microcat CTDs, but some were completed before and after recovery of moorings with oxygen sensors to enable in water calibration of oxygen, and others were completed for the experiments of Vanessa's PhD thesis.

There were 12 bottles on the frame and on most deep casts they were all used to obtain samples to calibrate oxygen and salinity. Bottle stops were all 5 minutes each when MicroCATs were being calibrated, otherwise they were for 1 minute.

Station	Start Date	Start Time	End time	Latitude	Longitude	Water depth (corr. m)	Profile depth (m)	Number of bottle stops	Active Heave Compensation
1	02-Feb	16:14	17:35	27°33.97	16°34.51	3530	1500	12	Yes
2*	02-Feb	18:35	21:58	27°33.97	16°34.52	3540	3530	12	Yes
3*	02-Feb	22:30	01:44	27°33.97	16°34.53	3540	3530	12	Yes
4	03-Feb	14:19	16:10	27°36.39	14°12.68	2022	2010	12	Yes
5	03-Feb	21:12	22:31	27°47.76	13°45.86	1430	1417	12	Yes
6	03-Feb	23:28	00:32	27°47.76	13°45.86	1433	700	12	Yes
7	04-Feb	16:12	17:27	27°47.76	13°45.84	1433	1420	12	Yes
8	04-Feb	18:50	19:22	27°48.73	13°45.69	1443	1430	12	Yes
9	04-Feb	21:17	21:45	27°44.58	13°50.37	1513	500	12	Yes
10	04-Feb	22:46	23:13	27°44.55	13°50.33	1513	200	12	Yes
11	05-Feb	19:07	20:34	27°36.51	14°13.05	2027	2014	12	Yes
12	06-Feb	12:08	14:01	27°36.29	14°14.00	2043	2033	12	Yes
13	06-Feb	14:36	15:20	27°36.29	14°14.00	2045	272	12	Yes
14	06-Feb	22:17	00:19	27°13.16	15°25.92	3046	3036	12	Yes
15	07-Feb	16:05	16:50	27°13.17	15°27.11	3000	350	12	Yes
16	07-Feb	17:49	20:06	27°13.18	15°27.11	3068	3053	12	Yes
17	07-Feb	20:51	21:24	27°14.13	15°26.70	3050	350	12	Yes
18	08-Feb	09:40	12:58	26°48.13	16°15.74	3526	3514	12	Yes
19	08-Feb	13:42	14:28	26°48.13	16°15.74	3526	640	12	Yes
20*	08-Feb	15:05	18:25	26°48.13	16°15.74	3526	3516	12	Yes
21	09-Feb	08:25	09:40	27°25.68	14°46.15	2572	1000	12	Yes
22	09-Feb	10:26	12:00	27°25.68	14°46.15	2570	2560	0	Yes
23	09-Feb	14:17	16:26	27°19.10	15°08.18	2779	1000	0	Yes

Table 8.1 CTD station summary. An asterisk (*) next to the station number indicates that the cast was used for MicroCAT calibration.

8.2 Adjustment of Temperature to Reference SBE35

A SBE35 stable temperature sensor fitted to the outside of the CTD frame recorded a reading each time a Niskin was fired. These readings were compared to the two CTD temperature sensors, with 35 of the 258 comparison points from low-gradient regions primarily used to determine the offsets. No adjustment were required to sensor S/N 34816, but a constant offset of -0.5m°C was applied to sensor S/N 35494.

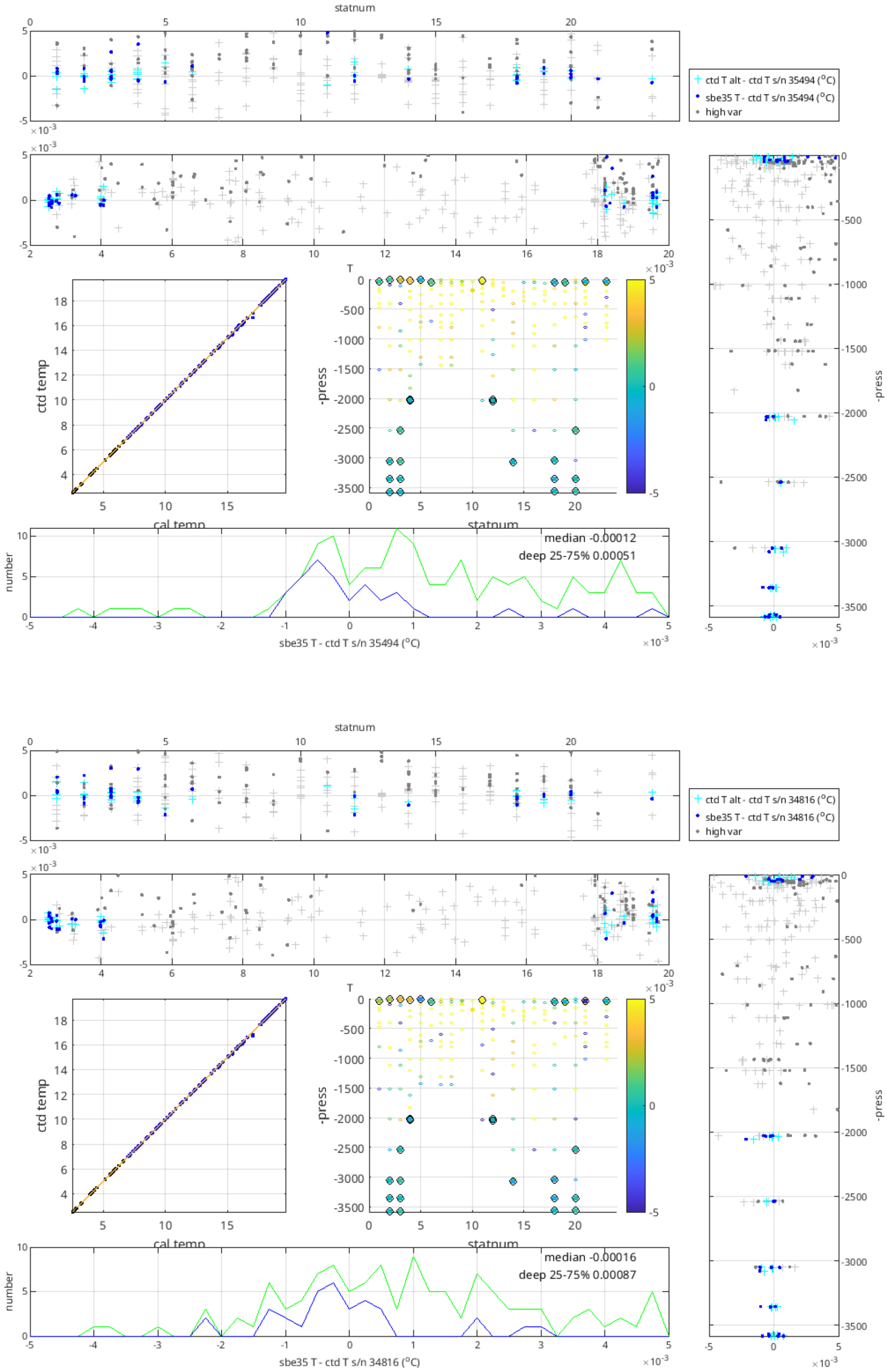


Figure 8.1 Comparison between SBE35 temperature and CTD temperature at bottle stops, after adjustment of CTD sensor temperatures. The grey dots (or unfilled circles) indicate points with high background variability or gradient. The cyan + show the comparison between the two CTD sensors for reference.

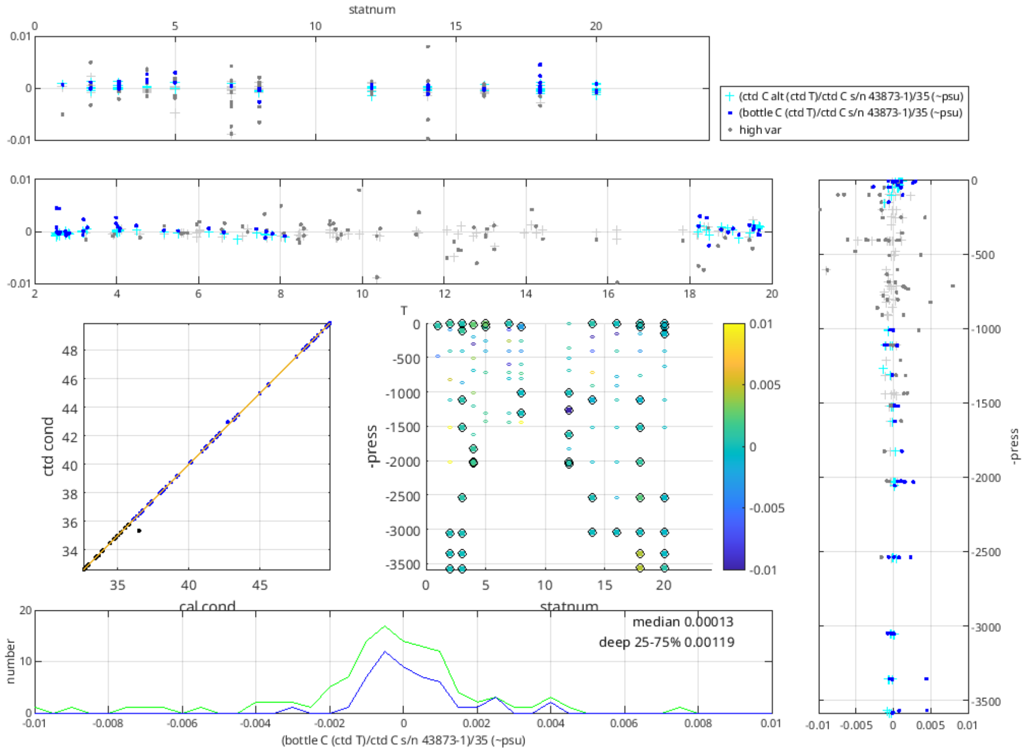
8.3 Analysis of Standard Seawater Samples and Calibration of the Salinometer

A total of 23 standards were used to calibrate the bottle salinity measurements made by the salinometer. A standard was used before each crate of salinity samples, and at the completion of each salinometer session. All standard seawater samples were from batch P167 with K15 = 0.99988. Salinometer offsets were mostly negative varying by a few 10^{-5} over each run. Standard 03 is the same as standard 02 due to an error with the recording program at the autosal, and the time for this standard was changed manually and copied from 02. The apparent offsets were applied as trends between each pair of standards at the start and end of each crate. The last four samples were run immediately following the last full crate, and the salinometer offset from the end of the last full crate was applied as a constant. The three conductivity ratio readings from each sample bottle were checked for outliers before averaging, adding the offsets derived from standard seawater above, and converting to salinity based on the salinometer set bath temperature.

8.4 Calibration of Conductivity

Conductivity from each of the two CTD sensors was compared with conductivity derived from bottle salinity (above) and CTD temperature (for the corresponding CTD sensor), for stations 1-20, again emphasising points with a lower background gradient (deep points as well as the surface mixed layer). Conductivity sensor S/N 42165 was corrected for a piecewise linear pressure trend using:
C_cal = C_uncal(1 + (interp([-10 2000 5000],[2e-3 4.5e-3 4.5e-3],P))/35),

while conductivity sensor S/N 43873 was corrected for a piecewise linear pressure trend using
C_cal = C_uncal(1 + interp([-10 1000 2000 5000],[0e-3 3e-3 3e-3 2e-3],P))/35).



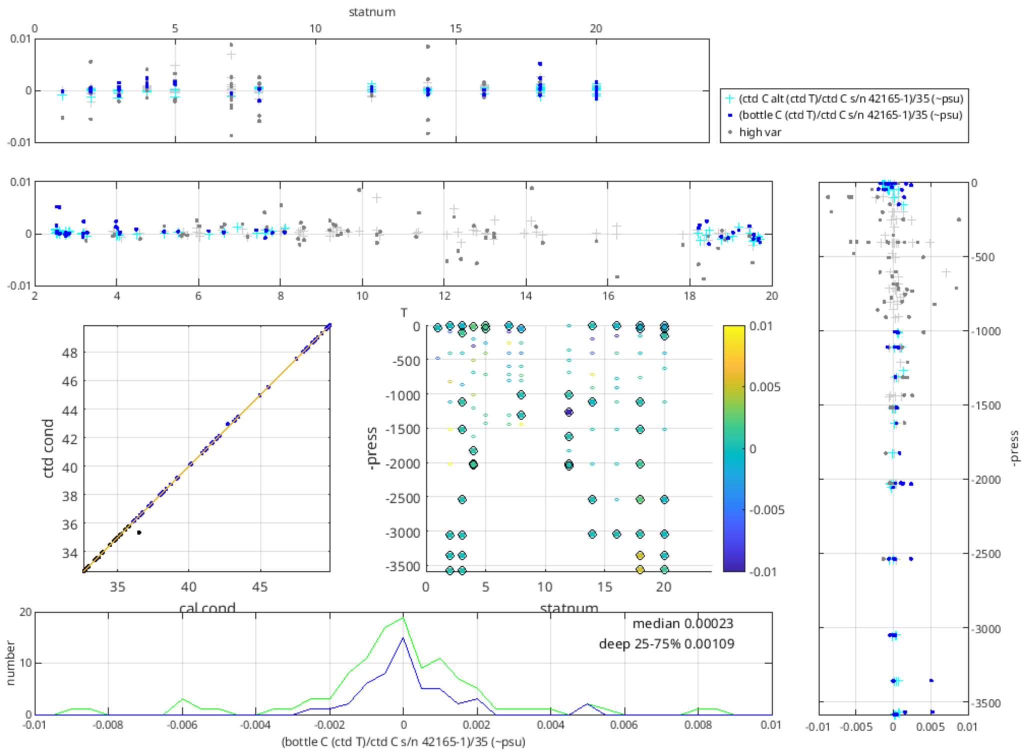


Figure 8.2 Comparison between CTD and bottle salinity after calibrating the CTD conductivity by comparison with conductivity derived from bottle salinity and CTD temperature.

8.5 Hysteresis Correction and Calibration of Oxygen

The defaults hysteresis correction applied to the two CTD oxygen sensors was not modified. Oxygen Winkler titration data (Section 10) were converted first to concentration in umol/L, using blanks and standards values set in opt_dy204, and then to umol/kg, using the CTD salinity at bottle stops and the sample fixing temperature. The blanks and standards values acquired by the analyst were used. One replicate sample was flagged as questionable. The oxygen sensor and bottle data were first compared in terms of their ratio, and the following factors were applied to agree with 93 points for stations 1 to 20:

S/N 43-2539:

O_cal = O_uncal (interp([-10 0 5000],[1.075 1.075 1.105], P)

S/N 43-4580:

O_cal = O_uncal (interp([-10 0 5000],[1.06 1.06 1.1] ,P)

The calibrated data compared to the bottle data are shown in Figure 8.3. While calibrations were derived based on upcast data, after calibration the density-matched downcast data were also compared (not shown), confirming no need to modify the default hysteresis correction.

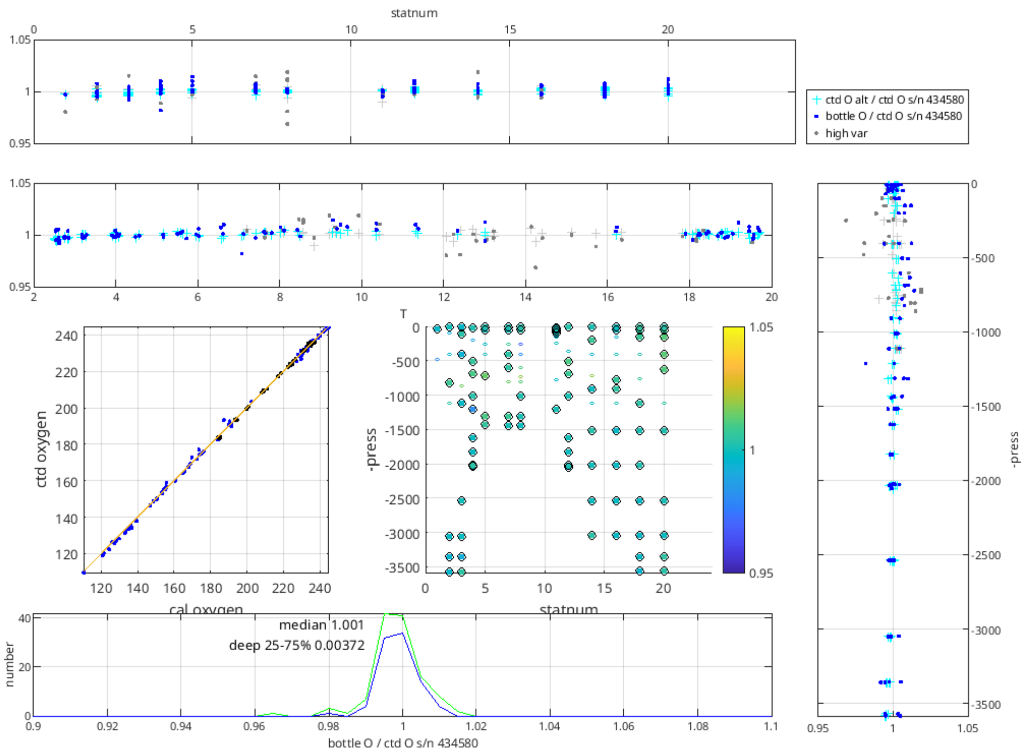


Figure 8.3 Comparison between CTD and bottle oxygen after calibrating the CTD sensors as above.

9. Argo Float deployment

Tillys Petit

One 2000 dbar NKE float was deployed during the cruise.

Float number	Date	Time (GMT)	Latitude	Longitude	Water depth (m)
ARVOR S/N: AI2600-25UK119 WMO ID :1902117	7th Feb 2026	Magnet 19:35 Beeping 19:40 Launch 20:16	27° 13.18N	15° 27.11W	3067

Table 9.1 Argo Float deployment

10. Oxygen Analysis

Wai Ching Rachel Chu

10.1 Introduction

Dissolved oxygen (DO) samples were collected during DY204 to calibrate both CTD DO sensors (primary and secondary), to correct for drift, temperature and pressure influences. The calibrated CTD oxygen in turn will be used to calibrate oxygen sensors deployed on moorings. Samples were taken from Niskin bottles on most CTD casts throughout the cruise, with the exception of known misfires and bottles observed to be leaking on CTD recovery and on CTD casts deployed specifically for PhD student's incubation experiment. Numbers of DO samples and replicates on each CTD cast, as well as when they were analysed, are given in Table 10.1. Duplicates were taken from either 1 or 2 Niskin bottles to achieve a minimum 10% duplicate rate. Discrete water samples collected were subsequently analysed by automatic Winkler titration using a Metrohm Ti-Touch titration system with amperometric endpoint detection.

CTD cast	Date	Total samples	Replicates	Date analysed
001 (testing)	02.02.2026	5	3	03.02.2026
002	02.02.2026	11	1	03.02.2026
003	03.02.2026	13	1	03.02.2026
004	03.02.2026	13	1	04.02.2026
005	03.02.2026	11	1	04.02.2026
007	04.02.2026	12	1	04.02.2026
008	04.02.2026	13	1	05.02.2026
011	05.02.2026	13	1	05.02.2026
012	06.02.2026	14	2	06.02.2026
014	07.02.2026	14	2	07.02.2026
016	07.02.2026	14	2	08.02.2026
018	08.02.2026	14	2	08.02.2026
020	08.02.2026	13	2	08.02.2026
Total		**160**	**20 (12.5%)**	

Table 10.2 Summary of CTD casts sampled for oxygen.

10.2 Metrohm Ti-Touch Setup and De-bubbling

All instruments used during Cruise 204 were listed in Table 10.2. Two titration instruments were brought on board, along with pre-prepared reagents. The burettes used for reagent dispensing had been acid washed and calibrated to 1 ml by Dr. Edward Mawji in the University of Southampton in August 2025 and October 2025. The sodium thiosulphate solution was made by adding one vial of pre-weighed sodium thiosulphate crystals to 1L of Milli-Q water and the titration system were subsequently set up on-board on Saturday 31st February. The Ti-touch was preloaded with 2 sets of programs for running blanks, standards, and samples, which are labeled: Set 1) BLANK DO2 (OLD), Dissolved O2 (OLD)1 and STD DO2 (OLD) and Set 2) BLANK DO2, Dissolved O2 and STD DO2. While there was no apparent difference in methods between the two sets, set 2 was used throughout the cruise. The system was tested by running a blank (see method in 10.3 below). Upon running, an error message popped up on the Metrohm Ti-Touch screen saying "020-142 Access not possible: Check the path on your PC as well as the permissions or select another path". The error message was solved by removing the reporting step in all the methods used. Large air bubbles were present in the dosing chamber and tubes. A process of de-bubbling the dosing units was carried out after setting up.

The "prepare" function was used in both dosing devices upon starting Metrohm Ti-Touch machine each day. Small bubbles had been continuously present in the dosing chamber even after re-setting the dosing and filling speed to 1 mL/min. A minimum of 3 blanks and 3 standards were tested before each run, so as to make sure the bubbles did not affect the result of titration.

On Thursday and Friday 5-6th February, an error message popped up on the Metrohm Ti-Touch screen saying "011-003 Electrode Check: either no electrode is connected to measuring input 1 or there is a break within the measuring chain" upon turning on the machine on Thursday and Friday 5-6th February. The error message disappeared upon waiting for 10 minutes after restarting the device. It should be noted that the green "On" light remained steadily lit, and the green "Status" light for dosing device 1 was flashing while the error message popped up.

Details of the debubbling process and changes made to the settings are described below:

- To get the bubbles off the dosing units, press the hand button from the icons, select Dosing and use manual dosing, dosing fixed vol (with automatic filling switched off) to partially empty the dosing unit. Remove the draw straw from liquid while refilling the dosing unit to draw up a larger air bubble that will subsume the smaller ones. Importantly, return the draw straw to the liquid (reattach unit to bottle) before the end of the filling period. This is to ensure that liquid is fully drawn up the draw straw, and there are no bubbles left in that portion of the device. Start dosing again, then, plugging both vent ports, invert the dosing unit, tap it to dislodge the large bubble to the bottom of the dosing unit (currently the top), rotate so the outlet valve is at the top and dose so the bubble is pushed out the outlet valve, down the straw and out of the burette tip – this will hopefully collect any bubbles within the tubing as well as the bubbles in the piston. Ensure you have righted the dosing unit and bottle before refilling to ensure the base of the draw straw is submerged. This seemed to be successful at removing all bubbles except in some cases one tiny one. However, the dosing unit barrels accumulated more bubbles over the course of hours to a day (whether the machine is in use or not). It was not clear whether they were coming out of solution or being let into the barrel possibly due to uneven greasing of seals. The pistons and to some extent the corresponding cups at the bottoms of the barrels appear to be somewhat adhesive to bubbles. It was found most effective to wait 30 minutes between drawing in a larger air bubble and then dispensing again.

- To avoid (or reduce) drawing in new bubbles, reduce the maximum dosing and fill speeds from maximum (estimated this is 20-50 mL/min) to 5 mL/min or less. This was done in various parts of various programs, wherever dosing parameters were specified.
- Consistency of blanks and standards is also aided by more vigorous stirring than previously programmed, with the stirrer on a speed of 7 (for the particular magnetic stirrer used here). This is again adjusted in various parts of the different methods (including the method for samples).

Instrument	Quantity	Serial Number (S/N)
Metrohm 916 Ti-touch	1	32976
Metrohm 807 5 mL dosing unit (for sodium thiosulphate)	1	006582
Metrohm 807 20 mL dosing unit (for iodate standard solution)	1	006581
Bottle-top dispensers Dispensette® S, analog-adjustable, DE-M	3	22E78232 19B19583 22E78248
HANNA Foodcare Thermistor thermometer	1	TA03070266

Table 10.3 Instruments used for oxygen analysis in DY204

10.3 Sample Collection

Water sampling was carried out according to the guidelines by Langdon (2010) with seawater being collected directly into pre-calibrated Pyrex iodine titration bottles (approximately 140 ml flasks with flared necks). This protocol is analogous to previous cruises (see RAPID cruise reports No. 30, 37, 52 and 76 for more details). The key steps were:

- Prior to sampling each station, the reagent dispensers (Brand dispensettes set to 1 mL) were emptied and refilled to remove any bubbles that had formed in the chemical lines. This minimizes the risk of bubble injection into samples. This process was repeated if bubbles were noticed.
- Silicon Tygon tubing was attached to the Niskin spigot to transfer water to the flask. The spigot was pushed in only after attaching the tubing, and the tap opened after that to allow checking for leaks (a good seal will not allow more than a small dribble of water to flow when the spigot is opened, if the top valve is still closed).
- Bottles and stoppers were rinsed three times with Niskin water, while filling the tubing completely by pressing and rolling it to push out any air bubbles.
- The tubing was inserted to the bottom of a bottle and the bottle was filled slowly, from the bottom, to minimize turbulence and bubble formation, with water flow decreased by pinching the tubing. The bottles were overflowed by three flask volumes of water

(approximately 15 seconds at full flow).

- During overfilling, the temperature of the sample was measured using a digital thermometer whilst the bottle was being overflowed. This temperature was used to correct the bottle volume due to glass expansion/contraction, and to convert the oxygen concentration measured from moles to µmol/L.
- The bottles were held at the neck to minimise heat transfer to the water.
- 1 mL of manganese chloride was carefully added to the bottle, immediately followed by 1 mL of alkaline iodide solution. Dispenser tips were lowered beneath the water surface to eliminate the loss of chemical through splashing, and the entrainment of bubbles into the sample.
- Stoppers were inserted slowly and at an angle to stop bubbles getting trapped beneath.
- Bottles were vigorously shaken for 15-30 seconds (twisted about 20 times) to facilitate the mixing and formation of the precipitate (manganese hydroxides). A second shake was performed after 30 minutes.
- Each stopper is uniquely matched to a volume-calibrated flask. Regular checks were made to ensure each stopper/flask pair had the same number attached to them. Cracks and chips in both the bottles and stoppers were also regularly checked for.

Figure 10.1 Photograph of the lab bench set-up.

10.4 Blank Analysis

Prior to the analysis of seawater samples, the system blank was measured and calculated. This represents the signal produced by the addition of the chemical reagents. Bottles were filled with 120 ml of Milli-Q water and a Milli-Q rinsed stirrer bead. The reagents were added in reverse order with thorough stirring in between (1 mL sulphuric acid, 1 mL alkaline iodide solution, 1 mL manganous chloride). 1 mL of iodate standard solution (1.667 mol/L, OSIL) was then added by the Ti-Touch dosing unit and titrated with thiosulphate solution up to an endpoint of current $0.1x10^{-6}$ A; this endpoint was recorded. The titration of 1 further addition of 1 mL iodate standard was carried out. The blank is the difference between the volume of the second addition and the first titre value. Additional blanks were run until three acceptable estimates were obtained where the mean difference between the two blank volumes was less than 0.004. All values are included in the calculations, and they all fall within 0.006 of the median value. Figure 10.2 shows the blank values obtained during DY204 between 3rd February and the 9th February, when oxygen sample analysis was carried out. The median value calculated from all blank titres during the cruise was 0.0015. Median blank volumes used for each CTD calculations are shown in Table 10.3. The complete record was saved as *BlankDetermination_DY204_CTD1-20*

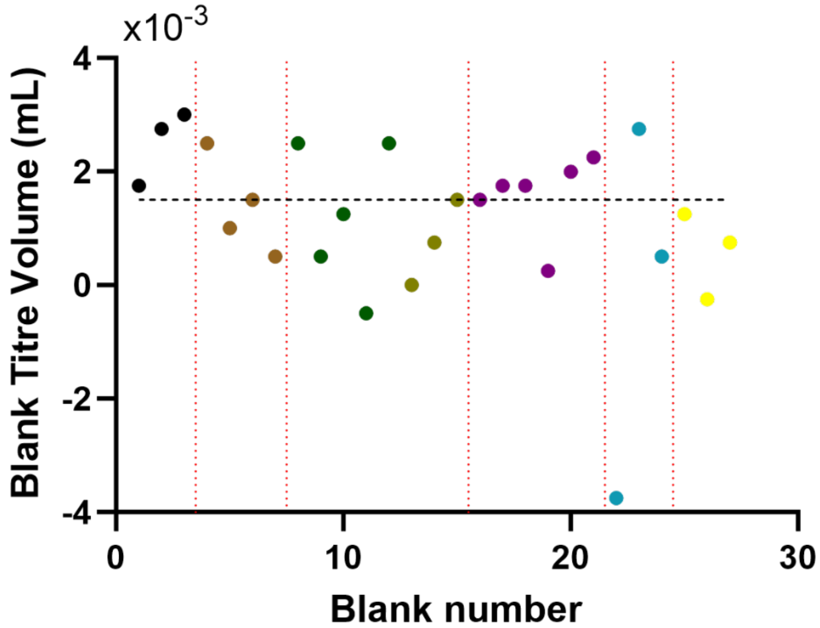


Figure 10.2 Titre volume from blank analyses during DY204. Colours indicate different runs of analysis, demarcated by the vertical orange dashed line. The cruise median is displayed as the grey dashed line.

10.5 Standard Analysis

After the blanks were measured, the thiosulphate molarity was checked against an iodate certified iodate standard of known molarity (1.667 mM, OSIL Scientific). The procedure is similar to that of the blank measurements except that exactly 5 mL of potassium iodate standard was added to a bottle in one injection and then titrated once. At least 3 standard runs were performed per set and values within ± 0.3% of each other were kept for calculation. The median value calculated from all the suitable standard titres during the cruise was 0.4580. Figure 10.3 shows the results of the standard analyses throughout DY204 and the median blank and standard titres per analysis set are shown in Table 10.3.

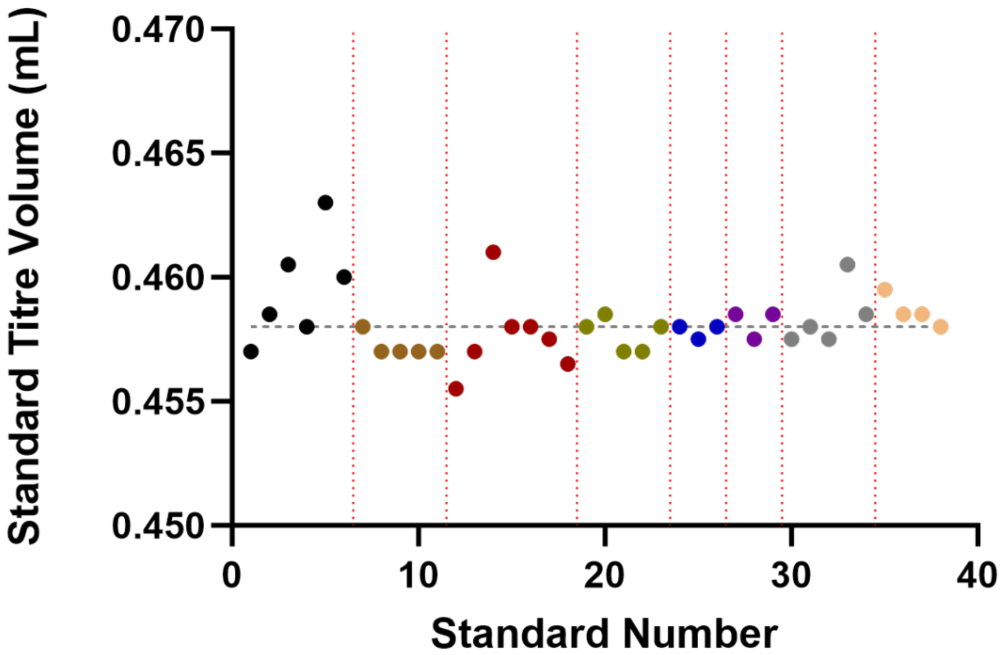


Figure 10.3 Results of 5 mL iodate standard titre volumes from DY204. Colours indicate different days of analysis, demarcated by the vertical orange dashed line.

All values were included in the calculations. The range of standard titre volume ranges from 0.4555 and 0.4630, with the standard deviations all below 0.003 in each run. No apparent drift can be observed from Figure 3 and considering the short time span of the analysis (6 days), it is unlikely that the quality of the standard or titre changed. The standard volumes obtained from analysis set 1 show the greatest spread, which may be attributed to the analyst's initial familiarization with the instrument and the procedures. The completed record was saved as *Sodium_Thiosulphate_Calibration_CTD1-20_DY204*

Whole Cruise Blank Median	CTD Cast	Day of analysis	Blank Median	Standard Median
0.0015	1	2026.02.03	0.0028	0.4593
	2	2026.02.03	0.0028	0.4593
	3	2026.02.03	0.0028	0.4593
	4	2026.02.04	0.0013	0.4570
	5	2026.02.04	0.0013	0.4570
	7	2026.02.04	0.0013	0.4575
	8	2026.02.05	0.0010	0.4575
	11	2026.02.05	0.0008	0.4580
	12	2026.02.06	0.0016	0.4580
	14	2026.02.07	0.0019	0.4585
	16	2026.02.07	0.0005	0.4580
	18	2026.02.08	0.0008	0.4585
	20	2026.02.08	0.0008	0.4585

Table 10.3 Median values for blanks and standards used in oxygen calculations over the course of the cruise

10.6 Sample Analyses

Samples were stored and analysed within 24 hours following the method outlined by Langdon (2010). Before running each sample batch, blanks and standards were run until satisfactory stability was achieved. Between each flask (blank, standard, or sample), the burette tips, electrode and stirrer were rinsed with Milli-Q and the electrode tip carefully dried, checking for any contamination.

When ready to titrate, the Milli-Q water seal was poured away, the neck dried, and the stopper of the flask carefully removed. A 1 ml aliquot of 5 M sulfuric acid was dispensed, immediately followed by a clean magnetic stirrer. The flask was placed on the stir plate and the electrode and thiosulfate burette were carefully inserted to place the tips in the lower-middle depth of the sample flask. The initial volume of sodium thiosulphate for each sample was 0.3 ml before continuing to be titrated at 0.0005 ml intervals using the amperometic end-point detection electrode (Culberson and Huang, 1987) to the end current of 0.1 x 10^{-6} A. The resultant volume of titrant was recorded both by manual logging and automatically on the Ti-Touch. Following this the value was converted to a DO concentration within an Excel file, using bottle volumes, expansion coefficients and sample temperatures, blank and standard titres, and standard volume, and saved as *Oxygen calculation_DY204_CTD1-20.xlsx*.

Figure 4 shows vertical profiles of oxygen concentrations measured on DY204 for the different CTD casts and Figure 5 shows the oxygen concentrations at the discrete depths sampled at each CTD.

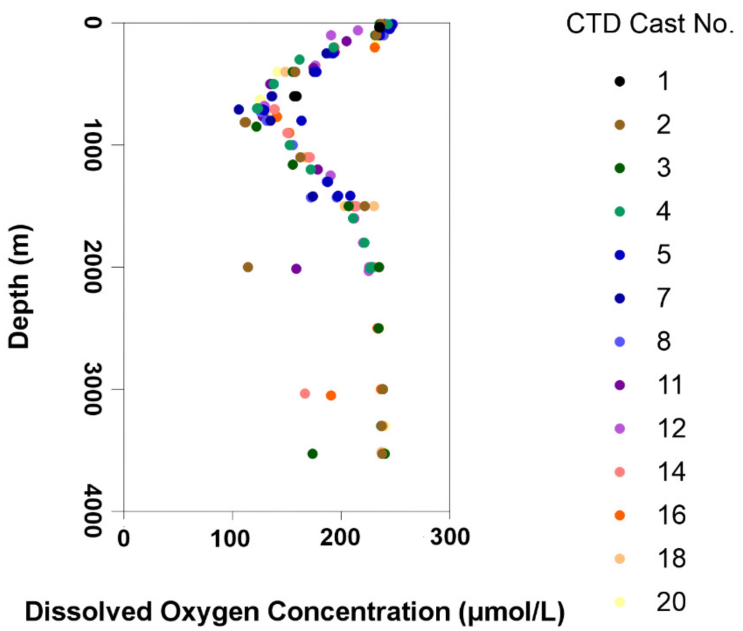


Figure 10.4 DY204 dissolved oxygen concentration profile. Colours correspond the CTD cast number.

10.7 Duplicate Sample Analysis

A total of 20 replicates were taken. The differences between sample and duplicate bottle results are shown in Figure 10.6, this is obtained by subtracted the duplicate oxygen concentration from the sample oxygen concentration. Of the 20 duplicate differences 4 are questionable due to their extreme values, these are marked on Figure 10.5 with red crosses. The median duplicate difference was negative 0.022 µmol L^{-1}., with the IQR range of -0.44 to 0.59. The extreme values of the questionable duplicates might suggest the duplicates from a Niskin is already “contaminated” by exposure to air, but there are not enough duplicate samples here for confidence.

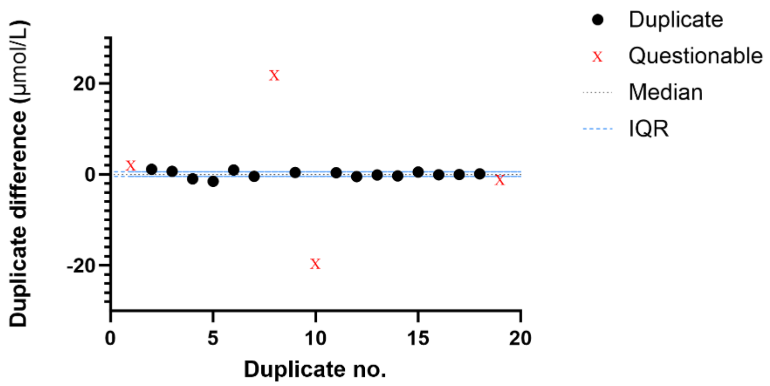


Figure 10.5 Differences between replicate oxygen concentrations on DY204. Red 'x' mark questionable duplicate differences. Blue dotted lines mark the interquartile range (IQR), which represents the middle 50% of the values from the 25th percentile to the 75th percentile. While the grey dotted line represents the median.

10.8 References

Culberson, C.H. and Huang, S. (1987). Automated amperometric oxygen titration. Deep-Sea Res. Pt A 34(5-6), 875-880. doi:10.1016/0198- 0149(87)90042-2.

Langdon, C. (2010). Determination of dissolved oxygen in seawater by Winkler titration using the amperometric technique. The GO-SHIP repeat hydrographic manual, IOCCP report 14, version 1.

11. Incubation experiments and Biogeochemical Sampling

Vanessa Cavucci and Sarah Reynolds

11.1 General background

The waters upwelling in the area can be identified from temperature and salinity records collected from sensors placed on the RAPID mooring array. The depth from which waters upwell in an upwelling system is related to mixed layer depth, as waters upwell from just below the mixed layer depth. Changes in Sea Surface Temperature (SST), as well as changes in wind strength, are expected to occur in future climate scenarios in the Canary Upwelling System. SST and winds are the main factors determining stratification and mixed layer depth. Hence, in the future, the depth of waters upwelling in the region is expected to change, but the effects on primary productivity, the phytoplankton community and nutrient dynamics remain unknown.

The questions to be answered are:

- How is phytoplankton community structure affected by a change in the depth and mixing ratios of source waters upwelled into the euphotic zone?
- What is the impact of different deep source waters on nutrient uptake and primary productivity in the euphotic zone?

- What are consequences of changes to upwelling depth and strength to the nutrient stoichiometry of both the inorganic and organic, dissolved and particulate nutrient and carbon pools?

11.2 Incubation experiment

The incubation experiment is conducted by sampling water from below the mixed layer depth and from the middle of the mixed layer depth, and mixing them in different percentages depending on the treatment. Waters from below the mixed layer depth, which are rich in nutrients, are mixed with surface waters (from the mixed layer centre) in bottles and kept in incubators where surface waters are continuously pumped through to mimic in situ weather conditions. After a timescale of 48 h, the bottles with different treatments are sampled to obtain information on nutrient usage and community structure development.

The source water of the study area is NACW (~150 m depth). There is also an influence of SACW at the same depth, which can be present or absent during different times of the year, and can also vary in its percentage of mixing with NACW. In this context, it can be beneficial to run an experiment with different percentages of mixture between SACW and NACW to answer the question:
How does the different input of SACW in the study area affect community structure and nutrient drawdown and transport?

11.3 Experiment set up

The incubation experiment is conducted inside 2 L or 1 L polycarbonate bottles placed in an incubator on deck, with attached tubes to allow surface water to be pumped inside and maintain constant surface water temperature conditions. Sampling occurs at time 0, directly from the CTD Niskin bottles, and at time 1 (~48 h), when the experiment is stopped.

Sampling at T0

The variables sampled at time 0 are:

- Dissolved inorganic carbon and total alkalinity (DIC/TA), directly sampled from Niskin bottles and fixed with 50 µl mercury chloride (saturated);
- Dissolved organic carbon (DOC), directly sampled from Niskin bottles and fixed with 100 µl HCl (4N trace metal grade);
- Inorganic nutrients, directly sampled from Niskin bottles;
- Particulate organic carbon (POC), chlorophyll-a (Chl-a), dissolved organic phosphate (DOP), flow cytometry, and FlowCam. These variables are sampled from water collected directly from the Niskin bottle at T0:
    - POC filtered using pre-combusted and weighed GFF filters;
    - DOP filtered and water collected using pre-combusted and acid-washed filters;
    - Chl-a filtered using GFF filters;
    - FlowCam collection of 150 ml of sampled water in amber bottles fixed with Lugol to a final concentration of 1–2%;

    - Flow cytometry collection of 1.96 ml of sampled water fixed with 40 µl of 25% glutaraldehyde .

Sampling after 48 h
After 48 h, bottles are removed from the incubator and the following variables are sampled:

- Inorganic nutrients: water directly from experimental bottles is filtered using a syringe and sterile nutrient filters;
- FlowCam collection of 150 ml of sampled water in amber bottles fixed with Lugol to a final concentration of 1–2%;
- Flow cytometry collection of 1.96 ml of sampled water fixed with 40 µl of 25% glutaraldehyde;
- POC, Chl-a, DOP, and DOC: all variables are sampled from water collected directly from the bottles and filtered using a peristaltic pump:
    - POC filtered using pre-combusted and weighed GFF filters;
    - DOC collected from POC-filtered water and fixed with 100 µl HCl (trace metal grade);
    - DOP filtered and water collected using pre-combusted and acid-washed filters;
    - Chl-a filtered using GFF filters.

Source Water experiment (SWex)
Treatments differ in the percentage of mixed waters taken from the same depth below the mixed layer and surface waters, as well as in the different depths sampled.

1) SWex 1
   Set up date: 02/02/2026
   Set up time: 18:30 pm
   Number of treatments : 1 + control
   End experiment: 04/02/2026
   End time: 19:00 pm

2) SWex 2
   Set up date: 04/02/2026
   Set up time: 2:30 am
   Number of treatments : 4 + control
   End experiment: 06/02/2026
   End time: 02:30 am

3) SWex 3
   Set up date: 05/02/2026

Set up time: 00:30 am
Number of treatments : 4 + control
End experiment: 07/02/2026
End time: 00:30 am

4) SWex 4
Set up date: 06/02/2026
Set up time: 16:30 pm
Number of treatments : 4 + control
End experiment: 08/02/2026
End time: 16:40 pm

5) SWex 5
Set up date: 07/02/2026
Set up time: 22:30 pm
Number of treatments : 4 + control
End experiment: 09/02/2026
End time: 22:30 pm

12. Biogeochemical Sampling

Vanessa Cavucci and Sarah Reynolds

During the cruise the following sampling has been done from CTD at all different stations:

- Dissolved inorganic carbon and total alkalinity (DIC/TA), directly sampled from Niskin bottles and fixed with 50 µl mercury chloride (saturated);
- Dissolved organic carbon (DOC), directly sampled from Niskin bottles and fixed with 100 µl HCl (4N trace metal grade);
- Inorganic nutrients, directly sampled from Niskin bottles;
- Particulate organic carbon (POC), chlorophyll-a (Chl-a), dissolved organic phosphate (DOP), flow cytometry, and FlowCam. These variables are sampled from water collected directly from the Niskin bottle at T0:
    - POC filtered using pre-combusted and weighed GFF filters;
    - DOP filtered and water collected using pre-combusted and acid-washed filters;
    - Chl-a filtered using GFF filters;
    - FlowCam collection of 150 ml of sampled water in amber bottles fixed with Lugol to a final concentration of 1–2%;
    - Flow cytometry collection of 1.96 ml of sampled water fixed with 40 µl of 25% glutaraldehyde .

CTD #	Activity
1	Biogeochemical sampling + incubation set up
4	Biogeochemical sampling
5	Biogeochemical sampling
6	Biogeochemical sampling + incubation set up
7	Biogeochemical sampling
9	Biogeochemical sampling
10	Biogeochemical sampling + incubation set up
11	Biogeochemical sampling
13	Biogeochemical sampling + incubation set up
15	Biogeochemical sampling
17	Biogeochemical sampling + incubation set up
18	Biogeochemical sampling
19	Biogeochemical sampling
21	Biogeochemical sampling
22	Biogeochemical sampling

13. Moorings

Yvonne Firing

13.1 Mooring Recoveries

All planned RAPID mooring recoveries were completed (Table 13.1). For EBH1 and EBH1L15 the upper part of the mooring was tangled at the surface, but there was no damage observed to any mooring or lander. On tall moorings EBH3 and EBH3B, some fouling was observed on the sensors in the top 200 m (as well as on the top buoyancy), and also on the deepest sensors (1400-1500 m).

Mooring	**Deployment cruise**	**Deployment date**	**Recovery date**	**Recovery start time (UTC)**	**Recovery duration**
EBH1	DY174	2024-04-01	2026-02-07	09:27	01:47
EBH1L15	DY146	2022-02-23	2026-02-07	07:36	01:23
EBH2	DY174	2024-03-31	2026-02-03	16:28	01:27
EBH3	DY174	2024-03-03	2026-02-04	08:34	01:59
EBH3B	DY174	2024-03-31	2026-02-05	08:37	01:27

Table 13.1 DY204 Mooring recoveries. Recovery duration is time from acoustic command to releases on deck.

All sensors (MicroCATs, MicroCAT-ODOs, Nortek Aquadopps) returned good data records (Table 11.2), except that S/N 3931 on EBH3 (500 m) stopped 4.5 months before recovery.

Mooring/ Lander	Instrument	S/N	Start Date	End Date	Records	Avg. P (dbar)
ebh1_16_2024	MicroCAT	6127	01/04/24	07/02/26	16236	2537.1
ebh1_16_2024	MicroCAT-ODO	12907	01/04/24	07/02/26	4060	2542.8
ebh1_16_2024	MicroCAT	6830	01/04/24	07/02/26	16242	3070.1
ebh1l15_15_2022	BPR	3	16/01/12	31/12/09	34673	3101.5
ebh1l15_15_2022	BPR	435	16/01/12	31/12/09	34673	3101.6
ebh2_16_2024	MicroCAT	6829	31/03/24	03/02/26	16178	1605.4
ebh2_16_2024	MicroCAT-ODO	10520	31/03/24	03/02/26	4044	1608.1
ebh2_16_2024	MicroCAT	3484	31/03/24	03/02/26	16178	
ebh2_16_2024	MicroCAT	6835	31/03/24	03/02/26	16178	2031.9
ebh3_16_2024	MicroCAT	4800	30/03/24	04/02/26	16214	60.9
ebh3_16_2024	MicroCAT-ODO	12832	30/03/24	04/02/26	4054	61.4
ebh3_16_2024	MicroCAT	4797	30/03/24	04/02/26	16214	112.6
ebh3_16_2024	MicroCAT	5984	30/03/24	04/02/26	16214	184.6
ebh3_16_2024	MicroCAT	3225	30/03/24	04/02/26	16214	260.8
ebh3_16_2024	MicroCAT	3483	30/03/24	04/02/26	16214	335
ebh3_16_2024	MicroCAT	4799	30/03/24	04/02/26	16214	411.9
ebh3_16_2024	MicroCAT-ODO	10556	30/03/24	04/02/26	4054	414.0
ebh3_16_2024	Nortek	6747	30/03/24	04/02/26	16216	514.3
ebh3_16_2024	MicroCAT	3931	30/03/24	04/02/26	16214	512.9
ebh3_16_2024	MicroCAT	5780	30/03/24	04/02/26	16215	612.1
ebh3_16_2024	MicroCAT	6122	30/03/24	04/02/26	16215	711.6
ebh3_16_2024	MicroCAT-ODO	10518	30/03/24	04/02/26	4054	761
ebh3_16_2024	Nortek	5831	30/03/24	04/02/26	16216	826.6
ebh3_16_2024	MicroCAT	5983	30/03/24	04/02/26	16216	819.3
ebh3_16_2024	MicroCAT	6322	30/03/24	04/02/26	16215	1011.8
ebh3_16_2024	Nortek	9210	30/03/24	04/02/26	16216	1015.2
ebh3_16_2024	MicroCAT-ODO	10545	30/03/24	04/02/26	4054	1019.7
ebh3_16_2024	MicroCAT	6325	30/03/24	04/02/26	16215	1224.4
ebh3_16_2024	Nortek	9420	30/03/24	04/02/26	16216	1328.6
ebh3_16_2024	MicroCAT	6800	30/03/24	04/02/26	16215	1418

ebh3b_1_2024	MicroCAT	4475	31/03/24	05/02/26	16222	61.6
ebh3b_1_2024	MicroCAT	6804	31/03/24	05/02/26	16222	115.8
ebh3b_1_2024	MicroCAT	4461	31/03/24	05/02/26	16222	186.7
ebh3b_1_2024	MicroCAT	4713	31/03/24	05/02/26	16222	262.7
ebh3b_1_2024	MicroCAT	5978	31/03/24	05/02/26	16222	345.4
ebh3b_1_2024	MicroCAT	7681	31/03/24	05/02/26	16222	414.5
ebh3b_1_2024	MicroCAT	6822	31/03/24	05/02/26	16222	513.8
ebh3b_1_2024	MicroCAT	6112	31/03/24	05/02/26	16222	615.1
ebh3b_1_2024	MicroCAT	11424	31/03/24	05/02/26	16222	712.8
ebh3b_1_2024	MicroCAT	6335	31/03/24	05/02/26	16222	815.3
ebh3b_1_2024	MicroCAT	4796	31/03/24	05/02/26	16222	1017
ebh3b_1_2024	MicroCAT	6814	31/03/24	05/02/26	16222	1225.3
ebh3b_1_2024	MicroCAT	5776	31/03/24	05/02/26	16222	1512.4

Table 13.2 DY204 moored instrument data recovery.

13.2 Calibration Casts

Pre-deployment calibration dips for MicroCAT(-ODO)s were performed on CTD casts 2 and 3, and post-recovery dips were performed on casts 18 and 20. Seven of the potential deployment instruments were not used: one instrument because it would not communicate before the cal dip, five with bad conductivity, and one with a slower response of the oxygen sensor.

CTD	S/N	To mooring	Allocated depth	Notes
	6813	EBH3B	400	
	6815	EBH3B	325	
	6818	EBH3	175	
	6819	EBH3	250	
	6820	EBH3	1200	Switched with 6831 (P good at 400 and 1100)
	6833	EBH3	400	
	6834	EBH3	500	
	6839	EBH3	600	
2	7363	EBH3	700	
	7468	EBH3	800	
	11744	EBH3	1000	
	6831	EBH3	325	Switched from initial 1200 dbar due to P
	10716	EBH3	1400	
	10542	EBH3	50	
	10546	DO NOT USE		no comms
	10547			O response slow
	12965	EBH3	1000	

	6836	EBH1	2500	
	14146	EBH1	2500	
	3270			C + 0.03
	3264	EBH3	50	Switched from initial 1000 dbar (P good at 50)
	3265	EBH1	3000	
	12967	EBH3	400	
	6326	EBH3B	50	
	3932	EBH3B	100	
	3934	EBH3B	175	
	4305	EBH3B	250	
	4307			C+.022
	4549	EBH3B	1500	
	6808	EBH3B	500	C+.02
	5240	EBH3B	600	
	5765	EBH3B	700	
	5777	EBH3B	800	
3	5784	EBH2	1600	
	5238	EBH3B	1200	
	6805	EBH2	2000	
	6826			C+.03
	6119	EBH2	1800	
	6126			C+.025
	12964	EBH2	1600	
	3256	EBH3	100	
	3257	EBH3B	1000	
	20254	EBH3	750	
	20255			C-.025

CTD	S/N	From mooring	Nominal depth	Offsets
	6829	EBH2	1600	C+.022
	10520	EBH2	1600	
	3484	EBH2	1800	
	6835	EBH2	2000	
	4800	EBH3	50	C+.024
18	12832	EBH3	50	
	4797	EBH3	100	C+.029
	5984	EBH3	175	
	3225	EBH3	250	
	3483	EBH3	325	
	4799	EBH3	400	

	10556	EBH3	400	
	3931	EBH3	500	
	5780	EBH3	600	
	6122	EBH3	700	
	10518	EBH3	750	
	5983	EBH3	800	
	6322	EBH3	1000	
	10545	EBH3	1000	C+.025
	6325	EBH3	1200	
	6800	EBH3	1400	
	4475	EBH3B	50	
	6804	EBH3B	100	C+0.049
	4461	EBH3B	175	C+.033
	4713	EBH3B	250	C+.04
	5978	EBH3B	325	P+5.7, C+.031
	7681	EBH3B	400	C+.029
	6822	EBH3B	500	C+.023
	6112	EBH3B	600	
20	11424	EBH3B	700	
	6335	EBH3B	800	
	4796	EBH3B	1000	
	6814	EBH3B	1200	
	5776	EBH3B	1500	
	6127	EBH1	2500	
	12907	EBH1	2500	
	6830	EBH1	3000	

Table 13.3 DY204 calibration dips, S/Ns in blue are ODOs.

13.3 Mooring Deployments

Four moorings (two full-depth and two short) and two landers were deployed (Table N.3). Currents were changeable with what appeared to be eddies reversing the direction of 0.3-0.4 kt currents over the time from positioning to deployment, but all deployments were completed in time for the target positions. Each mooring deployed was ranged to determine its position on the seabed by trilateration (Figure 12.12). EBH3B, a new MicroCAT-only mooring, was sited not far from the EBH3 position as backup to compensate for the removal on DY146 of the former end of the line at EBH4.

	Deployment start	Anchor drop time, position, depth				Trilaterated anchor seabed position		Fall-back [m]
Mooring		**Time**	**Lat [N]**	**Lon [W]**	**Depth [m]**	**Lat [N]**	**Lon [W]**	
EBH3	04 Feb 2026 12:15	4 Feb 2026 14:17:50	27° 48.61'	13° 44.72'	1417	27° 48.55'	13° 44.71'	110
EBH3L2	04 Feb 2026 15:19	30 Feb 2026 15:25:00	27° 48.24'	13° 45.46'	1430	27° 48.21'	13° 45.37'	85
EBH3B	05 Feb 2026 12:01	05 Feb 2026 13:52:00	27° 45.12'	13° 53.02'	1514	27° 45.03'	13° 49.98'	174
EBH2	06 Feb 2026 08:57	06 Feb 2026 09:24:30	27° 36.92'	14° 12.66'	2018	27° 36.88'	14° 12.70'	100
EBH1	07 Feb 2026 13:03	07 Feb 2026 13:19:00	27° 13.36'	15° 25.33'	3042	27° 13.35'	15° 25.39'	103
EBH1L17	07 Feb 2026 14:38	07 Feb 2026 14:44:00	27° 13.04'	15° 25.45'	3050	27° 13.05'	15° 25.97'	40

Table 13.4 DY204 moorings/landers deployed and deployment details

The MicroCAT and MicroCAT-ODOs deployed are listed in Table 13.3 above, while BPRs, Norteks, and ADCPs are listed in Table 13.5.

Instrument	Mooring	S/N	Deployed Depth (m)
SBE53	ebh1l17	0030	3047
SBE53	ebh1l17	0081	3047
SBE53	ebh3l2	0033	1428
SBE53	ebh3l2	0080	1428
Nortek	ebh1_17_2026	9213	2910
Nortek	ebh2_17_2026	13588	1900
Nortek	ebh3_17_2026	5879	500
Nortek	ebh3_17_2026	5490	800
Nortek	ebh3_17_2026	5590	1000
Nortek	ebh3_17_2026	5884	1300

Table 13.5 DY204 BPRs and current meters deployed

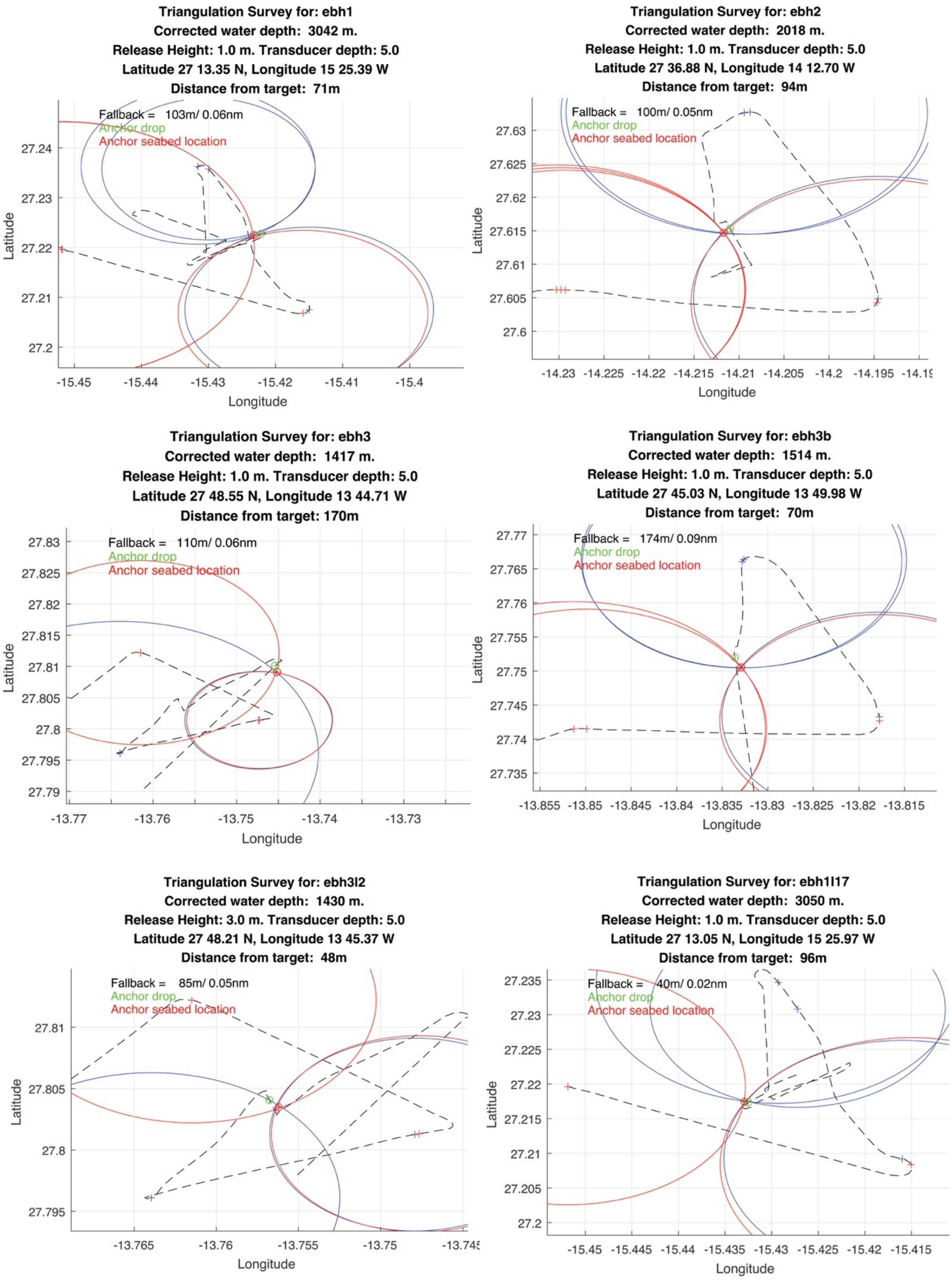
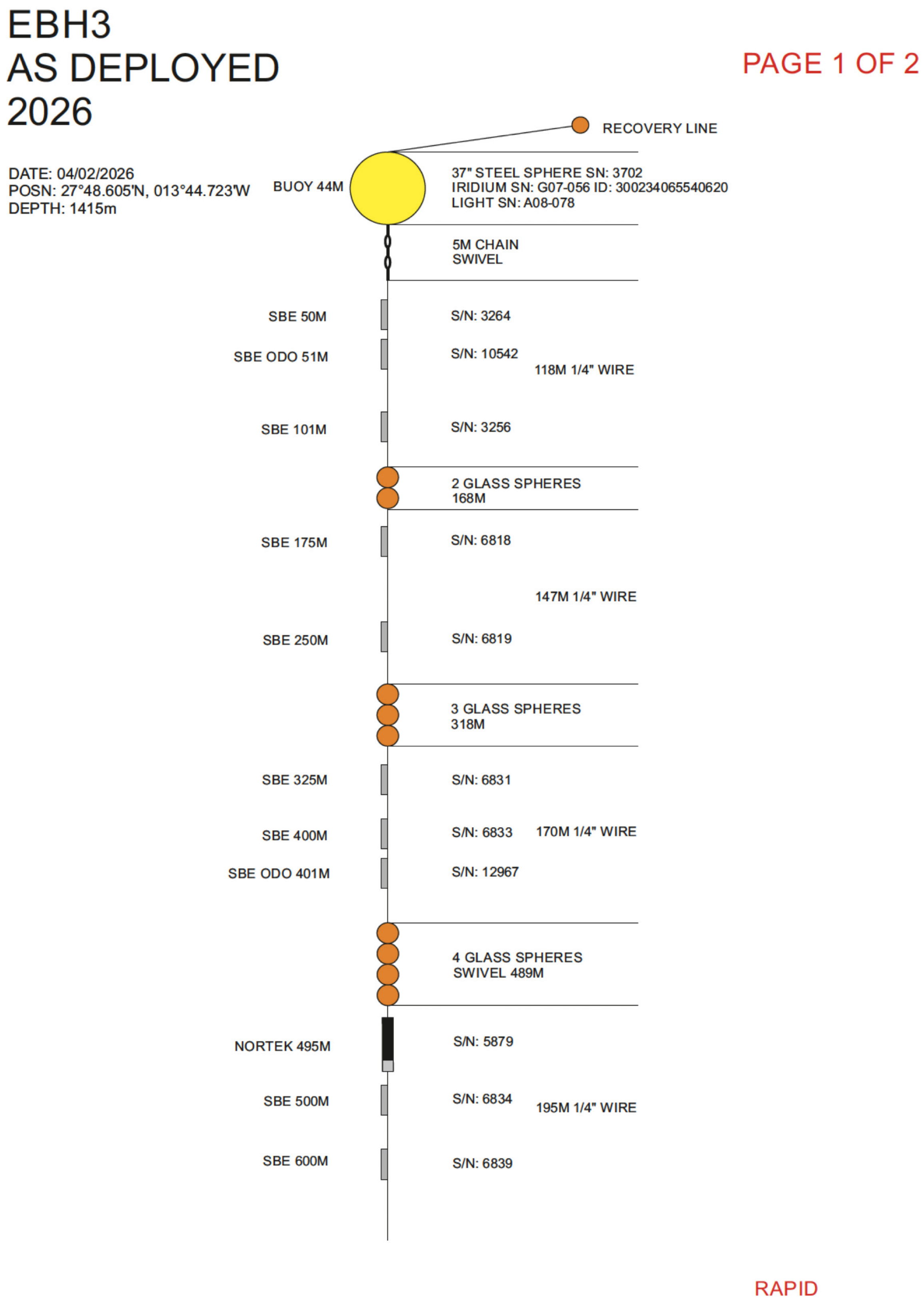


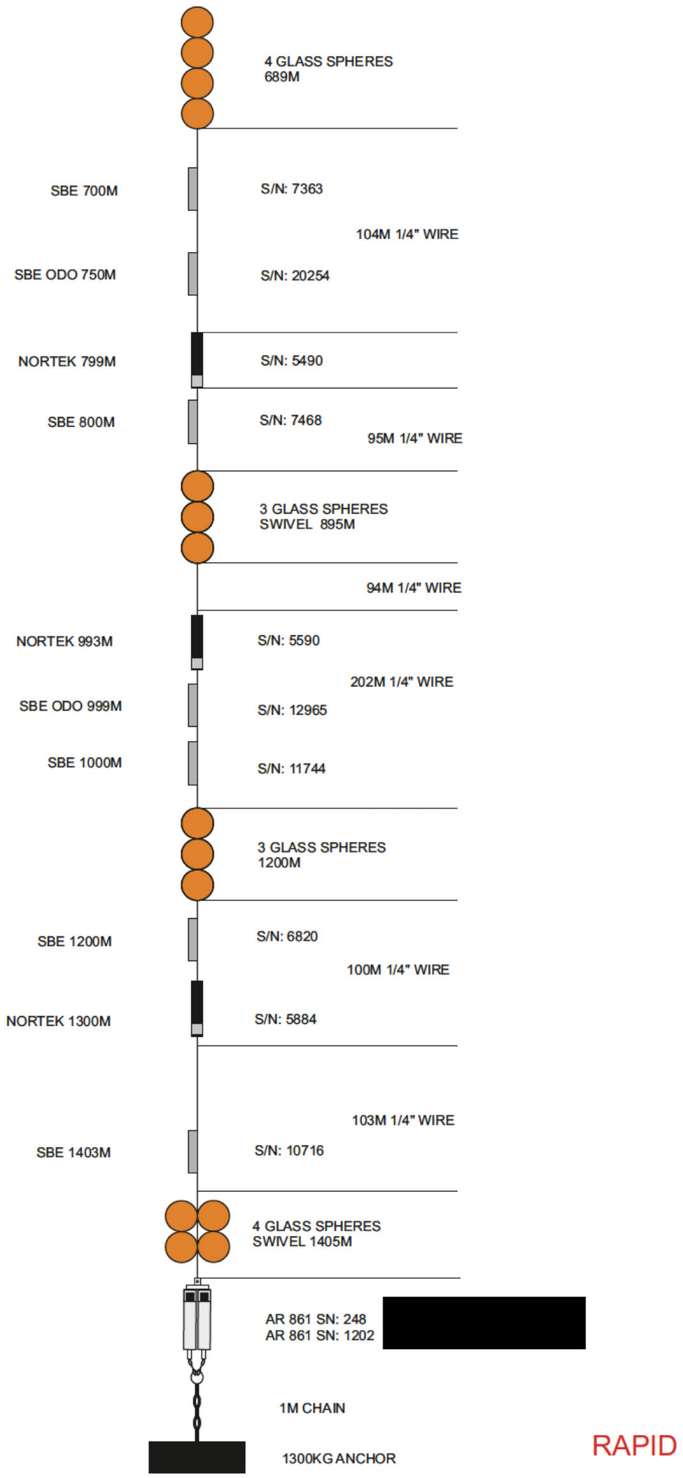
Figure 13.1 Mooring trilaterations

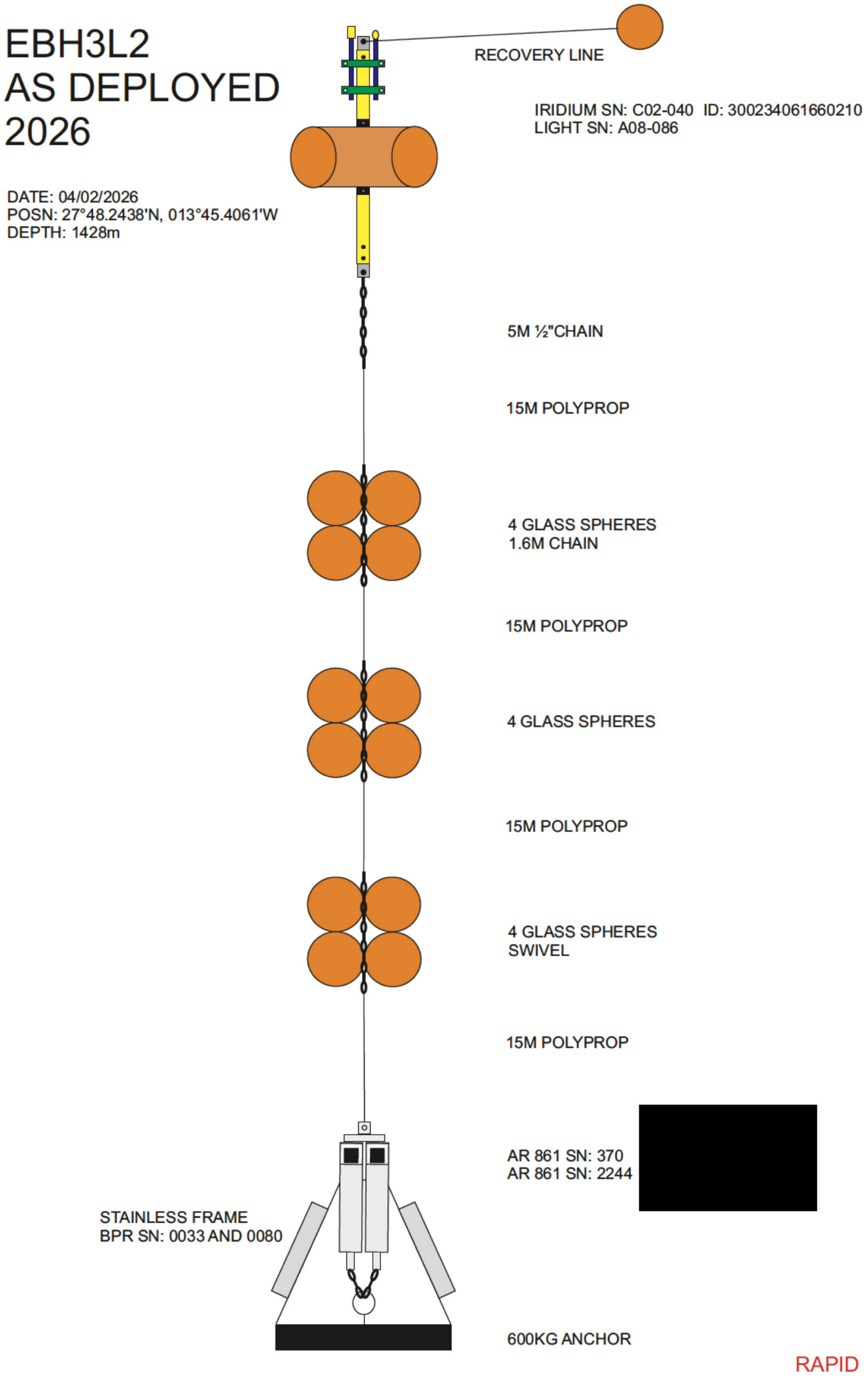
Appendix A: Diagrams of Deployed Moorings

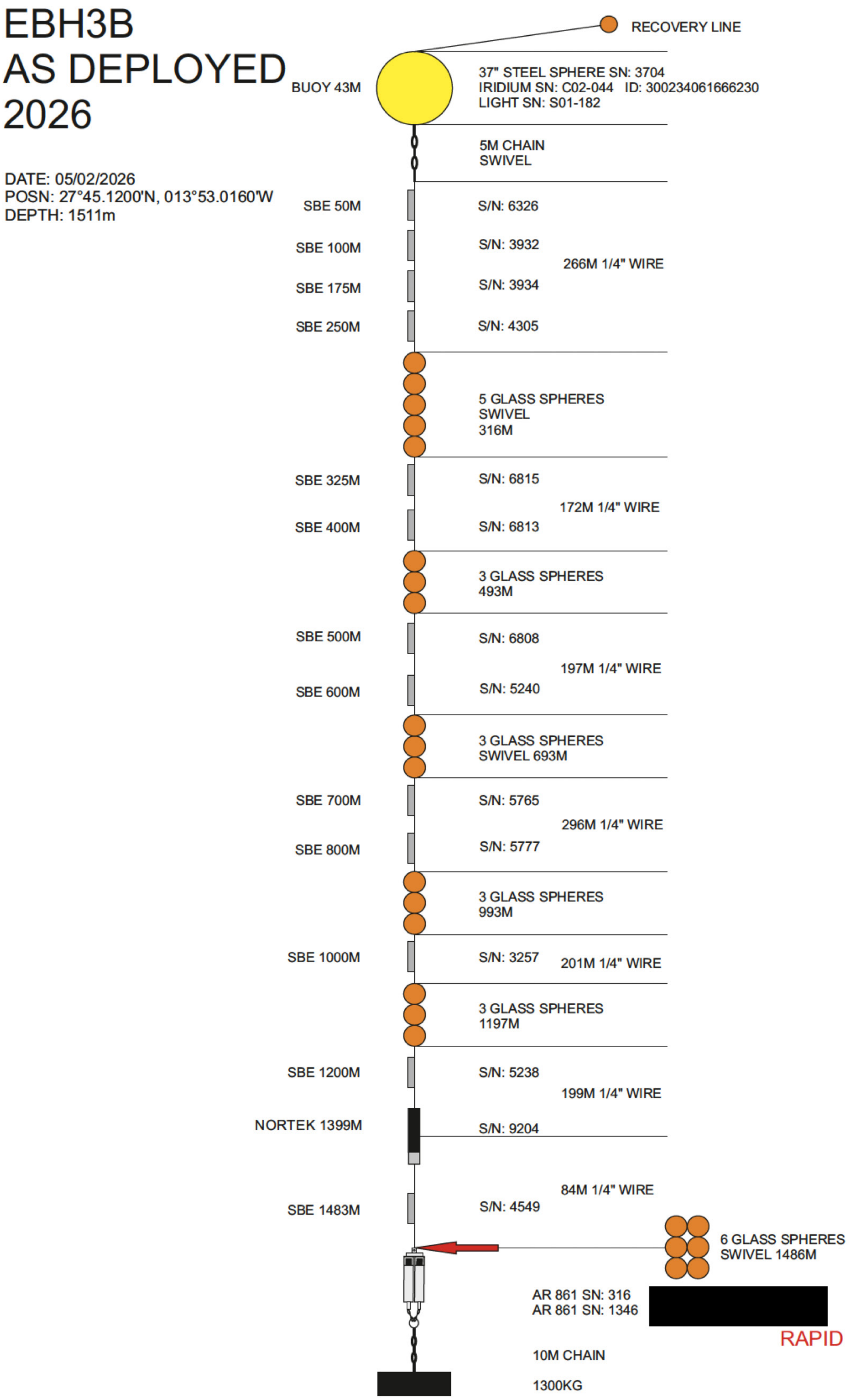


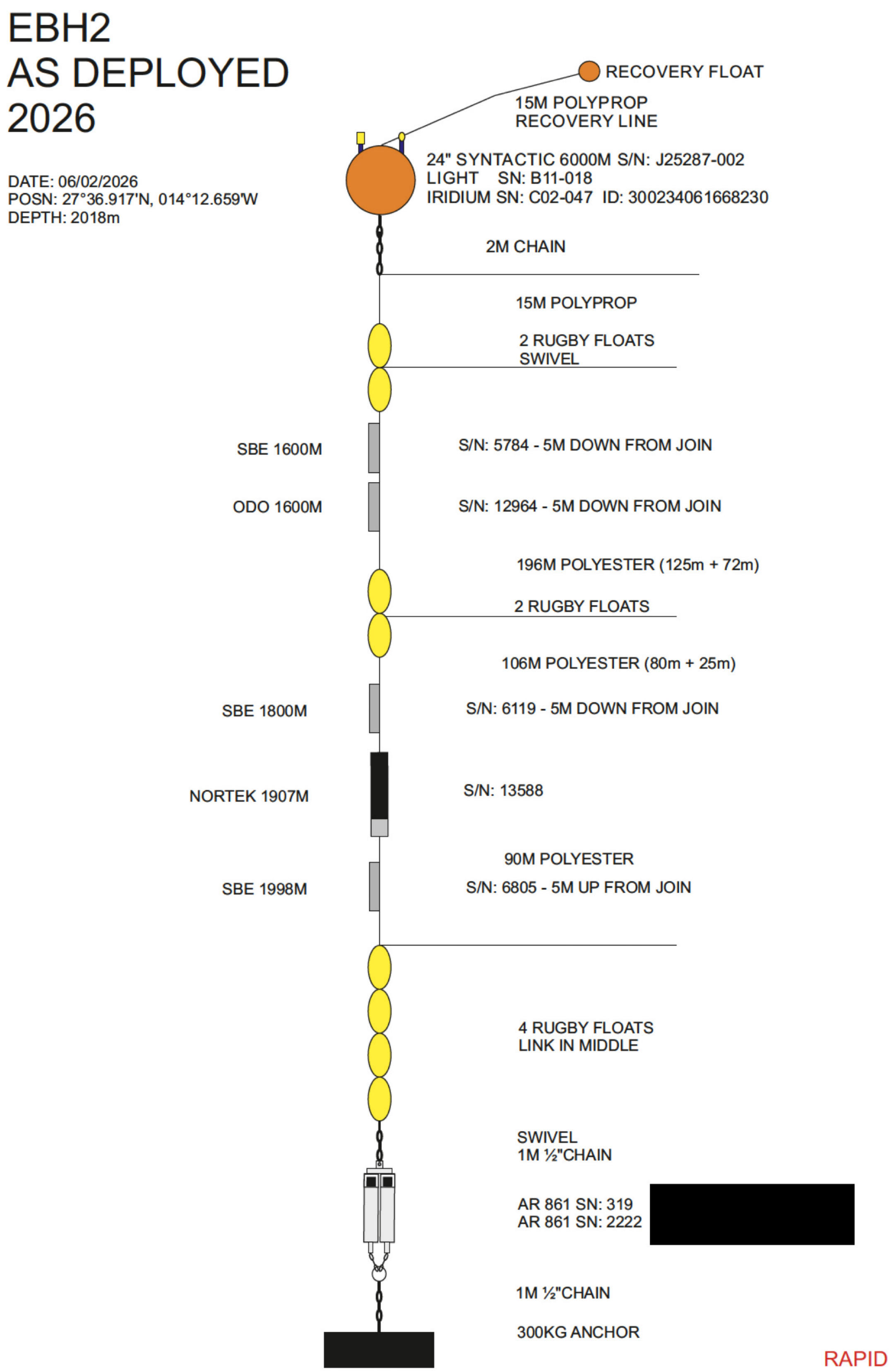
EBH3
AS DEPLOYED
2026

PAGE 2 OF 2



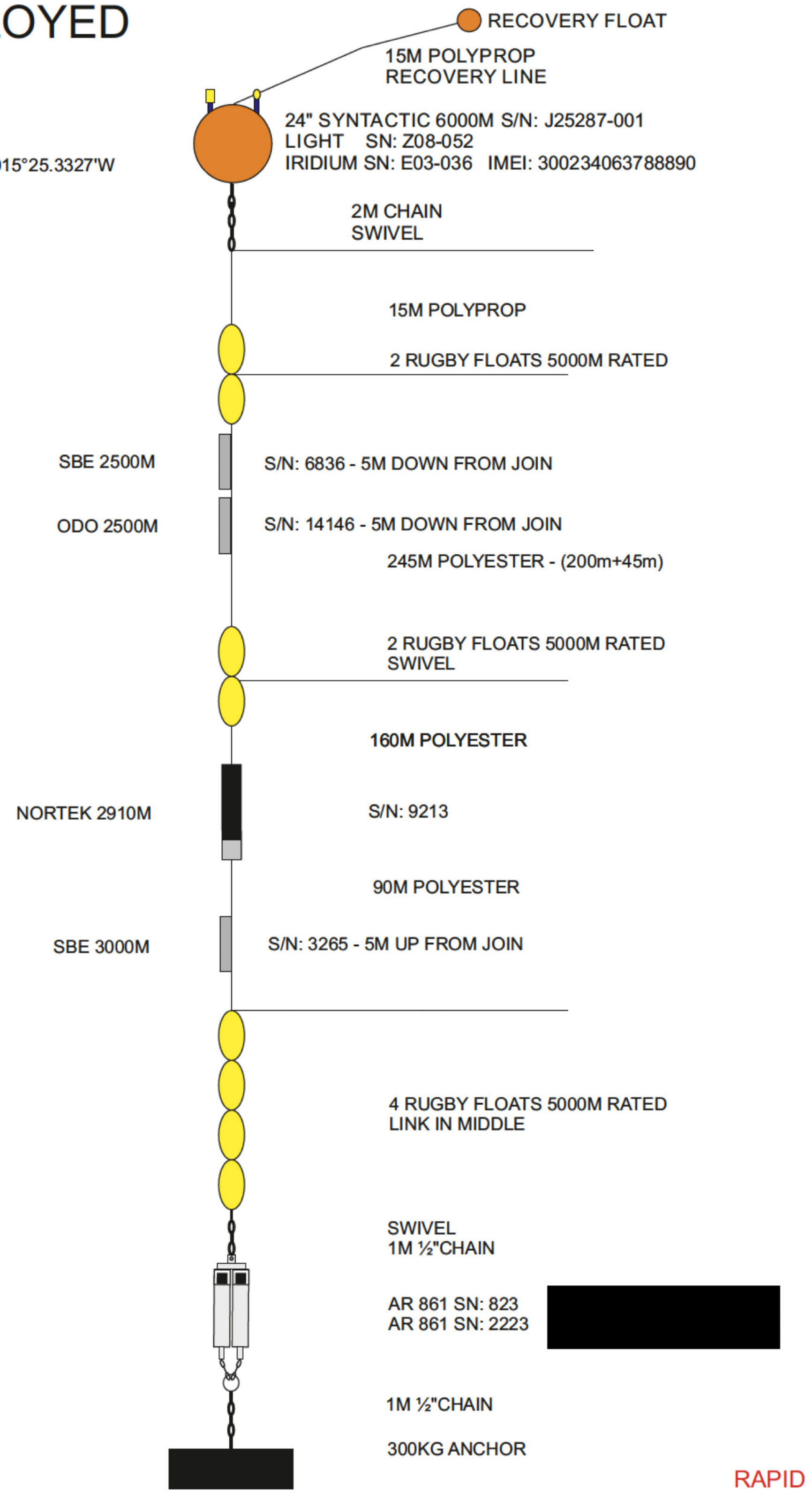

EBH3L2
AS DEPLOYED
2026
DATE: 04/02/2026
POSN: 27°48.2438'N, 013°45.4061'W
DEPTH: 1428m
RECOVERY LINE
IRIDIUM SN: C02-040 ID: 300234061660210
LIGHT SN: A08-086
5M ½"CHAIN
15M POLYPROP
4 GLASS SPHERES
1.6M CHAIN
15M POLYPROP
4 GLASS SPHERES
15M POLYPROP
4 GLASS SPHERES
SWIVEL
15M POLYPROP
AR 861 SN: 370
AR 861 SN: 2244
[redacted]
STAINLESS FRAME
BPR SN: 0033 AND 0080
600KG ANCHOR
RAPID


EBH3B
AS DEPLOYED
2026
DATE: 05/02/2026
POSN: 27°45.1200'N, 013°53.0160'W
DEPTH: 1511m
RECOVERY LINE
BUOY 43M
37" STEEL SPHERE SN: 3704
IRIDIUM SN: C02-044 ID: 300234061666230
LIGHT SN: S01-182
5M CHAIN
SWIVEL
SBE 50M
S/N: 6326
SBE 100M
S/N: 3932
266M 1/4" WIRE
SBE 175M
S/N: 3934
SBE 250M
S/N: 4305
5 GLASS SPHERES
SWIVEL
316M
SBE 325M
S/N: 6815
172M 1/4" WIRE
SBE 400M
S/N: 6813
3 GLASS SPHERES
493M
SBE 500M
S/N: 6808
197M 1/4" WIRE
SBE 600M
S/N: 5240
3 GLASS SPHERES
SWIVEL 693M
SBE 700M
S/N: 5765
296M 1/4" WIRE
SBE 800M
S/N: 5777
3 GLASS SPHERES
993M
SBE 1000M
S/N: 3257
201M 1/4" WIRE
3 GLASS SPHERES
1197M
SBE 1200M
S/N: 5238
199M 1/4" WIRE
NORTEK 1399M
S/N: 9204
84M 1/4" WIRE
SBE 1483M
S/N: 4549
6 GLASS SPHERES
SWIVEL 1486M
AR 861 SN: 316
AR 861 SN: 1346
RAPID
10M CHAIN
1300KG


EBH2
AS DEPLOYED
2026
DATE: 06/02/2026
POSN: 27°36.917'N, 014°12.659'W
DEPTH: 2018m
RECOVERY FLOAT
15M POLYPROP
RECOVERY LINE
24" SYNTACTIC 6000M S/N: J25287-002
LIGHT SN: B11-018
IRIDIUM SN: C02-047 ID: 300234061668230
2M CHAIN
15M POLYPROP
2 RUGBY FLOATS
SWIVEL
SBE 1600M
S/N: 5784 - 5M DOWN FROM JOIN
ODO 1600M
S/N: 12964 - 5M DOWN FROM JOIN
196M POLYESTER (125m + 72m)
2 RUGBY FLOATS
106M POLYESTER (80m + 25m)
SBE 1800M
S/N: 6119 - 5M DOWN FROM JOIN
NORTEK 1907M
S/N: 13588
90M POLYESTER
SBE 1998M
S/N: 6805 - 5M UP FROM JOIN
4 RUGBY FLOATS
LINK IN MIDDLE
SWIVEL
1M ½"CHAIN
AR 861 SN: 319
AR 861 SN: 2222
[redacted]
1M ½"CHAIN
300KG ANCHOR
RAPID

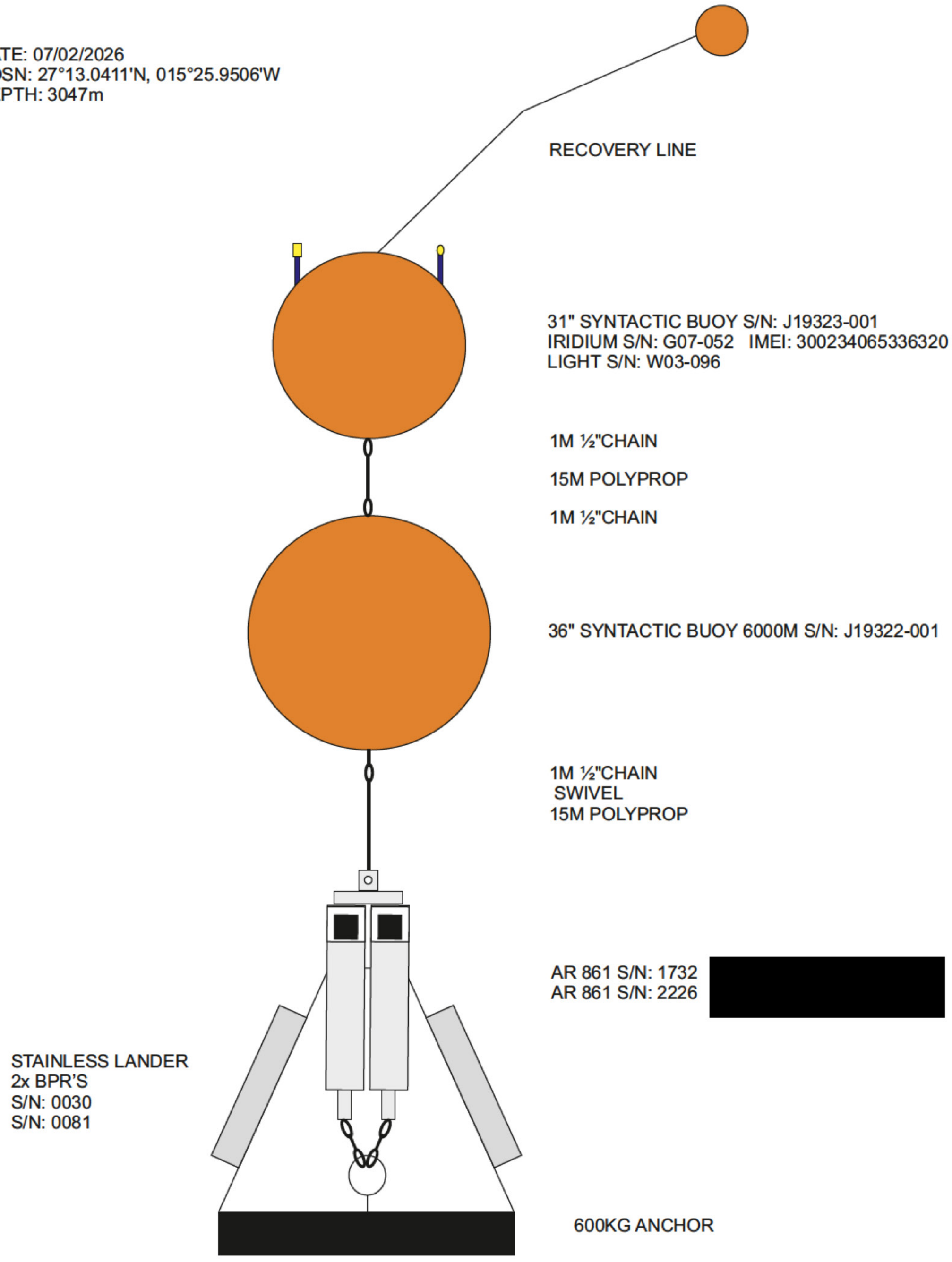
EBH1
AS DEPLOYED
2026

DATE: 07/02/2026
POSN: 27°13.3625'N, 015°25.3327'W
DEPTH: 3039m



EBH1L17
AS DEPLOYED
2026

DATE: 07/02/2026
POSN: 27°13.0411'N, 015°25.9506'W
DEPTH: 3047m



RAPID

Appendix B: Log Sheets of Recovered Moorings

RAPID-AMOC MOORING LOGSHEET **RECOVERY**

Mooring **EBH2** Cruise **DY204**

NB: all times recorded in GMT

Date 3rd Feb 26 **Site arrival time** 16:20

Time of first ranging 16:27 surf 1653

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		17:24
Billings Float	n/a		17:28
with Light	Z02-020 ✓		17:26
and Iridium Beacon	C02-043 ✓	Beacon ID: 300234061667220	17:28
2 x Rugby Floats	n/a		17:38
MicroCAT (1600m)	6829 ✓		17:31
MicroCAT ODO (1600m)	10520 ✓		17:31
2 x Rugby Floats	n/a		17:46
MicroCAT (1800m)	3484 ✓	2x S/N (3834)	17:47
MicroCAT (2000m)	6835 ✓		17:55
4 x Rugby floats	✓	4@ 17:55 ~~@ 17:44~~	
Acoustic Release #1	1405 ✓	[redacted]	17:55
Acoustic Release #2	282 ✓	[redacted]	17:55
~~300kg Anchor~~	n/a		X

Ascent Rate 80

Ranging

Time	Range 1	Range 2	Command/comment
16:27		2072	ARM/ARM,
10:28:	50 2072	2072	ARM/Release ok
16:29:	50 2002	1994	
16:30:	50 1918	1911	

RAPID-AMOC MOORING LOGSHEET **RECOVERY**

Mooring **EBH3** Cruise **DY204**

NB: all times recorded in GMT

Date 4th Feb 26 **Site arrival time** overnight.

Time of first ranging __________ **Sighted on surface** 08:40

Grappled @ 09:04

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	On board	09:05
37" Steel Sphere	3705		09:11
with Light	A08-080 ✓		"
and Iridium Beacon	C02-041 ✓	Beacon ID: 300234061665220	"
MicroCAT (50m)	4800 ✓	Heavy Fouling	09:19
MicroCAT - ODO (51m)	12832 ✓	"	09:20
MicroCAT (101m)	4797 ✓	Light Fouling	09:25
2 x 17" glass	n/a	"	09:27
MicroCAT (175m)	~~4~~5984 ✓	S/N 5984 Light Fouling	09:27
MicroCAT (250m)	3225 ✓		09:37
3 x 17" glass (318m)	n/a		09:38
MicroCat (325m)	3483 ✓		09:40
MicroCat (400m)	4799 ✓		09:42
MicroCat – ODO (401m)	10556 ✓		09:43
4x17" glass (489m)	n/a		09:45
Nortek (493m)	6747 ✓		09:46
MicroCat (498m)	3931 ✓		09:48
MicroCat (598m)	5780 ✓		09:51
4x 17" glass (689m)	n/a		09:54
Microcat -(698m)	6122 ✓		09:54
Microcat - ODO (748m)	10518 ✓		10:02
Nortek (798m)	5831 ✓	Downwards looking	10:04
MicroCat (804m)	5983 ✓		10:04
3 x 17" Glass 895m)	n/a		10:08
MicroCat (993m)	6322 ✓		10:12
Nortek (998m)	9210 ✓	Downwards looking	10:12
MicroCat – ODO (999m)	10545 ✓		10:14
3 x 17" Glass (1200m)	n/a		10:19
MicroCat (1203m)	6325 ✓	BC 250007113 (NO S/N visible)	10:19
Nortek (1303m)	9420		10:28
Microcat (1403m)	6800 ✓	Light Fouling	10:31
4x17" Glass (1405m)	n/a		10:33
Acoustic release #1	1198 ✓	[redacted] Light Fouling	"
Acoustic release #2	498 ✓		"

Ascent Rate 82 m/min

Ranging

Time	Range 1	Range 2	Command/comment
08:33	—	1493	ARM/ARM.
0834:50	1493	1493	ARM/Release ok
08:35:53	1419	1410	
08:36:53	1336	1328	

RAPID-AMOC MOORING LOGSHEET **RECOVERY**

Mooring **EBH3B** Cruise **DY204**

NB: all times recorded in GMT

Date 5 Feb 2026 **Site arrival time** overnight.

Time of first ranging 0838 **Sighted on surface** 08:38

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	Grappled @ 09:04	09:05
37" Steel Sphere	3706		09:09
with Light	X01-048		"
and Iridium Beacon	C02-046	Beacon ID: 300234061667230	"
MicroCAT (50m)	4475 ✓	Moderate (live) Fouling	09:13
MicroCAT (100m)	6804 ✓	Moderate Fouling	09:17
MicroCAT (175m)	4461 ✓	Light Fouling	09:19
MicroCAT (250m)	4713 ✓		09:21
5x17" Glass (316m)	n/a ✓		09:24
MicroCat (325m)	5978 ✓		09:25
MicroCat (400m)	7681 ✓		09:28
3x17" Glass (493m)	n/a		09:30
MicroCat (500m)	6822 ✓		09:32
MicroCat (600m)	6112 ✓		09:34
3x17" Glass (692m)	n/a		09:37
MicroCat (700m)	11424 ✓		09:38
MicroCat (800m)	6335 ✓	little critters (x2)	09:41
3 x 17" Glass (993m)	n/a		09:46
Microcat (1000m)	4796 ✓		09:47
3x17" Glass (1196m)	n/a		09:54
MicroCat (1200m) ??	6814 ✓		09:54
MicroCat (1486m) 1484	5776 ✓	Light fouling (feathering)	10:04
4x17" Glass (1196m) 1486	n/a		10:04
Acoustic release #1	2079 ✓	[redacted]	10:04
Acoustic release #2	253 ✓	[redacted]	10:04
1200kg Anchor	n/a		—

~~1486~~ ?

Ascent Rate 81 m/min

Ranging

Time	Range 1	Range 2	Command/comment
08:35	—	1595	ARM/CMD.
08:36	1595	1596	ARM/CMD.
08:37:30	1596	1595	ARM/REL Release ok
08:38:30	1518	1508	ARM/REL.
08:39:30	1434	1427	

RAPID-AMOC MOORING LOGSHEET **RECOVERY**

Mooring **EBH1L15** Cruise **DY204**

NB: all times recorded in GMT

Date 7 Feb 2026 **Site arrival time** overnight

Time of first ranging 07:35

grapple 0828

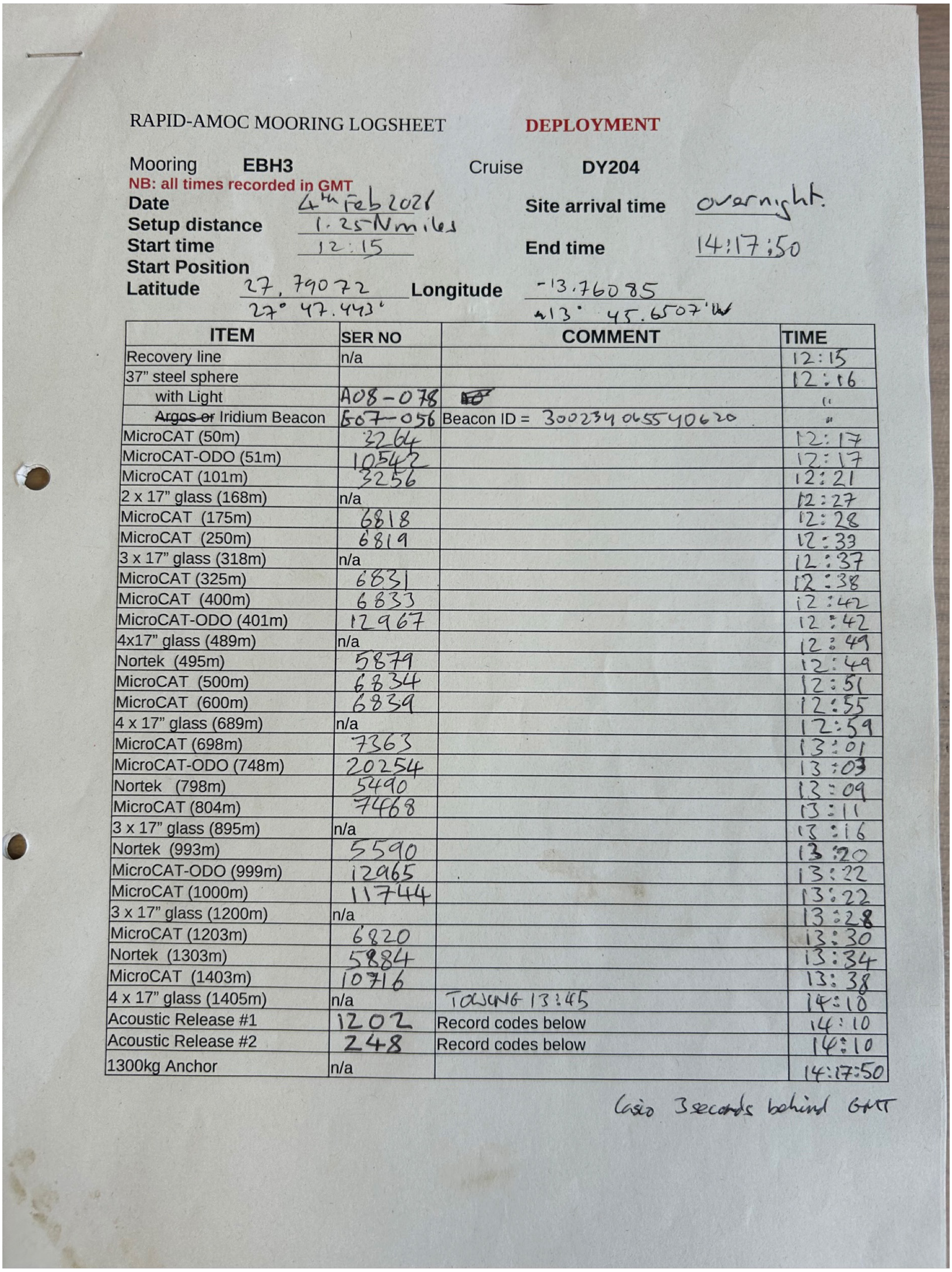
ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		0853
McLane-12"	n/a	Beacon bagged briefly on deck	
~~Billings sphere~~	~~n/a~~		0841
With light	G06-062		0841
Argos or Iridium Beacon	E03-036	Beacon ID = 300234063788890	0841
4X17" glass	n/a	0841	~~0837~~
4X17" glass	n/a		0837
4X17" glass	n/a		0855
SBE26/53	0003		0858
SBE26/54	0435		0858
Acoustic Release #1	1749		0858
Acoustic Release #2	1194		0858

Ascent Rate 80 m/min

Ranging

Time	Range 1	Range 2	Command/comment
07:35	—	3072	ARM / CMD
07:36:00	3072	3072	ARM / REL OK
07:37:00	~~3~~2998	2990	
07:38:00	2920	2911	
			spotted at 08:15

Appendix C: Log Sheets of Deployed Moorings



RAPID-AMOC MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH3** Cruise **DY204**

NB: all times recorded in GMT

Date 4th Feb 2026 **Site arrival time** overnight.

Setup distance 1.25 Nmiles

Start time 12:15 **End time** 14:17:50

Start Position

Latitude 27.79072 **Longitude** -13.76085

27° 47.443' 13° 45.6507' W

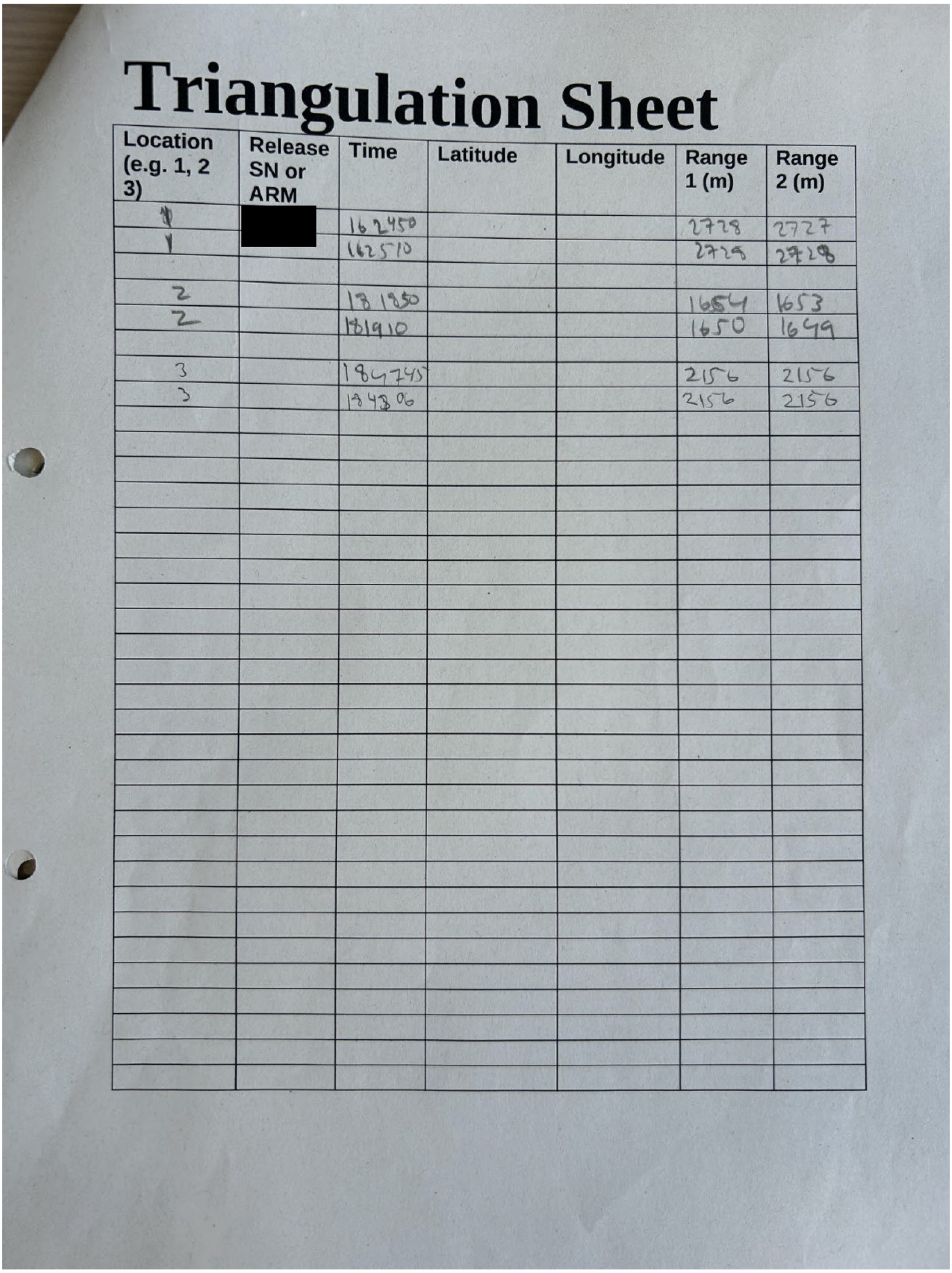
ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		12:15
37" steel sphere			12:16
with Light	A08-078		"
~~Argos or~~ Iridium Beacon	E07-056	Beacon ID = 300234065540620	"
MicroCAT (50m)	3264		12:17
MicroCAT-ODO (51m)	10542		12:17
MicroCAT (101m)	3256		12:21
2 x 17" glass (168m)	n/a		12:27
MicroCAT (175m)	6818		12:28
MicroCAT (250m)	6819		12:33
3 x 17" glass (318m)	n/a		12:37
MicroCAT (325m)	6831		12:38
MicroCAT (400m)	6833		12:42
MicroCAT-ODO (401m)	12967		12:42
4x17" glass (489m)	n/a		12:49
Nortek (495m)	5879		12:49
MicroCAT (500m)	6834		12:51
MicroCAT (600m)	6839		12:55
4 x 17" glass (689m)	n/a		12:59
MicroCAT (698m)	7363		13:01
MicroCAT-ODO (748m)	20254		13:03
Nortek (798m)	5490		13:09
MicroCAT (804m)	7468		13:11
3 x 17" glass (895m)	n/a		13:16
Nortek (993m)	5590		13:20
MicroCAT-ODO (999m)	12965		13:22
MicroCAT (1000m)	11744		13:22
3 x 17" glass (1200m)	n/a		13:28
MicroCAT (1203m)	6820		13:30
Nortek (1303m)	5884		13:34
MicroCAT (1403m)	10716		13:38
4 x 17" glass (1405m)	n/a	TOWING 13:45	14:10
Acoustic Release #1	1202	Record codes below	14:10
Acoustic Release #2	248	Record codes below	14:10
1300kg Anchor	n/a		14:17:50

Casio 3 seconds behind GMT

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]

Anchor Drop Position
Latitude ~~47~~. 27' 48.605'N Longitude 13° 44.723'W

Uncorrected water depth 1411.1 (at anchor launch)
Corrected water depth 1415.4 (at anchor launch)



Triangulation Sheet

Location (e.g. 1, 2 3)	Release SN or ARM	Time	Latitude	Longitude	Range 1 (m)	Range 2 (m)
1	[redacted]	162450			2728	2727
1		162510			2729	2728
2		181850			1654	1653
2		181910			1650	1649
3		184745			2156	2156
3		184806			2156	2156

RAPID-AMOC MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH3L2** Cruise **DY204**

NB: all times recorded in GMT

Date 2026/02/04 **Site arrival time** 1507

Setup distance ____

Start time 1519 **End time** 152530

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		1519
McLane-12"	n/a		1519
Billings 4 sphere	n/a		"
with Light	A08 - 086		"
Argos or Iridium Beacon	C02 - 040	Beacon ID = 300234061660210	"
4 x 17" glass	n/a		1520
4 x 17" glass	n/a		1521
4 x 17" glass	n/a		1522
BPR	0833		1525
BPR	0080		"
Acoustic Release #1 (tripod)	370	Record codes below	"
Acoustic Release #2 (tripod)	2244	Record codes below	"
600kg Anchor	n/a		"

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]

Anchor Drop Position

Latitude 27° 48.2438' N **Longitude** 13° 45.4061' W

Uncorrected water depth 1423.2 (at anchor launch)
Corrected water depth 1428.2 (at anchor launch)

Time	RANGE
1627	1814
1628	1814 1815
1628	1814 1815
1633	1814 1815
181734	1665 1667
1810	1673 1675
184841	1799 1800
184901	1799 1799

RAPID-AMOC MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH3B** Cruise **DY204**

NB: all times recorded in GMT

Date 5th Feb 2026 **Site arrival time** overnight

Setup distance 1.5 Nmiles

Start time 11:54 **End time** (secs) 13:52:33

Start Position

Latitude 27° 43.4820'N **Longitude** 13° 49.8420' W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		1201
37" steel sphere			1202
with Light	501-182		1202
~~Argos or~~ Iridium Beacon	C02-044	Beacon ID = 300234061666230	1202
MicroCAT (50m)	6326		1205
MicroCAT (100m)	3932		1206
MicroCAT (175m)	3934		1210
MicroCAT (250m)	4305		1213
5 x 17" glass (316m)	n/a		1217
MicroCAT (325m)	6815		1219
MicroCAT (400m)	6813		1222
3 x 17" glass (493m)	n/a		1226
MicroCAT (500m)	6808		1228
MicroCAT (600m)	5240		1231
3x17" glass (692m)	n/a		1235
MicroCAT (700m)	5765		1237
MicroCAT (800m)	5777		1240
3 x 17" glass (993m)	n/a		1246
MicroCAT (1000m)	3257		1248
3 x 17" glass (1196m)	n/a		1256
MicroCAT (1200m)	5238		1256
Nortek (1399m)	9204		1301
MicroCAT (1484m)	4549		1305
6x 17" glass (1486m)	n/a	Towing from 1311	1312
Acoustic Release #1	1346	Record codes below	13:52
Acoustic Release #2	316	Record codes below	13:52
1200kg Anchor	n/a		13:52

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code

[redacted]

Anchor Drop Position

Latitude 27° 45.1200'N **Longitude** 13° 53.0160'W

Uncorrected water depth 1513 (at anchor launch)

Corrected water depth 1511.0 (at anchor launch)

Triangulation Sheet

Location (e.g. 1, 2 3)	Release SN or ARM	Time	Latitude	Longitude	Range 1 (m)	Range 2 (m)
1	[redacted]	141157			2291	2298
		141218			2315	2322
2		142703			2272	2276
		142733			2291	2295
3		144345			2459	2468
		~~144410~~				
		144440			2561	2575
		~~1444~~			~~[illegible]~~	~~2628~~
		144540			2714	2729
		144845			3270	3282

RAPID-AMOC MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH2** Cruise **DY204**

NB: all times recorded in GMT

Date 2026/02/06 **Site arrival time** overnight

Setup distance 0.25nm

Start time 8.56 **End time** 9:24

Start Position

Latitude 27° 36.627'N **Longitude** 14° ~~15.992~~ 12.534' W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		~~8.56~~ 8.57
24" Syntactic			~~8~~ 8.58
with Light	B11-048		"
Iridium Beacon	C02-047	Beacon ID = 300234061668230	"
2 Rugby floats	n/a		9.03
MicroCAT (1600m)	5764		9.03
MicroCAT-ODO (1600m)	12964		9.03
2 Rugby floats	n/a		9.09
MicroCAT (1800m)	6119		9.09
Nortek (1907m)	13588		9.14
MicroCAT (1998m)	6805		9.16
4 Rugby floats	n/a		9.21
Acoustic Release #1	319	Record codes below	9.21
Acoustic Release #2	2222	Record codes below	9.21
300kg Anchor	n/a		9.24.30

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code

[redacted]

Anchor Drop Position

Latitude 27°36.917'N **Longitude** 14° 12.658'W

Uncorrected water depth 2018 (at anchor launch)

Corrected water depth 2018.2 (at anchor launch)

Triangulation Sheet

Location (e.g. 1, 2 3)	Release SN or ARM	Time	Latitude	Longitude	Range 1 (m)	Range 2 (m)
↓	[redacted]	093545			1614	1629
		093630			1719	1734
		093730			1865	1880
1		095025			2843	2845
		095055			2849	2849
~~2~~		~~0~~				
2		100703			2853	2856
		100733			2864	2865
3		102613			2822	2827
		102644			2850	2856
3	[redacted]	102716			2882	2886

RAPID-AMOC MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH1** Cruise **DY204**

NB: all times recorded in GMT

Date 07/02/26 **Site arrival time** Overnight

Setup distance 0.5nm

Start time **End time** 1338:29

Start Position

Latitude 27° 13.0678' N **Longitude** 15° 25.7855' W

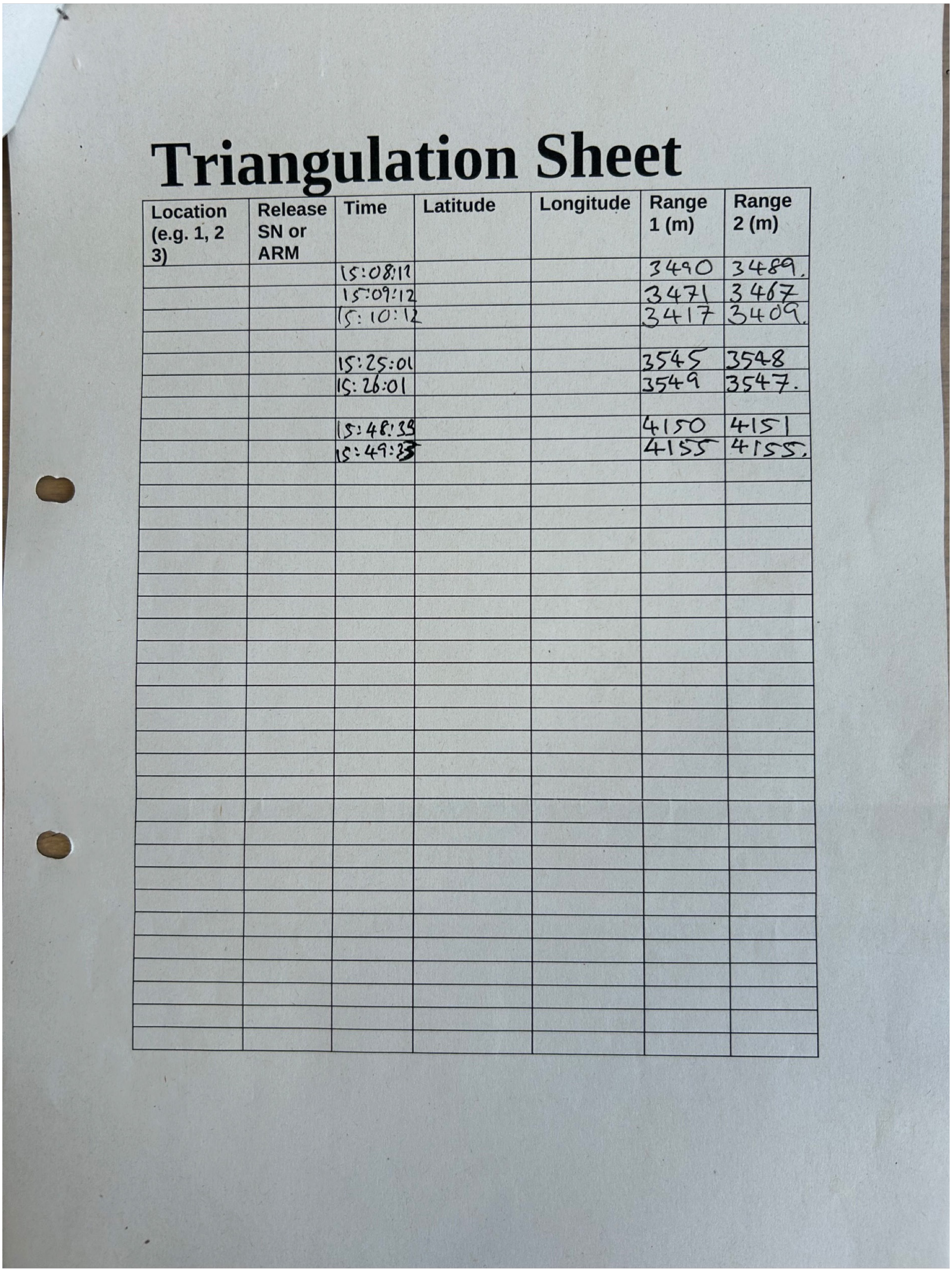
ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		1303
24" Syntactic			1303
with Light	208-052		1303
Iridium Beacon	E03-036	Beacon ID = 300234063788890	1303
2 Rugby floats	n/a		1305
MicroCAT (2500m)	6836		1306
MicroCAT-ODO (2500m)	14146		1306
2 Rugby floats	n/a		1314
MicroCAT (3000m)	3265	Towing (1322)	1320
4 Rugby floats	n/a		1330
Acoustic Release #1	2223	Record codes below	1330
Acoustic Release #2	823	Record codes below	1330
300kg Anchor	n/a		1330
Nortek 2910m	9213	~~Towing (1322)~~	1319

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]

Anchor Drop Position

Latitude 27° 13.3625' N **Longitude** 15° 25.3327' W

Uncorrected water depth 3035 (at anchor launch)
Corrected water depth 3039 (at anchor launch)



Triangulation Sheet

Location (e.g. 1, 2 3)	Release SN or ARM	Time	Latitude	Longitude	Range 1 (m)	Range 2 (m)
		15:08:12			3490	3489.
		15:09:12			3471	3467
		15:10:12			3417	3409.
		15:25:01			3545	3548
		15:26:01			3549	3547.
		15:48:39			4150	4151
		15:49:33			4155	4155.

RAPID-AMOC MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH1L17** Cruise **DY204**

NB: all times recorded in GMT

Date 20260207
Setup distance at location.
Start time 1438
Site arrival time overnight
End time 1445:57

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		1438
31" Syntactic			1439
36" Syntactic			1441
with Light	W03 096		1439
Iridium Beacon	607052	Beacon ID = 300234065336320	1439
BPR	0030		1444
BPR	0081		1444
Acoustic Release #1 (tripod)	2226	Record codes below	1444
Acoustic Release #2 (tripod)	1732	Record codes below	1444
230kg Anchor	n/a		1444

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]

Anchor Drop Position
Latitude 27° 13,0401'N **Longitude** 15° 25.9506'W

Uncorrected water depth 3043 (at anchor launch)
Corrected water depth 3047 (at anchor launch)

Time	range 1	range 1.
15:11:01	3603	3593.
15:12:01	3512	3502.
15:13:01	3421	3412.
15:23:15	3582	3590.
15:24:15	3644	3648
15:50:15	3578	3578
15:50:15	3578	3578.

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