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Cruise Report No. 30

RRS *James Cook* Cruise JC103

23 APR - 03 JUN 2014
Bermuda – Canary Islands

RAPID moorings cruise report

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2015

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ABSTRACT

This cruise report covers scientific operations conducted during RRS *James Cook* Cruise 103. The purpose of the cruise was the refurbishment of an array of moorings spanning the latitude of 26.5°N from the Bahamas to the Canary Islands. Cruise JC103 departed from Port of Spain on Wednesday 23rd April 2014, calling twice at Nassau, Bahamas before finally docking in Santa Cruz de Tenerife on Wednesday 3rd June 2014.

The moorings are part of a purposeful Atlantic wide mooring array for monitoring the Atlantic Meridional Overturning Circulation and the associated heat transport. The array is a joint UK-US programme and is known as the RAPID-MOCHA array.

During JC103 moorings were serviced at sites: WBAL, WBADCP, WB1, WB2, WB2L, WBH2, WB4, WB4L, WB6, MAR0, MAR1, MAR1L, MAR2, MAR3, MAR3L, EB1, EB1L, EBHi, EBH1, EBH1L, EBH2, EBH3, EBH4, EBH4L. Sites with suffix 'L' denote landers fitted with bottom pressure recorders, WBADCP is a bottom mounted 75kHz ADCP. At the other sites moorings were equipped with CTDs and current meters. CTDs with oxygen sensors were, for the first time, deployed at WB1, WBH2, and WB4. Additionally two PIES (pressure and inverted echo sounder instruments) were recovered but not re-deployed at sites WBP1 and EBP2. Mooring MAR0 was not able to be recovered but was redeployed. A sediment trap mooring NOGST was also recovered and redeployed for the Ocean Biogeochemistry and Ecosystems Group at the NOCS.

CTD stations were conducted throughout the cruise for purposes of providing pre- and post-deployment calibrations for mooring instrumentation and for testing mooring releases prior to deployment.

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 800 m depth were obtained using the two vessel mounted Acoustic Doppler Current Profilers (one 75 kHz and one 150 kHz).

Six APEX Argo floats supplied by the UK Met Office, were deployed during the cruise

KEYWORDS

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1 Scientific and Ship's Personnel

Scientific Personnel

David Smeed	Principal Scientist, NOC
Gerard McCarthy	Senior Scientist, NOC
Darren Rayner	Senior Scientist, NOC
Ben Moat	Senior Scientist, NOC
Eleanor Frajka-Williams	Lecturer, University of Southampton
Maria Pérez Hernández	PhD Student, Universidad de Las Palmas de Gran Canaria
Neela Morarji	PhD Student, NOC

Technical Personnel

Dave Childs	Senior Technical Officer
Nick Rundle	CTD Technician
Steve Whittle	Moorings
Colin Hutton	Moorings
Chris Crowe	Sensors
Howard King	Moorings
Paul Provost	Moorings (29th April to 6th May)
Martin Bridger	ITO

Ship's Personnel

Peter Sarjeant	Master
Phillip Gauld	Chief Mate
Paul Munro	2nd Officer (3rd Officer 23 April to 29 April)
Malcolm Graves	2nd Officer (23 April to 29 April)
Declan Morrow	3rd Officer (from 29th April)
George Parkinson	Chief Engineer
Michael Murray	2nd Engineer
Michael Murren	3rd Engineer
Lawrence Porrelli	3rd Engineer
Peter Marquick	E.T.O.
Martin Harrison	CPOS
Philip Alison	CPOD
David Price	POD
Charles McGrath	ERPO
Mark Moore	SG1A
Jarrod Welton	SG1A
David MacKenzie	SG1A
Nicholas Byrne	SG1A
Paula McDougall	Purser
Peter Lynch	Head Chef
Mark Brown	Chef
Peter Robinson	Steward
Carl Piper	Steward

2 Itinerary

David Smeed

The main activity on RRS *James Cook* was the recovery, servicing and redeployment of the moored instruments. In addition a number of CTDs were completed to calibrate, both pre- and post-deployment, the microcat instruments from the moorings and to test acoustic releases before deployment.

During the cruise continuous underway measurements of navigation, surface meteorology, and near-surface temperature and salinity were collected. In addition currents were measured with the 75kHz and 150kHz vessel mounted ADCPs and bathymetry was measured using the single beam echo sounder (EA600) and the EM120 swath.

Mobilisation was scheduled for Port of Spain, Trinidad and Tobago over Easter weekend from Friday 18th to Tuesday 22nd April. However, docking of the ship was delayed until the evening of Saturday 19th due to industrial action in the port. Consequently sailing of the ship was delayed by one day.

RRS *James Cook* sailed on the morning of Wednesday 23rd after completing bunkering overnight. From Port of Spain the ship the ship sailed for 6 days to reach Nassau (29th April) where formalities of diplomatic clearance were completed and one technician and some air-freighted equipment were transferred by small boat. During this passage three CTDs were completed in the waters of the Turks and Caicos Islands (26th and 27th April). Logging of underway measurements commenced at this time. Diplomatic permission to complete the CTDs in the EEZ of Dominican Republic had been sought but was not received at the time of sailing. During the passage a significant amount of preparation of mooring equipment was completed.

After departing Nassau on 29th April all of the moorings in the western boundary out to WB4 (76°37 W) were serviced before returning to Nassau where one technician disembarked on 6th May. For the first time Microcats with oxygen sensors were deployed on moorings WB1, WBH2 and WB4. From there RRS *James Cook* sailed east to service the final mooring of the western array, WB6 at 70°31 W before moving on to the mid-Atlantic ridge array starting with MAR0 on 13th May and finishing on 19th May with the NOGST. This last mooring was a deployment of sediment traps for the NOC Ocean Biogeochmesity and Ecosystems group

Servicing of the eastern boundary array commenced with EB1 on 23rd May. The final, and most easterly, mooring in the eastern array, EBH4, was deployed on 31st May and was followed by a number of CTD stations. However, problems with the CTD wire were encountered and the final calibration CTDs (numbers 23 and 24) were completed after a final retermination of the wire.

A detailed itinerary is given in table 1 and some further details are noted below:

Table 1: Summary of cruise itinerary. Times are ship's time which varies from UTC-4 at the start in the west to UTC at the end on the east.

Date	Operation	Year day	Start time	End time	Durat. (hrs)	Latitude (°N)	Long. (°W)	Notes
Wed 23 Apr	Depart Port of Spain	113	7:30					Time is UTC - 4 hours
	Transit to test CTD site	113	7:30	-	80.5			857 nm @ 10.7 kts
Thu 24 Apr	Load test CTD	114	16:00					
Sat 26 Apr	CTD 0 (Test to 500m)	116	18:38	19:18	0.7	21°47.53	70°23.99	
	CTD1	116	22:11	2:45	4.6	22°01.21	70°45.99	
Sun 27 Apr	CTD2	117	4:40	8:51	4.2	22°08.55	70°57.81	
	Transit to Nassau	117	9:00	-	47			435 nm @ 9.3 kts
		119	-	8:00				
Tue 29 Apr	Boat transfer Nassau	119	9:20	10:20				Personnel and equipment
	Transit from Nassau to WBP!	119	10:20	22:20	12			127 Nm @ 10.4 kts
	CTD 3	119	22:45	2:37	3.9	27°06.27	76°36.75	c. 4,990m
Wed 30 Apr	Recover WBP1 lander	120	4:33	6:17	1.75	27°06.10	76°36.71	
	Transit to WB4	120	6:20	12:50	5.5			61 Nm @ 9.5 kts
	Recover WB4	120	12:50	17:23	4.5	26°28.74	75°42.25	
	CTD 4	120	19:24	2:11	3.8	26°32.11	75°42.30	c. 4,650m
Thu 1 May	Recover WB4L8 lander	121	5:13	6:36	1.3	26°28.94	75°42.24	
	Deploy WB4	121	8:50	14:23	5.5	26°28.74	75°42.25	See text re winch
	Deploy WB4L10 lander	121	14:50	14:56	0.1	26°28.93	75°42.24	
	Triangulate WB4 + WBL10	121	15:50	17:16	1.6			
	CTD 5	121	18:59	23:07	4.1	26°32.19	75°42.23	c. 4,475m
	Transit to WB2	121	23:15	4:45	5.5			56 Nm @ 10.2 kts

Fri 2 May	Triangulate WB2	122	5:18	6:22	1.1			
	Recover WB2L8	122	7:15	8:40	1.5	26°30.59	76°44.78	
	Recover WB2	122	9:03	12:52	3.8	26°30.59	76°44.78	
	Deploy WB2L10	122	13:25	13:28	0.1	26°30.98	76°44.32	
	Attempt recover WBAL3	123	14:49	17:50	3			Did not surface. See text.
	CTD 6	122	19:30	23:20	3.8	26°32.78	76°44.44	c.3,500m
Sat 3 May	Deploy WB2	123	8:13	11:43	3.5	26°32.5	76°44.5	50 min tow
	Recover WB1	123	12:36	14:18	1.7	26°30.60	76°49.09	
	Recover WBAL3	123	14:30	16:45	2.25			See text
	Recover WBADCP	123	17:58	18:27	0.5	26°31.51	76°52.06	
	Deploy WBADCP	123	18:58	19:04	0.1	26°31.80	76°52.05	
	CTD 7	123	20:54	0:35	3.7	26°32.80	76°42.22	C 3,850m
Sun 4 May	Triangulate WB2 and WB2L10	124	1:00	2:00	1			
	Recover WBAL4	124	7:56	8:43	0.8	26°31.57	76°52.54	
	Deploy WBAL5	124	9:50	9:56		26°32.13	76°52.45	
	Deploy WB1	124	12:04	13:29		26°30.60	76°49.09	
	Recover WBh2	124	14:37	19:23	4.75	26°29.14	76°37.76	
	Triangulate WB1	124	20:35	21:50	1.25			
Mon 5 May	Deploy WBH2	125	8:29	10:54	2.4	26°29.14	76°37.7	
	Triangulate WBH2	125	12:00	12:45				
	Load test CTD	125						After re-termination of CTD
	CTD 8	125	15:13	19:07	3.9	26°29.53	76°40.57	c. 4,550m
	Transit to Nassau	125	19:20	8:20	13			91 nm
Tue 6 May	Boat transfer Nassau	126						Personnel leaving ship
	Transit to WB6	126	10:00	-	27.5			250 nm @ 9.1 kts
		127	-	13:30				

Wed 7 May	Stream CTD	127	13:30	15:40	2.2			
	Continue transit to WB6	127	15:40	5:10	13.5			128 nm @ 9.5 kts
Thu 8 May	CTD 9	128	5:23	9:58	4.6	26°30.71	70°52.53	c 5,480m
	Recover WB6	128	10:11	12:17	2.1	26°29.65	70°31.36	
	Deploy WB6	128	13:55	14:20	0.4	26°29.65	70°31.36	
	Transit towards MAR0	128	14:30	-	92.8			865 nm @ 9.3 kts
		132	-	13:20				2 x 1 hour clock changes
Mon 12 May	Stream CTD	132	13:20	14:30	1.5			Time is UTC - 2 hours
	Continue transit to MAR0	132-	14:40	-	15.3			141 nm @ 9.2 kts
		133	-	6:00				
Tue 13 May	Attempt recover MAR0	133	7:00	11:30	4.5	25°06.60	52°01.00	See text
	CTD 10	133	11:38	16:18	4.7	25°06.60	52°01.00	
	Deploy MAR0	133	16:59	17:24	0.4	25°08.22	52°01.58	
	Triangulation	133	18:50	20:16	1.5			
	Transit towards MAR1	133	20:16	-	13.3			134 nm @ 9.8 knt
		134	-	9:40				
Wed 14 May	Recover MAR1L7	134	9:40	11:26	2.8	24°11.57	49°44.71	
	Recover MAR1	134	12:30	15:49	3.4	24°09.91	49°45.02	
	Deploy MAR1L9	134	16:34	14:40	0.1	24°12.00	49°44.00	
	CTD 11	134	18:02	21:21	3.3	24°13.00	49°43.90	c. 5.000m
Thu 15 May	Deploy MAR1	135	8:04	13:04	5	24°10.00	49°45.00	
	Recover MAR2	135	13:10	15:30	2.3	24°10.66	49°45.77	
	Deploy MAR2	135	16:08	17:38	1.5	24°11.00	49°45.75	
	Triangulate	135	18:30	19:35	1.1			
	Transit MAR3	135	19:35		47.4			473 nm @ 10.0 kts
		137	-	19:00				
Sat 17 May	CTD 12	137	19:25	23:46	4.3	23°53.93	41°04.67	5,310m

Sun 18 May	Recover MAR3	138	6:50	9:58	3.1	23°52.21	41°05.40	
	Recover MAR3L7	138	10:03	12:00	2	23°51.90	41°05.64	
	Deploy MAR3	138	15:12	17:37	1.5	23°52.15	41°05.45	
	Deploy MAR3L9	138	16:01	16:06	0.1	23°51.75	41°05.90	
	CTD 13	138	16:58	21:24	4.5	23°53.90	41°04.46	5,330m
	Triangulate	138	21:24	22:50	1.5			
Mon 19 May	Recover NOG	139	12:45	19:55	1.2	23°46.25	41°05.92	
	Deploy NOG	139	12:45	19:55	1.2	23°46.25	41°05.92	
	Argo 0244 - deployed	139	18:58			23°46.3	39°58.7	
	Transit to EB1	139	20:00		91.8			879 nm @ 9.6 kts
Tue 20 May	Load test CTD	140						After re-termination of CTD
Wed 21 May	Argo 0241 - deployed	141	9:00			23°45.9	33°22.3	
Thu 22 May		142						Time is UTC - 1 hours
	Argo 247 deployed	142	10:00			23°45.6	29°21.5	
Fri 23 May	Argo 242 deployed	143	9:04			23°45.8	25°28.8	
	End transit	143		14:30				
	Recover EB1	143	14:30	18:18	4.2	23°45.27	24°09.39	
Sat 24 May	Recover EB1L8	144	6:57	9:40	2.7	23°47.47	24°06.80	Rose slowly due to implosion
	Deploy EB1	144	11:08	15:33	4.5	23°45.40	24°09.50	See note X re winch
	Deploy EB1L10	144	16:08	16:14	0.1	23°47.50	24°06.50	
	Argo 0250 deployed	144	16:36			23°47.5	24°06.5	
	CTD14	144	16:45	21:55	5.2	23°47.49	24°06.94	c. 5,000m
	Triangulation	144	20:55	22:33				
	Start transit to EBHi	144	22:35	-				171 nm @ 6.3 kts
Sun 25 May	Argo 0249 deployed	145	14:57			24°36.4	22°05.6	
	End transit	146	-	1:00				
Mon 26 May	Recover EBHi	146	6:50	9:15	2.4	24°55.97	21°16.39	

	Deploy EBHi	146	9:55	10:41	0.8	27°13.33	15°25.39	
	Triangulate	146	11:50	12:36	0.8			
	CTD15	146	12:35	16:30	3.9	24°53.83	21°14.91	c. 4,400m
	Start Transit to EBH1	146	16:30	-	50.5			340 nm @6.7 kts
Tues 27 May								Change clocks to UTC
Wed 28 May	Day lost due to poor weather							
Thu 29 May	Recover EBH1L8	149	5:58	7:14	1.3	27°08.12	15°21.85	
	Recover EBH1	149	8:20	9:54	1.6	27°13.34	15°25.36	
	Deploy EBH1	149	10:46	11:05	0.3	27°13.33	15°25.39	
	Deploy EBH1L10	149	11:55	12:01	0.1	27°12.24	15°25.01	
	Triangulate	149	13:00	15:20	2.3			Slowed by bad weather
	Transit							69 nm
Fri 30 May	Recover EBH2	150	6:26	7:55	1.5			
	Deploy EBH2	150	9:00	9:12	0.2	27°36.85	14°12.69	
	Transit to EBH3	150	9:15	12:55	3.7			27 nm @ 7.2 kts
	Recover EBH3	150	12:57	14:52	1.9	27°48.74	13°44.71	
	Deploy EBH3	150	15:27	16:48	1.3	27°48.36	13°44.91	
	Triangulate	150	17:40	18:55	1.2			
	Transit to EBP2	150						12 nm
Sat 31 May	Recover EBP2	151	5:45	6:37	0.9	27°52.19	13°31.12	Flipped upside down so light was not visible.
	Recover EBH4L3	151	7:44	8:41	1	27°51.86	13°30.85	
	Deploy EBH4L5	151	9:11	9:16	0.1	27°51.99	13°30.84	Strong current allowed for
	Recover EBH4	151	9:50	11:10	1.3	27°51.06	13°32.42	
	Deploy EBH4	151	12:22	13:26	1.3	27°50.98	13°32.45	
	CTD 16 -	151	14:15	15:05		27°52.48	13°35.49	
	CTD 17 -	151	16:10	16:50		27°50.65	13°28.73	

	CTD 18 -	151	17:30	17:50		27°44.77	13°24.24	
	CTD 19 -	151	18:35	18:50		23°48.82	13°19.73	
	Triangulation	151	20:30	21:30				
Sun 1 June	CTD 20 -	152	6:00	7:10		27°52.37	13°35.54	
	CTD 21 -	152	8:05	9:15		27°53.10	13°39.84	
	CTD 22 -	152	10:20	11:45		27°55.60	13°48.40	CTD section abandoned
		152	13:00					Re-terminate CTD wire
	Transit to deep water site	152						103 nm
Mon 2 June	CTD 23	153	5:05	8:25		28°27.26	15°40.00	
	CTD 24	153	8:50	12:15		28°27.20	15°39.97	
Wed 3 June	Dock St Cruz de Tenerife	154	8:00					Approximate time

3 Introduction

David Smeed

RRS *James Cook* cruise JC103 was the 27th cruise in the UK-US RAPID program and completed the first decade of monitoring of the Atlantic Meridional Overturning Circulation (AMOC) at 26°N. The primary objective of the cruise was to service the entire array of UK moorings from the Bahamas in the west to the Canaries in the east. This was the second time the entire array was serviced in a single cruise. A plot of the cruise track is shown in Figure 1.

3.1 The RAPID-MOC project

The main objective of the RAPID-MOC project is to deliver a time series of calibrated and quality-controlled measurements of the AMOC.

The AMOC at 26°N carries a northward heat flux of 1.3 PW (Johns et al., 2010). Northward of 26.5°N over the Gulf Stream and its extension much of this heat is transferred to the atmosphere and subsequently is responsible for maintaining north eastern European climate about 5°C warmer than the zonal average at this latitude. Previous sparse observations did not resolve the temporal variability of the AMOC and so it is unknown whether it is slowing in response to global warming as suggested by recent model results (Bindoff et al., 2007).

In 2004, NERC, NSF and NOAA funded a system of observations in the Atlantic at 26.5°N to observe on a daily basis the strength and structure of the AMOC. It is fair to say that this programme has revolutionised our understanding of the AMOC. Early in the project, Cunningham et al. (2007) demonstrated that the AMOC reveals dramatic richness of variability. As the timeseries has been extended, modes of variability have been revealed on seasonal (Kanzow et al., 2010; Chidichimo et al., 2010) and interannual (McCarthy et al., 2012) timescales. The latest published version of the timeseries from Smeed et al. (2014) can be seen in Figure 2.

The RAPID-MOC project has now completed 10 years of observation at 26°N. The NERC contribution to the first four years of continuous AMOC observations was funded under the directed programme RAPID Climate Change. This was followed by further funding under the RAPID-WATCH programme. Recently NERC, NSF and NOAA have committed to funding the array until 2020.

3.2 The AMOC system

The Atlantic at 26.5°N is separated into two regions: a western boundary region, where the Gulf Stream flows through the narrow (80 km), shallow (800 m) Florida Straits between Florida and the Bahamas, and a transatlantic mid-ocean region, extending from the Bahamas at about 77°W to Africa at about 15°W (Figure 3). Variability in Gulf Stream flow is derived from cable voltage measurements across the Florida Straits (Baringer & Larsen, 2001), and variability in wind-driven surface-layer Ekman transport across 26.5°N is derived from either CCMP (Atlas et al., 2011) or ERA-Interim winds (Dee & co authors, 2011).

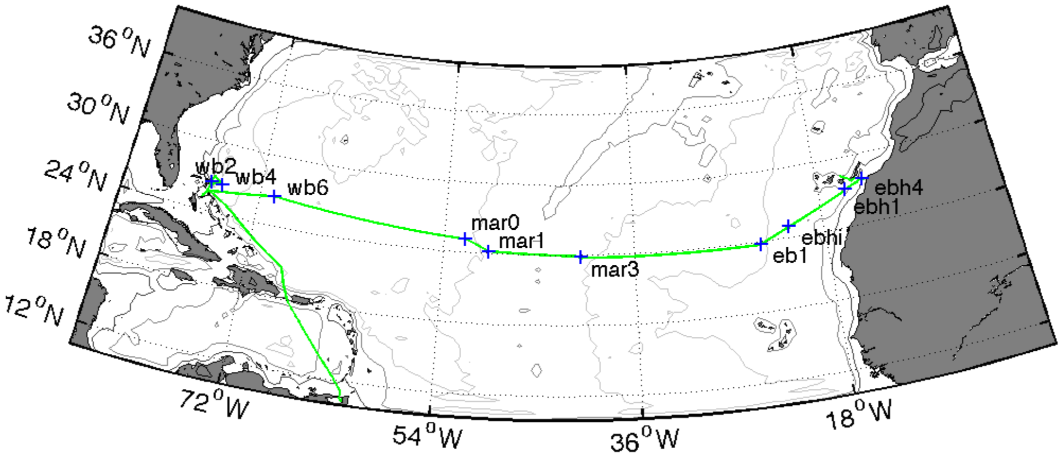


Figure 1: Cruise track. The path of the ship is shown by the green line. A number of mooring locations are shown by blue crosses. For clarity where there are a number of moorings close by not all locations are shown. Grey conours indicate the 1000m, 3000m and 5000m isobaths.

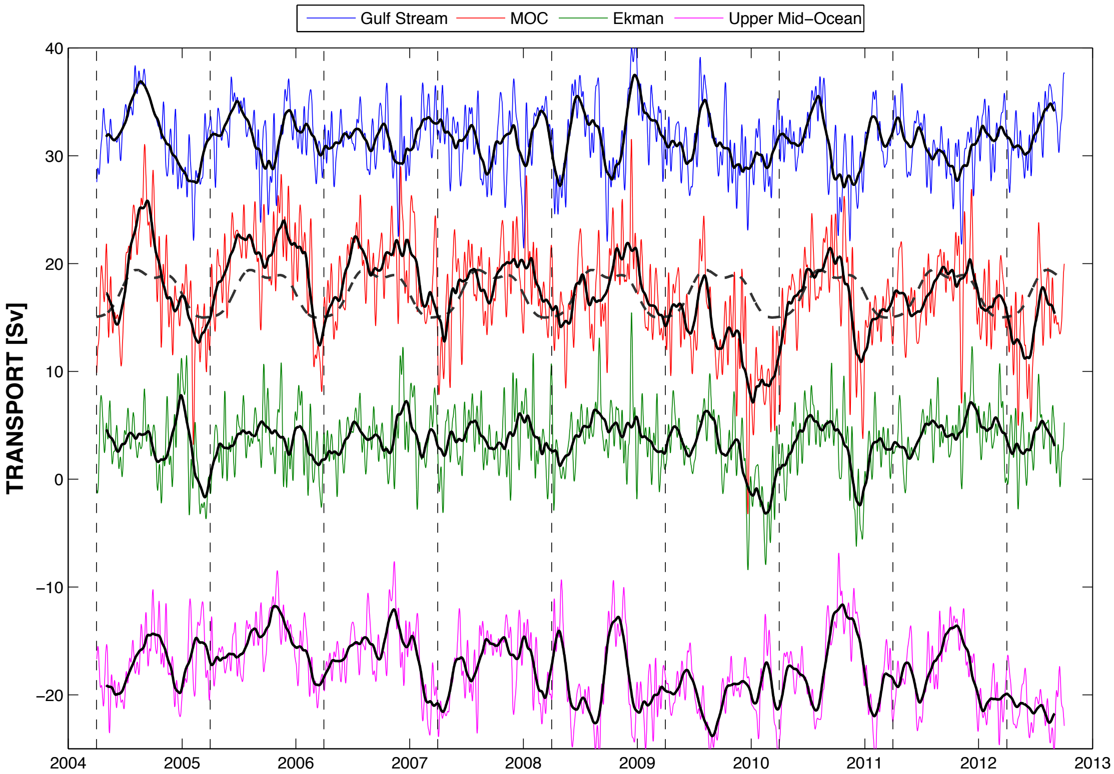


Figure 2: Ten-day (colours) and three month low-pass (black) timeseries of Gulf Stream transport (blue), Ekman transport (green), upper mid-ocean transport (magenta), and overturning transport (red) for the period 1 April 2004 to 1 October 2012 based on the figure in Smeed et al. (2014).

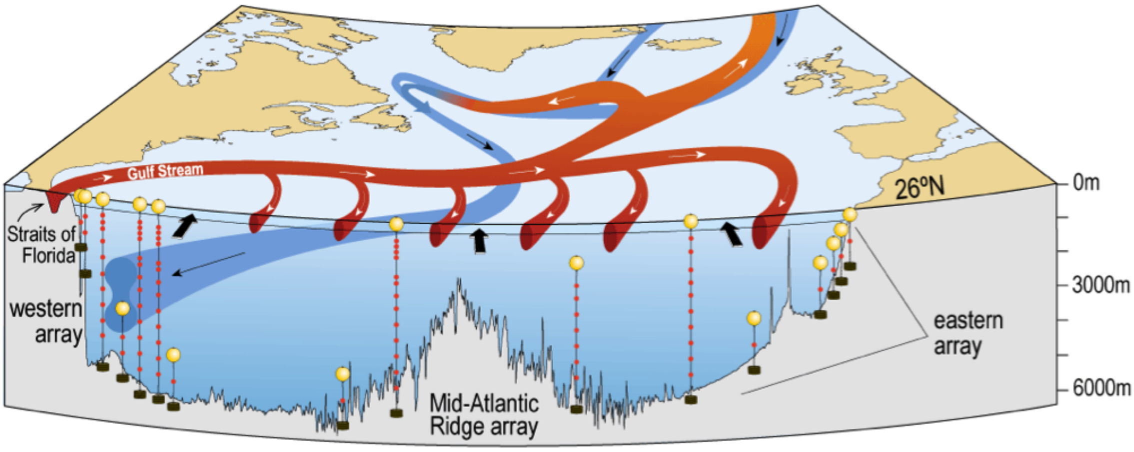


Figure 3: Schematic of the principal currents of the Atlantic meridional overturning circulation. The vertical lines across the Atlantic at 26.5°N indicate moorings instrumented to measure the vertical density profiles. The Gulf Stream (red) transport is measured by a submarine cable in the Straits of Florida and the western boundary array includes current meters to directly measure transports of the shallow and deep western boundary currents (blue). Bottom pressure recorders are located at several sites across the Atlantic to measure depth-independent fluctuations of the basin-wide circulation.

To monitor the mid-ocean flow we deployed an array of moored instruments along the 26.5°N section. The basic principle of the array is to estimate the zonally integrated geostrophic profile of northward velocity on a daily basis from time-series measurements of temperature and salinity throughout the water column at the eastern and western boundaries. Inshore of the most westerly measurement of temperature and salinity, components of the Antilles current and deep western boundary current are monitored by direct velocity measurements. For a review, see Rayner et al. (2011).

3.3 Array specification

The UK array at 26 °N currently consists of 16 moorings and 7 pairs of landers. Only one of each lander pair is serviced at one time so that overlapping time series are obtained at each site. This greatly aids the calibration of bottom pressure recorders (BPRs). Figure 4 shows the array after JC103. The array is largely unchanged from the previous array deployed in autumn 2012 but there are a few small differences described below.

Moorings are named in three sub-arrays. Western boundary WB with mooring number increasing to the east; Mid-Atlantic Ridge MAR; Eastern Boundary EB. The letter H is a historical reference to moorings originally intended to be HOMER profilers. Bottom landers instrumented with pressure recorders are indicated by L in the name. ADCP indicates an Acoustic Doppler Current Profiler mooring.

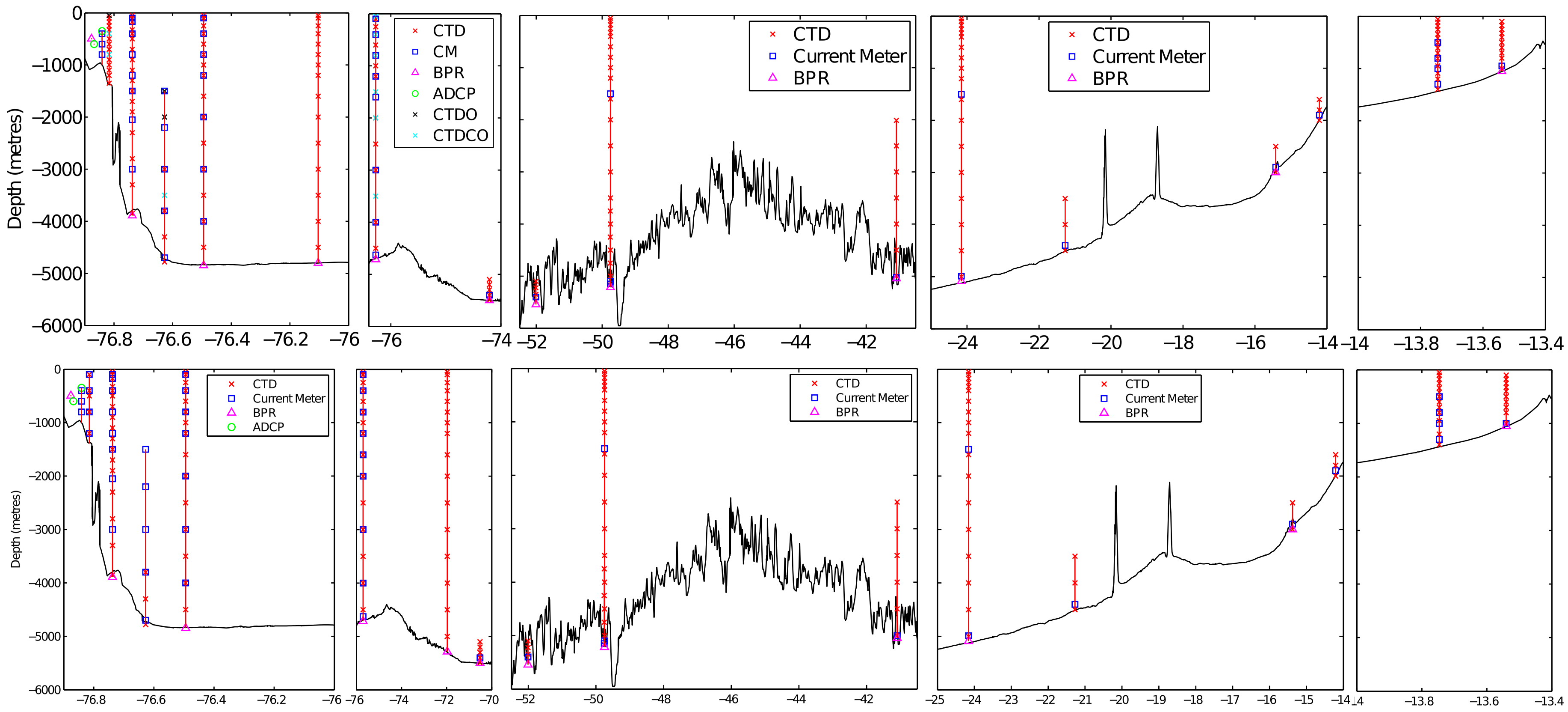


Figure 4: The RAPID/MOCHA array after JC103. Panels show, from left, the western boundary array at the continental shelf-edge including WBADCP, WBAL, WB0, WB1, WB2, WBH2, WB2L, WB3, WB3L and WBC. The deep western boundary array including WB4, WB4L, and WB6. The Mid-Atlantic Ridge array including MAR0, MAR1, MAR1L, MAR2, MAR3 and MAR3L. The deep eastern boundary array including EB1, EB1L, EBHi, EBH1, EBH1L and EBH2. The slope eastern boundary array including EBH3, EBH4, and EBH4L. Moorings WB0, WB3, WB3L and WBC comprise the MOCHA element of the array. .

Eastern boundary sub-array

The Eastern Boundary sub-array currently consists of one tall mooring EB1, with eighteen MicroCATs and two current meters, and a series of shorter dynamic height moorings EBHi, EBH1, EBH2, EBH3 and EBH4 that step up the slope reducing the influence of bottom triangles when combined with the more offshore EB1 mooring. The Eastern sub-array includes three pairs of bottom pressure landers; at the sites of EB1, EBH1, and EBH4. The Eastern Boundary sub-array remains almost unchanged from that deployed in autumn 2012. However, the PIES EBP2 was recovered on JC103 and not redeployed.

Mid-Atlantic ridge sub-array

The sub-array at the Mid-Atlantic Ridge consists of one full depth mooring MAR1, three shorter moorings MAR0, MAR2 and MAR3, and two pairs of landers: at MAR1, and MAR3. MAR0 consists of five MicroCATs, and one current meter to capture the Antarctic Bottom Water (AABW) contribution to the MOC to the west of the ridge. MAR1 provides a full depth density profile through eighteen MicroCATs, with MAR2 acting as a backup up to 2500m on the west of the ridge. MAR3 is sited to the east of the ridge and samples from the bottom up to 2,000m below the surface, and allows separation of the eastern and western basin MOC contributions.

The MAR array was largely unchanged from that deployed in autumn 2012 except that no BPRs were deployed on MAR0. Additionally MAR0 was extended up to 4,800m depth.

Western boundary sub-array

At the western boundary, WB2 is the pivotal mooring and provides a full depth density profile very close to the western boundary wall. WB2 comprises sixteen MicroCATs and eight current meters. WB1 comprises four MicroCATs and four current meters. Inshore of WB1 there is WBADCP (sometimes referred to as WBA) that comprises a Longranger ADCP at a depth of 600m to measure the shallow Antilles current. East of WB2 is WBH2 consisting of three MicroCATs and five current meters. At the normal offshore extent of the Deep Western Boundary Current (DWBC) is WB4, which comprises fifteen MicroCATs and nine current meters. Further offshore is WB6 comprising five MicroCATs and two bottom pressure recorders, which combined with MAR0 measures the contribution to the MOC of deep water below 5200m including the AABW. There are also three pairs of landers in this sub-array; at the sites of WBA, WB2 and WB4.

The UK array on the western boundary remained largely unchanged following JC103. However, microcats with oxygen sensors were deployed for the first time. A total of twelve instruments with oxygen sensors were deployed on WB1, WBH2 and WB4. Also WB6 was extended up to 4,800m depth. The PIES WBP1 was recovered but not redeployed. Also one fo the landers at WBA was recovered but not redeployed because of concerns about the rate of corrosion on the shallow landers.

In addition to the UK moorings listed above, the western boundary sub-array also contains three full depth moorings and one lander from the University of Miami, that were serviced on cruise AE-1404 on the R/V Atlantic Explorer in March 2014. Three changes were made to the this array during AE-1404. Mooring WB5 and WB5L at 71°59 W were not replaced and a new mooring WBC was deployed at 76°06 W. Thus the current US moorings are: WB0, WB3 and WBC. WB0 is located between WBADCP and WB1. WB3 is 13 km east of WB2 and so is a critical backup in case of loss of WB2. WBC is located mid-way between WB3 and WB4.

3.4 Results and data policy

All data and data products from this programme 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 `http://www.rapid.ac.uk/rapidmoc` and `http://www.rsmas.miami.edu/users/mocha/index.htm`). Data may also be obtained directly from `http://www.bodc.ac.uk/`.

4 Computing

Martin Bridger and Gerard McCarthy

4.1 TECHSAS data logger

Data were logged on Techsas from all GPS systems, underway instruments, and the ship's winch system. Further details about each of these is given in section 5.

The Techsas data logging system saves data in the self describing NetCDF format that can be easily read from Matlab programs or using the freely available NetCDF libraries. The time variable in the NetCDF files is the number of days since 30th December 1899 00:00:00 UTC. Techsas also broadcasts the logged data across the ships network in UDP NMEA packets.

The Level-C system logs the Techsas UDP packets in the Level-C binary format. It allows ASCII dumps of the data to be rapidly generated at custom intervals or averaging periods.

4.2 Scientific computing and data archive

An IBM workstation, `Banba`, running `SUSE` Linux was used for scientific processing and archiving of data. Each of the scientific staff used a Mac to connect to `Banba` via the ship's Ethernet or WiFi. The following disks were virtually mounted on Banba to enable access to the data on the ship's systems:

```
mount -t cifs //192.168.62.57/JC103/Ship_Systems/Acoustics
    /local/users/pstar/Acoustics --verbose -o user=cook/sciguest%sciguest

mount -t cifs //192.168.62.57/CTD /local/users/pstar/ctd
   --verbose -o user=cook/sciguest%sciguest

mount -t nfs 192.168.62.11:/data /local/users/pstar/NetCDF --verbose
```

Matlab version R2011a was installed on `Banba` and the `mstar` suite of Matlab routines was used to import and process data. Additional Matlab packages necessary for RAPID processing in Matlab are the signal processing, statistics and mapping toolboxes.

Samba was started on `Banba` to enable read and write access to the files on the local network.

This was the first outing for one of the pair of IBM sea-going workstations purchased for the group. The workstations are high spec in terms of memory and processing power: 40 GB of RAM, 8×2.4 GHz Intel processors. They have a 1 TB hard disk in mirror configuration.

The performance was somewhat slower than was hoped for. Processing of the MicroCATs from calibration dips was slow and users reported slow graphical processing. A speed test against Darren Rayner's MacBook Pro showed `Banba` to be slower in spite of having a higher specification. Traditional hard disks rather than solid state hard disks of the MacBook Pro were not a factor in the increased speed as, the MacBook was quicker when writing to the disk on `Banba`. The MacBook was also quicker to invert a large matrix in Matlab.

The workstation was rebooted twice during the cruise. First, to attempt to kill many ghost processes that seemed to have built up (including more than 40 Matlab sessions amongst 7 users). And second, as the machine had begun to use swap space memory and not release it. Virtual disks needed to be remounted following reboot.

An early problem with slow logon was found to be due to the workstation looking for a NIS server. This was solved by deleting the reference to the NIS server.

On previous cruises problems have been encountered when connecting external hard drives to a Linux workstation and so backups were made to disks connected to a Mac. Backups were made twice daily to one of two external hard drives. The `rsync` command was used to synchronise directories on Banba with directories on the external drives and to create a backup of files changed or deleted since the last backup using that disk. A logfile detailing the backup was stored on Banba in the directory `/noc/users/pstar/cruise/backup_logs`, where a copy of the backup script was also kept.

5 Underway Instrumentation

Martin Bridger

A list of instruments that were run while the ship was underway is given in Table 2 The processing of the underway data is described in section 6.

5.1 GPS navigation and attitude instrumentation

There are 5 GPS navigations systems on the RRS *James Cook* .

Applanix POSMV The Applanix POSMV is the primary GPS system used for science. The position output is the position of the ship's common reference point (the cross on the top of the POSMV MRU in the gravity room).

Seapath DPS200 Secondary poistion and attitude data. The position output is the position of the ship's common reference point (the cross on the top of the POSMV MRU in the gravity room).

Ashtech ADU5 The position output is the position of the antenna. This GPS is not referenced to any other systems. This system does not receive differential corrections.

DPS116 Ship's DP GPS with science output. The position output is the position of the antenna. This GPS is not referenced to any other systems.

CNAV GPS and RTCM Satellite Corrections Receiver. The position output is the position of the antenna. This GPS is not referenced to any other systems. It is primarily used to provide RTCM differential corrections to the other GPS systems.

5.2 Echo sounders

EA600 single-beam echosounder A 12 kHz Konsberg EA600 is fitted to the port drop keel as the primary scientific echo sounder. The EA600 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.

EM120 multi-beam echo sounder !The EM120 multi-beam echo sounder was run throughout the cruise to survey areas for mooring activities. Data was logged in Kongsberg .all format. Some areas were processed using Caris to get a better indication of actual depth in certain areas that had conflicting depth data. Resulting GoeTIFF and XYZ files were produced where necessary. Sound velocity profiles were derived from the CTD casts, and loaded into the EM120 when required.

5.3 Underway non-toxic water sampling system (Surfmet)

Near-surface oceanographic parameters were measured by sensors located in the non-toxic supply. These included fluorescence, light visibility (transmittance) of the surface waters, and a thermosalinograph (SB45 microTSG) measuring conductivity and housing temperature, based on which underway salinity was calculated in real time. In addition, a SBE38 Temperature Sensor, located in the inlet of the ship, was measuring remote temperature (i.e. sea temperature) at a depth of 5.5m below

Manufacturer	**Model**	**Function/data types**	**Comments**
Steatite	MM3S	GPS network time server (NTP)	Not logged but feeds times to other systems
Applanix	POS MV	DGPS and attitude	Primary GPS
Ashtech	ADU-5	DGPS and attitude	
C-Nav	3050	DGPS and DGNSS	
Kongsberg Seatex	DPS116	Ship's DGPS	Bridge GPS
Kongsberg Seatex	Seapath 200	DGPS and attitude	Secondary GPS
Sperry Marine		Ship gyrocompasses x 2	
Chernikeeff Instruments	Aquaprobe Mk5	Electromagnetic speed log	
Kongsberg Maritime	Simrad EA600	Single beam echo sounder (hull)	
Kongsberg Maritime	Simrad EM120	Multibeam echo sounder (deep)	
Kongsberg Maritime	Simrad EM710	Multibeam echo sounder (shallow)	Occasional Use
NMFSS	CLAM	CLAM system winch log	
NMFSS	Surfmet	Meteorology suite	
NMFSS	Surfmet	Surface hydrography suite	
		Skipper log (ships velocity)	
Teledyne RD Instruments	Ocean Observer 75 kHz	VM-ADCP	
Teledyne RD Instruments	Ocean Observer 150 kHz	VM-ADCP	

Table 2: Details of underway instruments that were operated during the cruise.

Time	**Details**
14 116 17:58	Salt water in the system for testing purposes
14 116 19:46	Flush System with fresh water
14 116 22:07	Start of Non-Toxic water measurements
14 119 12:54	Non-Toxic Switched Off
14 119 16:28	Non-Toxic Switched On
14 124 13:04	Off for cleaning
14 124 13:25	On after cleaning
14 126 12:37	Non-Toxic Switched Off
14 126 20:14	Non-Toxic Switched On
14 132 15:43	Off for cleaning
14 132 16:09	On after cleaning
14 133 09:34	Off for cleaning
14 133 09:56	On after cleaning
14 134 13:22	Off for cleaning
14 134 13:47	On after cleaning
14 139 11:08	Flush
14 139 15:26	Flush
14 140 13:15	Flush
14 142 10:15	Flush
14 151 13:48	Flush

Table 3: Times (given as YY DoY HHMM) at which the non-toxic supply was switched on and off.

the sea surface. The times at which the system was switched on and off are listed in Table 3.

6 Underway Data Processing

Eleanor Frajka-Williams, Maria Perez Hernandez, Neela Morarji, and Ben Moat

Underway data from the ship's fitted instruments include near surface velocities from the vessel-mounted acoustic Doppler current profilers (ADCPs), navigational data, bathymetry, near surface temperature and salinity, and meteorological data. Data were collected by the NMFSS Surfmet program. The TECHSAS (Technical Sensor Acquisition System) data logging system saved all data in NetCDF format that can be easily read using Matlab or using the freely available NetCDF libraries. The data files were then transferred to the cruise computer (`banba`), processed and calibrations applied using the `MEXEC` software package, v2.

Each day after 9 AM ship time (when the TECHSAS files from the previous day were completed), underway data processing was carried out. Processing was carried out using the `MEXEC` software package, v2, which involves transferring data files to the cruise computer (`banba`), and then running a number of steps to remove any periods where time stamps were running backwards, manually edit out spikes in some data fields, and then merge the best position (lat and lon) information onto different data streams. Generic processing steps are outlined in section 6.1. For some data fields additional corrections, calculations or calibrations were made (detailed in later sub-sections).

During the daytime, 2-hourly checks were made of the underway systems, to ensure that data were logging and reasonable. We began with 4-hourly checks, but at the start of the cruise, the 150 kHz ADCP data logging crashed frequently, and we switched to more frequent checks. The underway logsheet was used to verify that the ship's position was updating, both VMADCPs were updating, the echo sounder bathymetry and swath bathymetry were updating and reading similar values, the various streams of TSG and Met data were reasonable, and that the TECHSAS system itself was still writing files. We additionally checked the temperature in the controlled temperature (CT) lab where the crates of water samples were awaiting conductivity measurements by the salinometer, and that the non-toxic seawater supply was flowing in the CTD hangar. Bottle samples were taken 3 times a day from the non-toxic supply in the CTD hangar to calibrate the near surface salinity measurements.

6.1 Generic processing steps

The underway data were processed together, once a day, using the following generic processing steps. Additional steps for individual data streams are detailed further in the sections that follow.

1. Transfer data to the cruise computer: `mday_00_get_all.m`

   Raw data files were retrieved from the onboard logging system, TECHSAS, to the cruise computer (`banba`) system on a daily basis, using the `mday_00_get_all.m` script. Data files follow the naming convention `MMM_jc103_dNNN_raw.nc`, where `MMM` represents the data type/source (e.g. 'met' for surface meteorological data or 'cnav' for navigational data sourced from the CNAV system) and `NNN` represents the Julian day number.

Files created: `MMM_jc103_dNNN_raw.nc`

2. Remove bad time steps or aphysical data values: `mday_00_clean_all.m`

   The `mday_00_clean_all_jc103.m` script was run to remove repeated or backward time steps and produce edit files (`MMM_jc103_dNNN_edit.nc`).

   Files created: `MMM_jc103_dNNN_edit.nc`

3. Manually edit additional spikes in data: `mplxyed.m`

   Spikes in the meteorological and navigational data were removed by assigning an absent value using the `mplxyed.m` script. This script needs to be run in the directory containing the file to be edited (e.g. `met_tsg_jc103_d123_edit.nc`) in directory `met/surftsg`. When the ship's non-toxic intake was stopped, e.g. nearing Nassau or upon leaving Trinidad, the system was flushed with freshwater. These spikes can be seen in conductivity, fluorescence and transmittance, and were replaced with `NaN` values.

   Files overwritten: `MMM_jc103_dNNN_edit.nc`

4. Additional calculations (see sections below for further details)

   (a) Calculate salinity (`mcalc_salt.m`):
   Salinity was calculated from conductivity using the `mcalc_salt.m` script.
   Files created: `met_tsg_jc103_dNNN_cal.nc`
   and `met_tsg_jc103_dNNN_psal.nc`.

   (b) Calculate true wind (`mtruewind_01.m`):
   The ship's heading and speed were removed from the anemometer wind measurements (which measure wind relative to the ship).
   Files created: `wind_jc103_dNNN.nc`

5. Merge navigational data onto other data fields: `mmerge_nav_all.m`

   The most accurate GPS system for positional accuracy was chosen and merged with the daily met/tsg data via the `mmerge_nav_all.m` script (for further information, see the section entitled GPS Positional Accuracy below). The distance run data calculated from the navigation files were also merged onto the bathymetry data by the script. Water depths were corrected using the Carter tables, which roughly takes into account sound speed variation as a function of position.

   Files created: `MMM_jc103_dNNN_merged.nc`

6. Create a single file for the full cruise: `mapend_all.m`

   The `mapend_all.m` script accumulates each data stream over several days. Output is averaged into 5 km bins. The script also created figures for the data.

   Files created: `MMM_jc103_01.nc`

At the end of the cruise, additional calibrations were applied to the appended files (`MMM_jc103_01.nc`), including using the bottle salts to calibrate salinity, and applying recent manufacturer's calibrations to the light data. See the sections below for further details of additional processing.

6.1.1 Changes from previous processing

On JC103, underway data processing differed from previous RAPID cruises in a few ways:

- Only one surface temperature/salinity data file was processed:

  Files created: `met_tsg_jc103_dNNN_01.nc`

  This file contains all the fields which were previously contained within the `met_tsg` and `tsg_` files: (`temp_r`, `temp_h`, `cond`, `psal`, `fluor`, `trans`, `sndspeed`, etc). In previous versions, `met_tsg_jc103_dNNN_01.nc` contained: `temp_r`, `temp_h`, `cond`, `fluor` and `trans` , and `tsg_jc103_dNNN_01.nc` contained `temp_r`, `temp_h`, `cond`, `psal` and `sndspeed`. With the combined file, the data need only be despiked with `mplxyed.m` once.
- In previous cruises, the ASHTEC and GYRO were combined to create a best heading data stream. This was carried out in several steps (`mgyr_01.m`, `mash_01.m` and `mash_02.m`). From the checks undertaken on JC103, it was determined that the best heading came from the Seapath 200 sensor (called `ATTSEA` by the MEXEC software) and so it was determined that the merging of Adu5pat (called `ASH` by the MEXEC software) and GYRO were legacy and no longer needed.
- The previous RAPID cruise on the RRS *James Cook* (JC064) used `POSMVPOS` for the positional information. Using data from when the ship was in port, we determined that the `CNAV` provided finer resolution and used it for the "bestnav" data stream.

6.1.2 List of significant events

Table 4 lists notable events in underway acquisition and processing.

6.2 TSG underway data

Surface water properties are measured from seawater in the non-toxic supply. The intake is approximately 5.5 m deep with a flow through of approximately 24 L/min. Flow to instruments is degassed using a debubbler. A temperature sensor at the intake (the remote temperature, `temp_m`) measures the temperature at about 5.5 m deep. Pipes carry the water from the intake to the CTD hangar where additional properties are measured. The intake was stopped several times—upon leaving Trinidad, entering Nassau (two occasions) and entering Tenerife. These events are list in Tables 3 and 4 . On several occasions (including when the intake was turned off), the system was flushed with freshwater, which appears as near zero conductivity and drops in the fluorescence, and elevation in the transmissivity.

Data	Date	Notes
Non-toxic	113–116.7	Off (no flow)
Met	115.6	Port TIR and PAR sensors were shadowed by putting hand over the sensor. Readouts from both port sensors dipped on the display.
TSG	115.7	TSG was cleaned in preparation for starting sampling
Bathymetry	116.2–116.5	Echo sounder was reading too deep (in the 7000s, while the swath was around 5000–6100 m).
Non-toxic	116.7	Flush with freshwater and briefly turned on.
Non-toxic	116.7–116.9	Water intake was off
Non-toxic	116.9	Start of non-toxic water measurements
TSG bottles	117.2	First TSG bottle samples were taken
Non-toxic	119.5–119.7	TSG was off due to proximity to Nassau
Non-toxic	124.4	**TSG cleaned**
Non-toxic	126.1–126.7	Off near Nassau
Non-toxic	132.6	**TSG cleaned**
Non-toxic	133.4	**TSG cleaned**
Non-toxic	134.6	**TSG cleaned**
Non-toxic	134.5	A small snail was noticed in the 24 L/min intake regulator. It had likely been there a while, but only noticed when it made noise as it spun. Martin removed it.
Non-toxic	139.4	Flushed with freshwater
Non-toxic	139.7	Flushed with freshwater
Non-toxic	140.6	Flushed with freshwater
Non-toxic	142.4	Flushed with freshwater
Non-toxic	151.6	Flushed with freshwater. The fluorometer and transmissometer were flushed with freshwater after some apparent upwards drift in the data. Afterwards, there was a large drop in the values. This may also indicate that some of the previous data were suffering from similar problems–likely growth in the system.
Bathymetry	146–150	Wind and weather picked up, resulting in noisier data on the echo sounder.
Bathymetry	149	The echo sounder machine rebooted overnight. In restarting the software, the settings were different and we could not determine what the previous settings were. However, depth readings appeared reasonable and less noisy.

Table 4: Significant events in the underway data.

6.2.1 Additional processing steps

- Calculate salinity: `mcalc_salt.m`

  This step calculates the salinity from the temperature and conductivity data. It is performed after `mday_00_clean_all.m` and before `met_tsg_jc103_dMMM_cal.m`.

  Files created: `met_tsg_jc103_dMMM_psal.nc` and `met_tsg_jc103_dMMM_cal.m`

- Merge variables for sound speed: `mmerge_tsg_all_jc103.m`.

  This step takes the `met_tsg_jc103_dMMM_psal.nc` file and merges onto it the `sndspeed` variable from the `tsg_jc103_dMMM_edit.nc` file.

  Files created: `met_tsg_jc103_dMMM_edit.nc`

6.2.2 Bottle salts from TSG

From day 116 through day 150, bottle samples were collected from the seawater supply in the CTD hangar. From day 116–146, the samples were taken 3 times a day at 8 AM, 2 PM and 8 PM ship-time. For the final few days, 147–150, samples were taken twice a day (8 AM and 8 PM). Bottles were rinsed 3 times with freshwater, then flushed 3 times with salt water, before being filled and capped. The time at capping was recorded to match up with the underway data stream. Once a crate was full (about every 8 days) it was deposited in the controlled temperature lab for at least 24 hours at approximately 18°C before the samples were run through the salinometer. The same processing steps were used as for the CTD bottle salts.

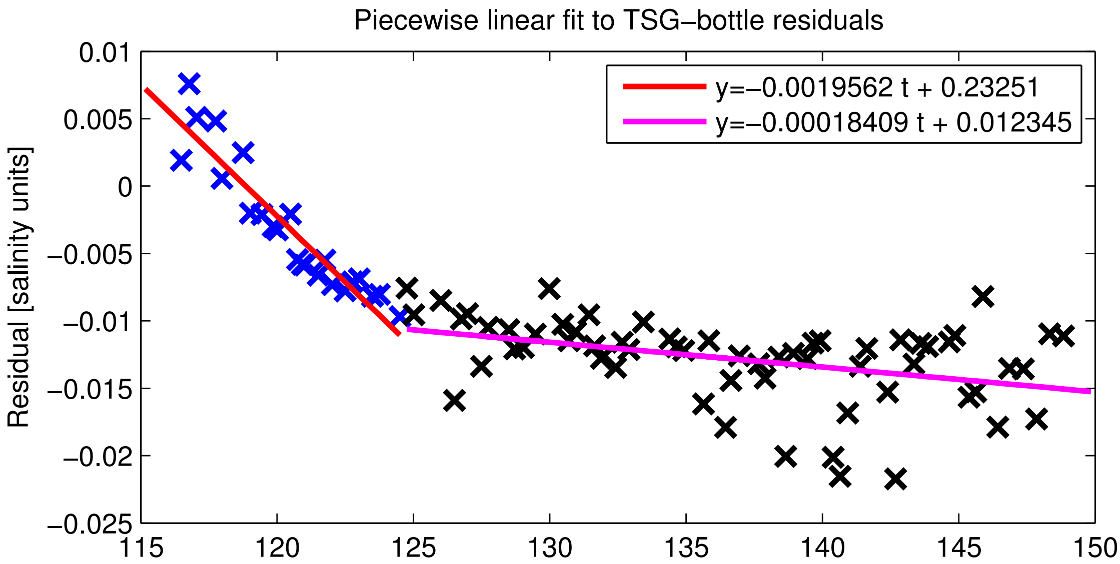


Figure 5: Bottle salts and residual from underway measurements, after throwing out outliers. The TSG was cleaned at day 124.

- Format salinometer data in spreadsheets. Spreadsheets were copied to `banba` and formatted according to what was expected by the `MEXEC` software. They were edited to include a column for time of the bottle sample (in JJJHHMMSS, where JJJ is julian day, HH is hour, MM is minute and SS is second) except in the case of the standard seawater samples, where a sample order number of `999YYY` was used, where `YYY` was the sequence number for the standard bottles.

Files created: `tsg_jc103_XXX.csv`, where `XXX` is the crate sequence.

- Apply salinometer drift to bottle data: `mtsg_01.m`

  The salinometer drift was determined from the standards run at the beginning and end of each crate (See §8). For each crate, `mtsg_01.m` was run, applying the salinometer drift to the bottle samples. (Crate 001, 0.00011; crate 002, 0.00012; crate 003, 0.00014; crate 004, 0.00015.) A netcdf file of the data was created.

  Files created: `tsg_jc103_XXX.nc`

- Create 1-minute averages of underway data, excluding bad data: `mtsg_medav_clean_cal.m` and `mtsg_findbad.m`

  Run `mtsg_findbad.m` which allows bad periods to be graphically excluded. Edit `mtsg_cleanup.m` to hard-code in the "bad" periods (i.e. when the non-toxic supply was near port, or off for being cleaned). After graphically-removing and hard-coding the bad periods, create 1-minute averages of the good data using `mtsg_medav_clean_cal.m`.

  Files created: `met_tsg_jc103_01_medav_clean.nc`

- Extract contemporaneous underway data for the bottle times: `mtsg_bottle_compare.m`.

  Using the time of the bottle sample, the corresponding underway measurements from the instruments on the non-toxic supply were extracted for a direct comparison. From the residuals, a correction was determined to be applied in the next step.

  Files created: `met_tsg_jc103_01_medav_clean_botcompare.nc`

- Apply salinity calibrations to the `met_tsg_*` files using `mtsg_apply_salcal.m` which needs `mtsg_salcal.m`

  After determining the best fit to the residual salinities, in terms of temporal drift or temperature dependence, this calibration was applied to all the underway TSG data.

  Files created: `met_tsg_jc103_01_medav_clean_cal.nc`

6.2.3 Comparison between near surface temperatures from TSG and CTD

While bottle samples are used to check the salinity measurements, temperature measurements are typically considered to be good. As an extra check, we compared the temperatures from the underway (approximately 5.5 m deep in the forward part of the hull) to the CTD measurements from casts between 5.25–5.75 m, on both the up- and down- casts. For this comparison, the CTD files of the form `ctd_jc103_001_psal.nc` were used which include 1 Hz averages. This meant that there were several points on the downcast to compare to the underway data and 1 point on the upcast. The Underway data compared are 1-minute averages nearest in time to the CTD samples.

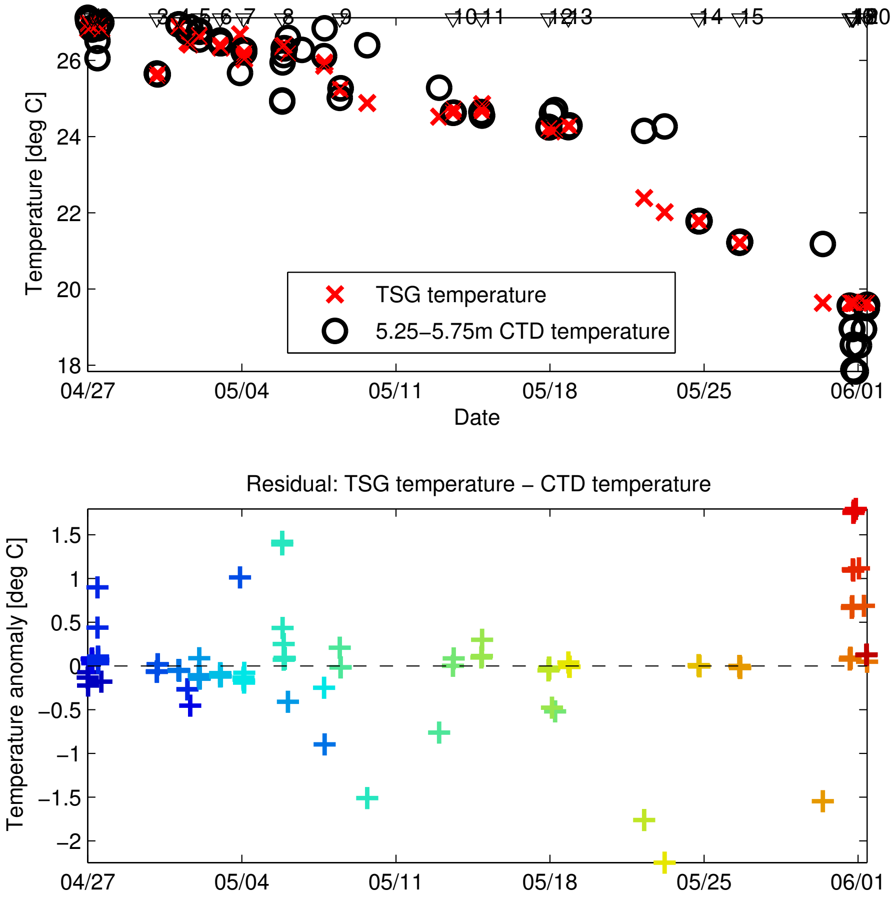


Figure 6: Sea surface temperatures from the TSG and CTD.

6.3 Meteorological underway data

Surface meteorological data logged on the RRS *James Cook* includes photosynthetically active radiation (PAR), total irradiance (TIR), wind speed and direction, humidity, air pressure, and air temperature. The instruments are located on the foremast to try to keep them somewhat away from the ship and the ship's boundary layer. Most of the surface meteorological data have calibrations applied (where necessary), excepting the light sensors. These calibrations were applied afterwards as part of the processing (see §6.3.1). Wind speed and direction is measured relative to the ship, so if the ship is moving quickly through stagnant air, the speed will match the ship's speed, and the direction the inverse of the ship's course. The ship's position and heading were removed from the wind data (see §??).

6.3.1 Additional processing steps for the met data

- Applying calibrations to the light data (PAR and TIR): `mmetlight_01_jc103.m`

  Applies the calibrations from the cal sheets to the port and starboard PAR and TIR data. This script previously ran on the daily files, but was updated to run on the `*01.nc` file instead at the end of the cruise.

  Files created: `met_light_jc103_01_cal.nc`

- Calculate true wind (`mtruewind_01.m`):

  This step was carried out after the `mplxyed.m` step and before the `mmerge` step. The ship's heading and speed were removed from the anemometer wind measurements (which measures wind relative to the ship).

  Files created: `wind_jc103_dNNN.nc`

6.4 Bathymetry

There were two main bathymetry systems in use on JC103: the Kongsberg EA600 single beam echo sounder and the Kongsberg EM120 Multibeam echo sounder. The former produces a single estimate of depth a few times a minute, while the latter makes swath (covering spatial area) estimates of bathymetry. Both the EA600 and EM120 transmit at 12 kHz which is standard for deep ocean sounding, though they experienced interference with bubble noise when the weather became rougher near the end of the cruise, and ship noise–particularly from the bow thruster. Since the frequency is near that used for the acoustic releases for the moorings, the acoustics (EA600 and EM120) were both switched off during acoustic release tests or when releasing or triangulating moorings.

The acoustic systems on the ship were synchronised with the K-Sync module. Since it was a relatively new addition to the RRS *James Cook* , the VMADCPs were not yet integrated, and only the echo sounder and swath bathymetry were controlled by it. There were several different profiles that could be used. We tended to use the setting for "full ocean depth > 5000 m and < 12000 m", which allowed longer times for the echos to be heard from the seabed.

Occasionally, when a response wasn't heard from the echo sounder for 3 pings or more, it went into STANDBY mode on the K-Sync switch and was no longer being triggered. When this happened, it was necessary to return the instrument to active mode at the K-Sync switch.

We did no additional processing on the swath bathymetry, but did edit the echo sounder data for bad data, and made corrections for the speed of sound (see 6.4.1).

6.4.1 Additional processing: Carter table corrections

Echo sounder data (`SIM` in MEXEC) were processed through the same steps above. Additionally, in the `mapend_all` step, the Carter table correction for depth was applied given the latitude and longitude of the measurement.

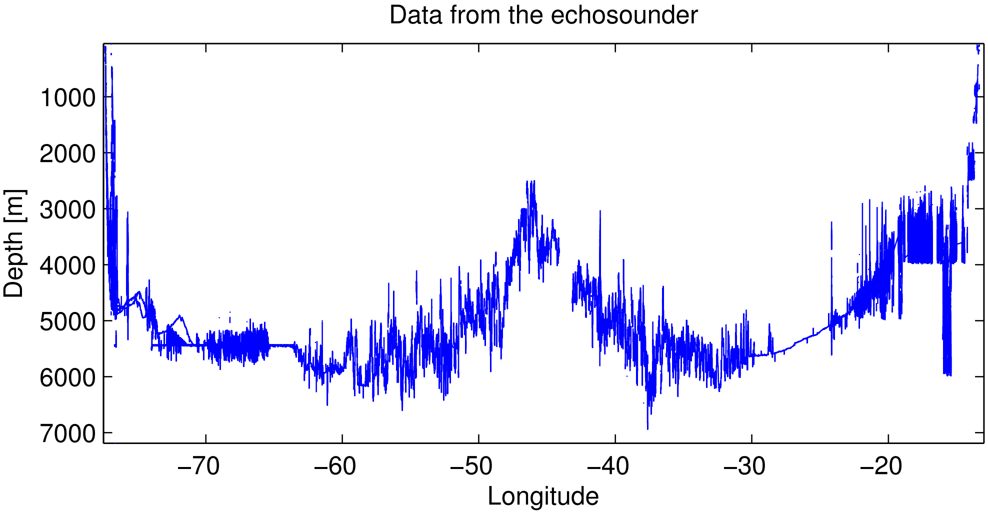


Figure 7: Bathymetry across the Atlantic from JC103. Problems with the echo sounder data are apparent east of 20°W.

6.4.2 Troubleshooting data logging

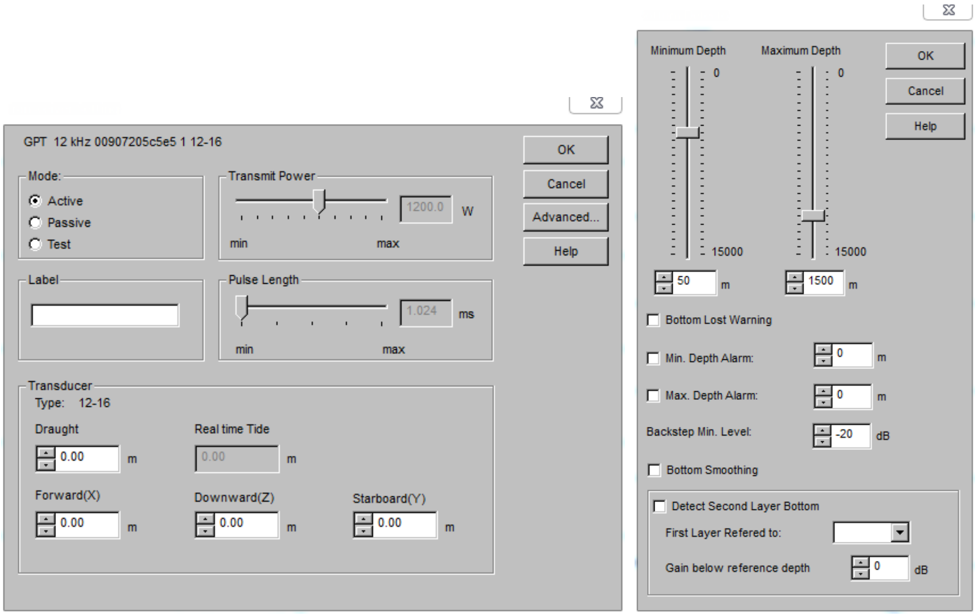
We used several strategies for dealing with poor data quality from the echo sounder. We changed the transmit power and pulse length. The menu if Fig. 8 (left panel) is accessed by right-clicking on the "12 kHz" square in the upper left corner of the screen. For deeper water depths, or rougher weather, we tended to increase the transmit power and the pulse length. In shallow water, these were both reduced. The other main setting that was adjusted was the minimum and maximum water depth (see Fig. 8, right panel). These settings could be narrowed to force the echo sounder to pick a bottom depth between the two depths and thus ignore any later (apparently deeper) echoes.

6.5 Navigation

RRS *James Cook* has several navigation systems (see below). The navigational data is used to locate the underway measurements in space, while the ship's speed and heading allow for absolute estimates of current and wind velocities rather than estimates of velocities relative to the ship's motion. The outputs from each of the GPS systems were logged by the TECHSAS and Level-C data loggers. Their operation is monitored either from the main lab or the bridge.

Applanix POSMV. Files `pos_jc103_*.nc` in directory `nav/posmvpos/`

> The Applanix POSMV system is located on the bridge mast and its common reference point is in the gyro/gravimeter room in the centre of the ship. Three data streams are output by the RVS system at 1Hz; 'posmvpos' contains data regarding the position of the ship: 'posmvtss' contains heading information; 'gyropmv' contains heading information rounded to 1 decimal place and is not analysed in this report.



GPT 12 kHz 00907205c5e5 1 12-16

Mode:
● Active
○ Passive
○ Test

Transmit Power: 1200.0 W

Label:

Pulse Length: 1.024 ms

Transducer
Type: 12-16
Draught: 0.00 m
Real time Tide: 0.00 m
Forward(X): 0.00 m
Downward(Z): 0.00 m
Starboard(Y): 0.00 m

Minimum Depth: 50 m
Maximum Depth: 1500 m
☐ Bottom Lost Warning
☐ Min. Depth Alarm: 0 m
☐ Max. Depth Alarm: 0 m
Backstep Min. Level: -20 dB
☐ Bottom Smoothing
☐ Detect Second Layer Bottom
First Layer Refered to:
Gain below reference depth: 0 dB

Figure 8: Echosounder settings for 1000 m of water. (Left) This menu is accessed by right clicking on the “12 kHz” square in the upper left corner of the screen. (Right) This menu is accessed by right clicking on the top bar behind the depth reading.

Seapath DPS200 system. Files `seapos_jc103_*.nc` in directory `seapath200`, and files `nav/attsea_jc103_*.nc` in directory `nav/attsea`

The Seapath 200 system serves as another source for GPS position and attitude. Like the Posmvpos system, the Seapath 200 antenna is located next to the bridge mast and has its common reference point in the gyro/gravimeter room. Two data RVS streams are available: ’seapos’ for the position of the ship; ’attsea’ for the attitude.

Ashtech ADU5. Files `ash_` in directory `nav/ash`

Ashtech is a GPS attitude determination and real-time positioning system. The position output is the position of the antenna. Thus, the Ashtech instrument is located on the Bridge deck on the starboard side. This GPS is not referenced to any other systems and doesn’t receive differential corrections. Ashtech provides heading, pitch and roll along with three-dimensional position and velocities at a rate of up to 5 Hz.

DPS116. Files `dps116_` in directory `nav/dps116`

The DPS 116 navigation system is located in the bridge mast, it does not provide heading data. It has one antenna for the position. Data are logged in the TECHSAS NetCDF files. The position output is the position of the antenna. This GPS is not referenced to any other systems.

CNAV. Files `cnav_` in directory `nav/cnav`

The CNAV antenna is located on the mast of the ship. It only provides the position and the data are characterised by good resolution, i.e. about 5 cm.

The position output is the position of the antenna. This GPS is not referenced to any other system. It is primarily used to provide RTCM differential corrections to the other GPS systems.

Gyro compasses. Files `gyr_` in directory `nav/gyros`, and files `gyp_` in directory `nav/gyropmv`

The ship's gyrocompasses provide reliable estimates of the heading (i.e. they are not dependent on transmissions external to the ship). However, the instruments are subject to an error which is dependent on latitude, on heading and an inherent oscillation following a change in heading. There are two Gyros on the ship. The bridge officers manually check gyro data for accuracy using an independent directional reference—the sky, using the observed and calculated azimuths and amplitudes of a celestial body—and comparing the gyros with each other. Presently, the gyros were out by about 0.5°.

6.5.1 Additional processing steps for navigation data: Appending files and 'bestnav'

Of the navigational data streams, only CNAV was edited using the `mplxyed.m` script, since it was deemed to have the greatest positional accuracy (for further information, see the section entitled GPS Positional Accuracy below).

- Additional processing step for navigational data, after `mapend_all.m` is run.

  The best navigational data stream was created using `mbest_all.m`: The `mbest_all.m` script isolates the best navigation data; `mbest_01.m` creates a 30-second 'nav' file from 1-Hz positions; `mbest_02.m` calculates the speed, course and distance; `mbest_03.m` creates a 30-second heading file from 1-Hz positions; `mbest_04.m` merges vector-averaged heading onto the average speed and course.

  Files created: `bstnav_jc103_01.nc`

6.5.2 GPS accuracy

Position data gained from each of the navigation systems, whilst moored in the Port of Spain, were plotted in order to determine their distribution and allow comparison.

The data were obtained for 21st April 2014 covering a full day. Figure 9 shows the difference in meters across longitude and latitude with the median chosen as the central reference point. It is evident that the Posmvpos, Seapath200 and DPS116 systems all log data in beams, with a similar resolution, though Seapath200 is marginally the better of the three. CNAV and Ashtech display a more detailed resolution, but Ashtech exhibits greater spread. Ashtech appears to be the least accurate, with a greater deviation from its median. CNAV, Posmvpos and Seapath200 exhibit a higher concentration of points, with excursions within 2 meters.

The last subplot is a comparison between each GPS system for the period of mooring in the Port of Spain, allowing easier comparison of the spread for each system.

The location of each GPS system, the orientation of the ship and its pitching and rolling explain the distance between the data points. The locations from the Seapath200 and Posmvpos coincide since they are translated to the gravimeter room. DPS116 and CNAV also overlap, though with a slight offset of their centres, as their antennas are located on the top of the ship's mast. The Ashtech system is located on the Bridge deck on the starboard side.

The most accurate GPS system appears to be CNAV, as it has the finest resolution and the least spread. CNAV latitude and longitude values were therefore chosen as the preferred values to be merged with the daily met/tsg data via the `mmerge_nav_all.m` script.

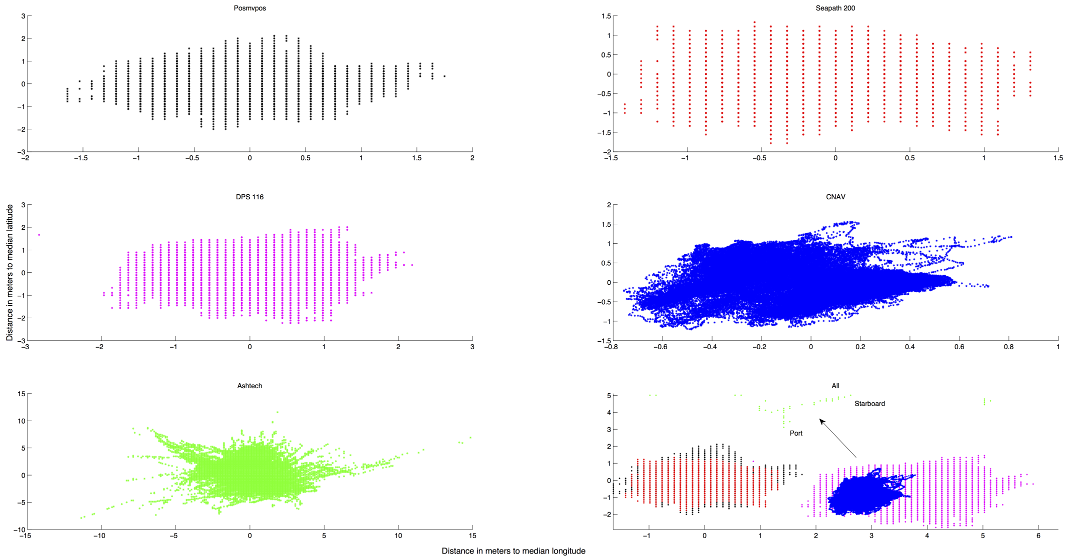


Figure 9: Scatter of the navigation data from the individual GPS systems on the RRS *James Cook* while moored in the Port of Spain. The last plot (in the bottom right corner) is a comparison of different GPS systems on the RRS *James Cook* , where the orientation is indicated with an arrow.

6.5.3 Heading accuracy

Heading data for a full day, 9th May 2014, whilst travelling eastward can be seen in Figure 10. With the exception of CNAV, the data for all systems that log the heading are broadly similar. The Seapath200 and Gyro systems display marginally less noise. Of these two systems, Gyro appears to have a slight offset of 1 degree (as is evident in the last subplot that displays a comparison of the two systems side-by-side), therefore, Seapath200 is the preferred system for heading data and was therefore the chosen heading, in the `mbest_03.m` script, for creating the 30-second heading file from 1-Hz positions.

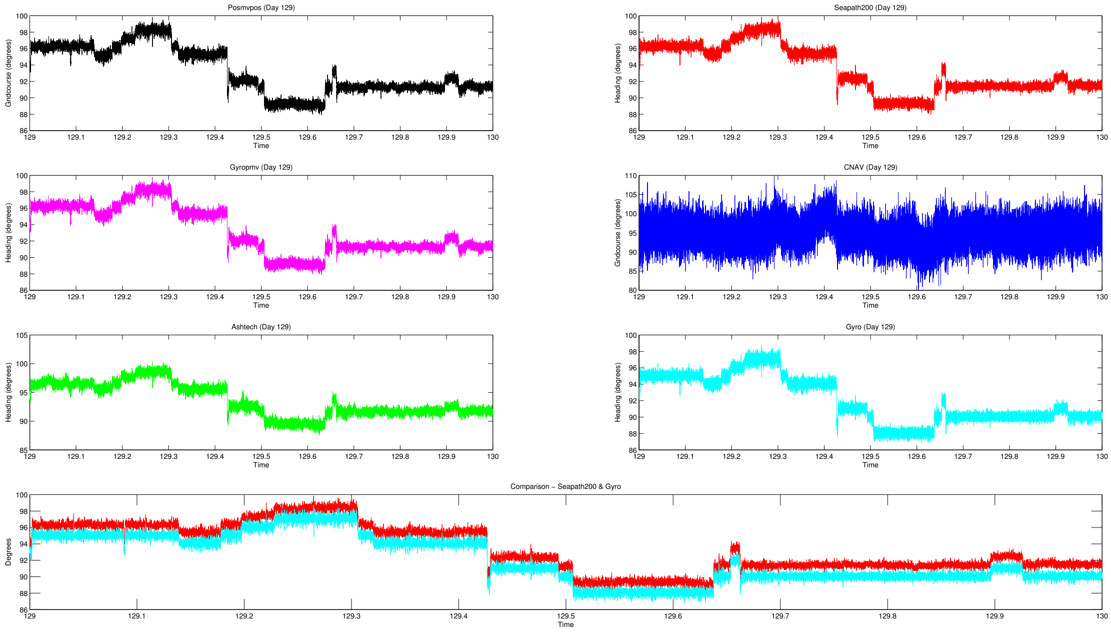


Figure 10: Plot of the heading from the individual GPS systems on the RRS *James Cook* whilst sailing approximately eastward. The last plot (in the bottom right corner) is a comparison of the Seapath 200 and Gyro data.

6.6 Vessel Mounted Acoustic Doppler Current Profiler (VMADCP)

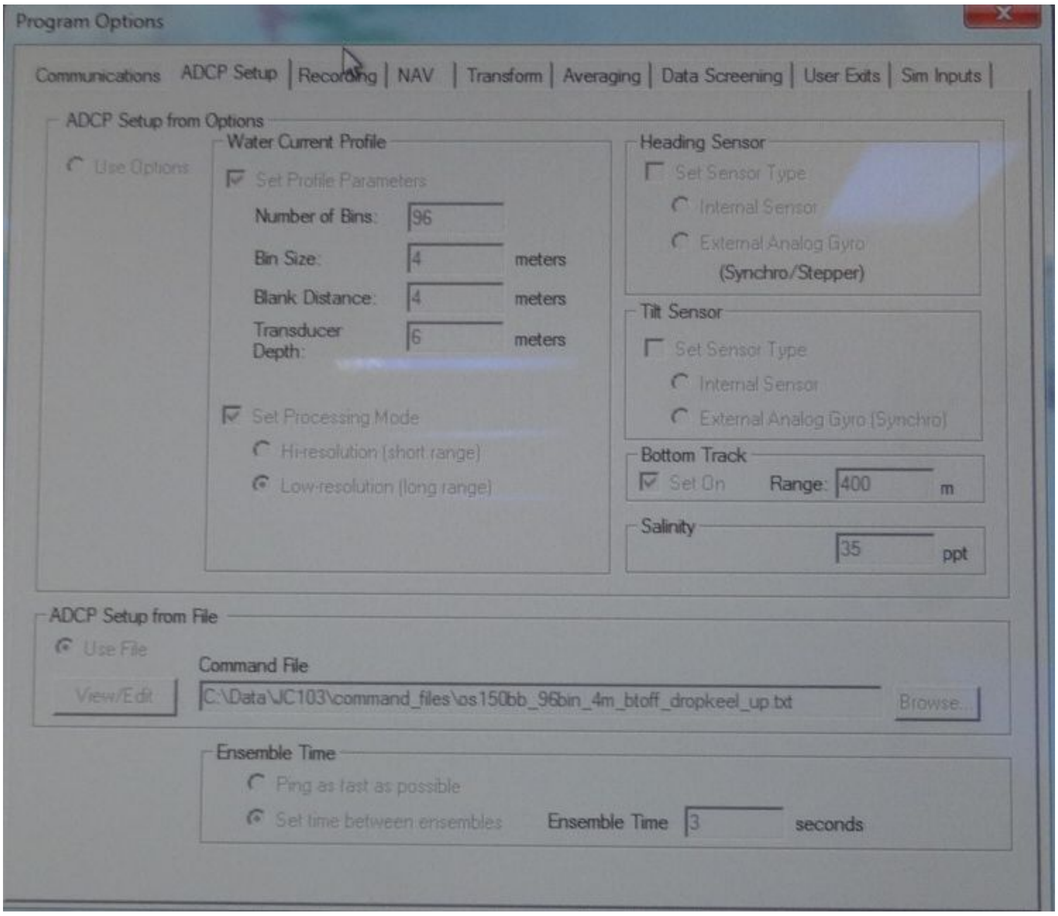
6.6.1 Overview

RRS *James Cook* has two Acoustic Doppler Current Profilers (ADCP) of 75 and 150 kHz mounted on the ship drop-keels. These instruments measure the horizontal velocity profiles relative to the ship, and down to about 1000 m. Since the velocities were relative to the ships position, and direction is relative to the ships heading, the velocities and directions were offset by the heading and position from the `posmvpos`. These NMEA streams were fed directly into the computer recording the ADCP data.

During JC103 the 75 kHz was run in narrowband mode, while the 150 kHz was run in broadband mode. With the configuration used (see Section 6.6.2), the 75 kHz provided data down to 1000 m at a vertical resolution of 16 m. The 150 kHz gave profiles at 4 m resolution down to about 300 m. The software used to record the data is the Teledyne RDI VmDAS for both VMADCPs.

Most of the processing was done following the steps in JC064. Primary differences in setup and processing include:

- The 150 kHz was run in broadband mode rather than narrowband.
- The processing was altered to fix a problem due to drift of the PC clock relative to GMT. This is detailed below in Section 6.7 . This necessitated a change in file structure and processing steps.
- Rotation angles were found to be slightly different from those found on JC064 (see Table 5).



○ Use Options

☑ Set Profile Parameters

Number of Bins: 96

Bin Size: 4 meters

Blank Distance: 4 meters

Transducer Depth: 6 meters

☑ Set Processing Mode

○ Hi-resolution (short range)

● Low-resolution (long range)

☐ Set Sensor Type

○ Internal Sensor

○ External Analog Gyro (Synchro/Stepper)

☐ Set Sensor Type

○ Internal Sensor

○ External Analog Gyro (Synchro)

☑ Set On Range: 400 m

35 ppt

● Use File

Command File: C:\Data\JC103\command_files\os150bb_96bin_4m_btoff_dropkeel_up.txt

○ Ping as fast as possible

● Set time between ensembles Ensemble Time 3 seconds

Figure 11: Locating the VMADCP Command File.

6.6.2 Software Configuration

Initially the software requires a command file that will configure the software for the way we want to measure. The command file specifies the narrowband or broadband mode, the bin sizes, and whether bottom tracking is on or off. Typically, in water shallower than 1000 m, bottom tracking was set to on. Bottom tracking allows the ADCP to estimate the speed and heading of the seabed relative to the ship, which allows an estimate of the rotation angle of the ADCP instrument relative to the ship direction. The bottom track will be needed later to calibrate. An example command file can be found in Appendix C. To add a new command file, we go to options/view data options/ADCP Setup/ADCP Setup from file/ browse as Figure 11 shows.

6.6.3 Data Acquisition

To begin the acquisition of data the blue triangle that is found below `file`, needs to be clicked (see Figure 12). While to stop an acquisition the blue square button on the right of the blue arrow is needed (Figure 13). There are 3 different ways to visualize the data: real time data (pushing the button with the R that is found below `chart`), the short term average (S button on the right of the one before) and longterm data (L button on the right of the one before). Normally

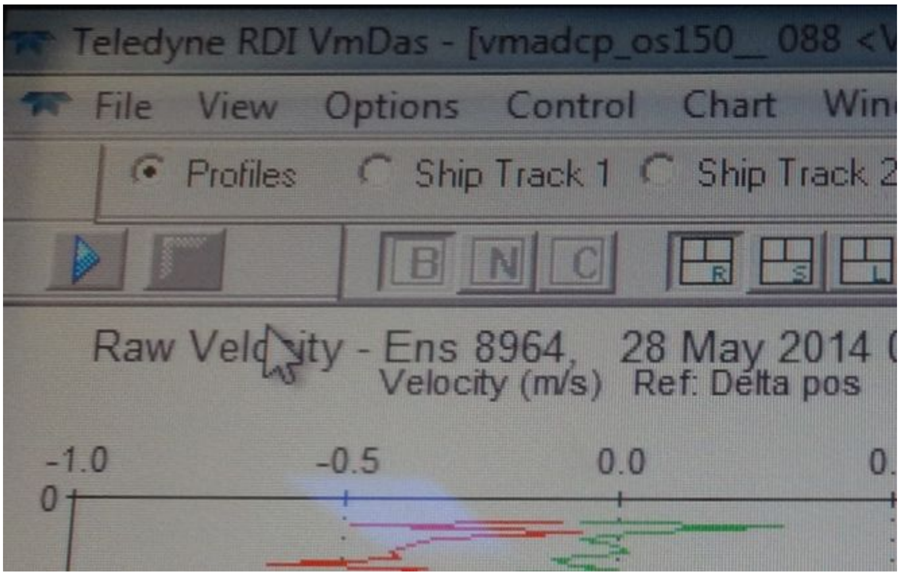


Figure 12: Locating the button that starts the acquisition of data.

the data was displayed in real time to see any posible incidents as soon as posible. Incidents like a frozen computer or a gap in the recording, might not be sensed in the longterm average display. Daily files are recorded under a sequence number, in `computer/localDisk(C:)/data/JC103/raw_data`. Some days might have more than one file due to a necessity of stopping the recording, e.g. changing bottom track to on/off or because the computer/software frozen and needs to be restarted. A copy of the raw files needs to be made on the `banba` sever at the end of each sequence file in `banba/rpmoc/jc103/data/vmadcp/jc103_osX/rawdata` where X stands for 75 or 150 depending on the vamadcp

A log sheet contained the details of each file. On paper the start/end day and time needs to be written in Julian days and GMT (to have a consistent time reference, that does not change along the cruise, in all the measurements) respectively together with the sequence number, ENX number and the ensemble number (it appears on the title of the figures displayed in the software after `ENS`) and any incident.

6.6.4 Post-processing

The processing is done using the Common Ocean Data Access System (CODAS) suite developed by the University of Hawaii. For this stage another log sheet exists. On this we must check that every step of the processing route is done. For this report the processing will be done using the example of sequence 2. The processing is completed on `banba`, the cruise computer. The whole processing is carried out in Matlab with the functions `vmadcp_proc2` and `mcod_ctdall_0304`. The function `vmadcp_proc2` accomplishes the following steps:

1. Create the folders with the raw data. To do this, the program uses `vmadcp_linkscript` that creates a folder with `rawdataXXX` where XXX is the sequence number, and copies in all the files with that sequence number. Next, a loop counts how many .ENX files the folder contains and creates, for

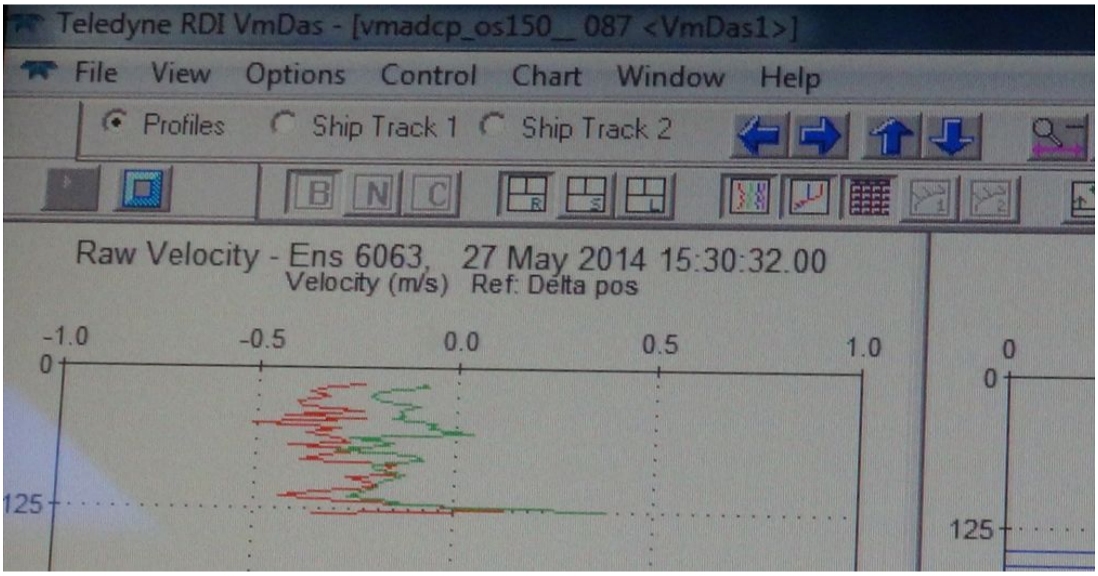


Figure 13: Locating the button that stops the acquisition of data.

each of them, a folder with their sequence number and ENX number (e.g. `rawdata_002_000`, will be the folder of the raw data with sequence number 002 and ENX number 0000000) and copies them inside.

2. Create the processing folder. This folder will have the same inner folder structure as all the processing folders. This step is carried out with the function `adcptree.py jc103002_000nbenx datatype enx`.
   This new folder `jc103002_000nbenx` will contain the folders `adcpb, cal, contour, edit, grid, load, nav,` `ping, quality, scan, stick and vector` needed for developing the processing.

3. Make the control files: q_py.cnt and q_pyedit.cnt. These files contain the name of the raw data and processing folder, the angle to rotate the velocities, and the settings in which each VMADCP is running. An example of these files can be found in the appendix (Figure 25).

4. The real processing is done in this step using the function `quick_adcp.py --cntfile ../q_py.cnt` that needs to be run inside the main folder created in step 2. This will develop the next steps of processing:
   I. Scan data
   II. Loads data into codas database
   III. Creates suitable setup files for editing
   IV. Run setflags
   V. Get fixes from load/*.gps2 files
   VI. Get heading correction
   VII. Rotate
   VIII. Run adcpsect
   IX. Run refabs
   X. Get smoothed navigation

XI. Put smoothed navigation back into database
XII. Plot reference layer
XVII List temperature and plot it
XVIII Bottom track and watertrack calibrations
XVIIII Make matlab files
Never run this step twice, it will rotate the velocities twice and their magnitude augments considerably.

5. Then the program uses the GUI `gautoedit` to check the results. The GUI runs inside the edit folder. The `autoedit` GUI contains several options for visualizing the data that appears when selecting the button `show now`. It also allows the user to remove bad data (peculiar or different to their neighbours measurements and with a low percent of confidence) by choosing the button `del bad times`. Once the selection of bad times/data is done, to save them the button `list to disk` is used. The default settings that appear in the `gautoedit` GUI are saved automaticaly, any other change done either with the option `del bad times` or by changing the default numbers of the GUI, needs to be saved.

6. The edited file is processed using the function `quick_adcp.py --cntfile q_pyedit.cnt`. This reprocessing acts on the ADCP data with the bad data removed.

7. Generation of a file that contains also the ship position, speed, measured velocities and scalar water speed. This is done by running the matlab functions `mcod_01` and `mcod_02`. The first one will introduce most of the already described new variables, while the second includes the scalar water speed.

8. The last step merges all the existing processed files into one. The matlab function responsible for this is `mcod_mapend2`. The final file with all the data is called `os75_jc103nnx_ctd_001_ave.nc`

Once all the processing is done, the file is broken into two different files by using `mcod_ctdall_0304`. This function will generate two files: one that will contain the VMADCP data recorded during CTD stations (e.g. `os75_jc103nnx_ctd_001.nc` is for the CTD station 1) and another that will have only the data between CTD stations (e.g. `os75_jc103nnx_stn001_to_stn002.nc`, file with the data between the CTD stations 1 and 2). This function can be run in three different ways: for a single CTD station, for all the CTD stations or for new stations without doing the previous or for a determined number of CTD stations.

6.7 Calibration

Running the VMADCP with the bottom track on provides information about the angle in which the instrument is oriented with respect to the ship. The VMADCP estimates velocities north-south and east-west using the navigation systems on board, referenced to the centre of the ship. Knowing the angle the instrument has with this reference, allows a correction in the angle in which velocities are estimated. Not

Table 5: Rotation Angles and amplitudes

	75 kHz			150 kHz		
	median	mean	std	median	mean	std
amplitudes	1.0021	1.0026	0.0030	1.0030	1.0041	0.0034
phase	−10.2364	−10.2267	0.1145	−1.5263	−1.5258	0.2191

projecting the velocities to the right angle will considerably change the magnitude of the velocities. To calibrate the VMADCP several files made with the bottom track on are needed, for the first calibration the sequence files 2 and 3 of both VMADCPs were used. These files are copied into a folder called `rawdata000`, after processing them the name was changed to `rawdata_bomtrkon` to be consistent with the next step 1, so that the raw data folder matches with the processing folder. To calibrate we have to:

1. Process all these data with bottom track on together following the same steps develop in Section 6.6.4, but as we don't want to break it into sequence numbers and ENX numbers, we will do the processing with the function vmadcp_proc. The processing folder was temporally called `jc103000nbenx`, but after the name was changed to `jc103bottomtrack_benx`. This is done to avoid merging it (with the function `mcod_mapend2`) with the current data as they will have the same name structure Not doing this will imply that the final file with all the merged estimations will have repeated segments
2. Take the angle by going into the folder `banba/cruise/data/vmadcp/jc103_os75/jc103002nbenx/cal/botmtrk` and opening the file `btcaluv.out`
3. Edit the file `q_py.cnt` created inside `vmadcp_proc2` and write the new rotate angle and amplitude observed in Table 5

A list of significant events

1. Every so often each of the VMADCPs froze. Occasionally, the recording software for the VMADCP crashed. There were several different types of crashes:
    (a) The data stopped recording, but the VMDAS software was still responsive. In this case, the `stop` button was pressed, and then a new file started.
    (b) The data stopped recording and the `stop` button was unresponsive. In this case, the software could be restarted. Sometimes, however, even after a restart, the data would not record.
    (c) The computer was unresponsive. In this case, we hard-restarted it (pressed down and held the power button) on the rack. After powering back on, the operating system booted up and we could restart the VMDAS software.

Table 6: Files included in the second calibration

75 kHz	150 kHz
2	2
3	3
11	9
17	53
18	
24	
28	
32	

Mid-way through the cruise, the 75 kHz started freezing, nearly every hour. In this instance, we went down to the hull transducer room and restarted the deck unit for the instruments. After restarting both systems the VMADCPs worked better. When both systems where restarted, the software had to be set up for running after the last sequence number to avoid overwriting the files that already had with data.

2. Due to the PC clock discrepancies with GMT time some files had segments that were not being processed and bad data appeared in segments that were processed. To fix this problem, the programs that where used originally: `vmacp_proc` and `mcod_mapend` that were doing the processing per sequence number were replaced by `vmacp_proc2` and `mcod_mapend2` now processing by sequence number and ENX number. The change from processing by sequence number to processing per sequence number and ENX number occurred on the 20th May and it involved reprocessing all the files. The folder old_data contains the files processed only by sequence number. After replacing the old functions for the new ones the quality of the data improved and less gaps were found.

3. A second calibration was done in order to check if the chosen angle was working well for the new files. To do this all the files done with the bottom track on were used (see Table 6). In this second calibration no significant difference was observed in comparison with the first calibration and consequently no changes were made. Amplitudes were around 1 and the phases were quite small (≤ 0.07). These new calibrations can be found in the folders `jc103botmtrack2to32` and `jc103botmtrack2to53` for the 75 and 150 kHz respectively.

Table 7 provides a list with the bad data or empty files observed for each VMADCP. Some of these files are just empty files created when trying to restart the VMADCP once it was frozen.

Table 7: Files included in the second calibration

75 kHz		150 kHz	
Sequence number	ENX number	Sequence number	ENX number
001	all	001	all
004	all	002	001
007	all	004	006
010	all	008	all
013	002	011	all
018	all	013	all
026	all	014	all
034	all	015	002
047	all	019	010
053	all	022	all
062	all	025	all
066	004	026	all
		027	all
		028	all
		029	all
		031	all
		033	all
		035	001
		036	all
		038	all
		044	all
		048	001
		049	all
		051	all
		061	all
		067	006
076	all	092	001

7 Lowered CTD Operations

Nick Rundle

7.1 CTD system configuration

One CTD system was prepared with a prudent number of spares available should replacement sensors or repairs be required. The water sampling arrangement was built up on a NOCS stainless steel frame (SBE CTD1). The frame was populated with 10l water samplers 1 through 12 occupying all the even numbers on the carrousel 2 to 24. The sensors on the frame are listed in table 8. The Sea-Bird 9Plus configuration file `JC103_0637.xmlcon` was kept throughout for all casts for continuity although the calibration data were changed for the replacement oxygen sensor on cast 3.

7.2 Operations and procedures

All CTD casts were performed using CTD winch 1.

The 10 litre water sampling bottles were cocked and prepared approximately half an hour before each cast. All bottle stops were timed at 5 minutes except for cast 004 station 004 which had 15 minute bottle stops for calibration of the moored oxygen sensors, and 16 to 22 on which no samples were taken. Casts 23 and 24 had 5minute calibration stops but no bottles were fired or salts taken.

After each cast the instruments/sensors were rinsed through with 1 litre miliQ water using a JEBAO AP-90 0A fresh water pump. The 24-way carousel and 10 litre water sampling bottles were also rinsed with fresh water approximately every other cast.

Water samples for salinity analysis were taken for each bottle after 3 full rinses. And the bottles stored in the controlled temperature workshop for 24 hours before running in the salinometer.

7.3 Terminations

The CTD wire was reterminated three times during the course of the cruise. In each instance the lays in the wire had become increasingly irregular with one strand lifting significantly. On the first occasion on 05/05/2014, 50m of wire was removed from the end of the wire and on the second and third occasions on 20/05/2014 and 02/06/2014 200m was removed each time. After each termination a load test was carried out, as at the start of the cruise.

7.4 Salinometer

Two salinometers were available for the cruise. The initial system set up at the end of JC097, a Guildline Autosal 8400B serial number 68426, was unstable during multiple attempts at standardisation and replaced with another Guildline Autosal

Instrument	**Serial number**	**Comments**
Seabird underwater unit SBE 9Plus	09P-24680-0637	
24-way Carousel SBE32	32-31240-0423	
Primary pump SBE 5T	4510	
Primary temperature sensor SBE 3P	4381	Channel F1
Primary conductivity Sensor SBE 4C	3873	Channel F2
Primary side dissolved oxygen SBE 43	6363	Channel V0 Casts 1, 2 only)
Primary side dissolved oxygen SBE 43	0862	Channel V0 Cast 3 onwards
Secondary pump SBE 5T	4539	
Secondary temperature sensor SBE 3P	4593	Channel F1
Secondary conductivity Sensor SBE 4C	3529	Channel F2
Secondary side dissolved oxygen SBE 43 sensor	430709	Channel V1
Digiquartz pressure sensor Paroscientific	79501	Channel F3
Altimeter Benthos PSA-916T	41302	Channel V7

Table 8: Instruments on the lowered CTD frame.

8400B serial number 65764. Both units were installed in the temperature controlled electronics workshop and the temperature was recorded on the worksheet at the beginning and end of each run by the operator. The bath temperature was set at 21°C.

The salinometer was standardised at the beginning of the cruise and then each crate started and ended with a standard run as a normal sample as requested. All standards for the CTD water samples were run with the OSIL P156 standard seawater batch.

8 CTD Oxygen Sample Collection

Darren Rayner

In order to calibrate the oxygen concentration as measured by the sensors on the CTD frame, water samples for oxygen titration were collected from all 12 Niskins on the rosette (for the first 11 casts) where possible. Four additional samples per CTD were taken as duplicates to check the method reproducibility.

Silicon tubing was attached to the Niskin bottle spigot to transfer water to the Oxygen sample bottle. The tubing was soaked for 2-3 days before use then kept wet between uses to reduce the tendency of bubbles to form. The wide-neck borosilicate glass bottles have an approximate volume of 120ml. The elongated bottle stoppers are unique to each bottle and have the same number attached to them; they have been produced to have a sloping surface to break the water tension of the solution. Regular checks were made for cracks and chips in the bottles and stoppers.

At the start of each sample collection, the tubing connected to the Niskin outflow was flushed with the Niskin water for several seconds. Once the water was flowing it was sometimes necessary to pinch the tubing to remove bubbles. The tubing was then bent upwards and the sample bottle inverted over the end of the tube, which is pushed to the base of the bottle. This gives a rapid flow of water over the bottle walls to give effective washing and temperature equilibration. The bottle is then righted and filled to overflowing. At least three bottle volumes were allowed to flow though the bottle. Sample agitation was minimised to avoid aeration. The fixing temperature was recorded and the filling tube removed from the bottle before being transferred to the next Niskin prior to the next sample.

At the start of each sample set the first 2 ml from the reagent dispenser pipette tips was discarded to reduce the risk of injecting bubbles into the sample. 1 ml of manganous chloride solution was injected into the sample bottle, immediately followed by 1 ml of Alkaline Iodide solution. The tips of the dispensers were slowly eased into the bottle below the neck, about 1 cm beneath the surface, to avoid reaction with water that is displaced when the stopper is inserted into the sample. Due to their greater density, the reagents sank to the bottom of the bottle. The stopper was then inserted slowly into the sample with a firm twisting motion. Care was taken to ensure no bubbles were trapped below the stopper and that a tight seal was achieved. The sample bottle was shaken vigorously for 30 seconds to disperse the manganous precipitate that scavenges oxygen from the sample. This reduces the flocculent size and increases the surface area, increasing the efficiency of the oxidation of $Mn(OH)_2$. The tightness of the stopper was checked before returning the sample to the rack to prevent 'pop back' occurring due to nitrogen coming out of solution. If the stopper does not remained tightened a bubble will form under the lid and the Niskin must be resampled. Thirty minutes after the sample bottles were returned to the laboratory they were shaken a second time. The samples were stored and analysed approximately 12-24 hours later.

Sample Analysis (the Winkler Titration)

Dissolved oxygen becomes chemically bound by manganese (II) hydroxide in a strongly alkaline medium. This is the key reaction of the Winkler method. The oxidation results in a mixed precipitate of manganese (II) and (III) hydroxides. The endpoint of the titration occurs when the number of equivalents of thiosulphate added and the number of equivalents of iodate balance (the stirring of the solution must be constant) and the fraction of iodate neutralised reaches unity. One mole of iodate is equivalent to six moles of thiosulphate and one mole of oxygen is equivalent to four moles of thiosulphate, thus the oxygen concentration in the sample is calculated by proportion. For this cruise we used a Metrohm Titrino, with amperometric end point detection to accurately perform the titration of the water samples.

In order to obtain high quality data consistent procedures must be followed at every stage from sampling through to reporting. The basic outline of the procedure, after sample collection, was as follows:

1. Slowly remove the stopper from the sample to avoid any sample loss, some of the sample will remain on the stopper, this last drop must be pulled off the stopper by dragging it across the top of the sample bottle.
2. Slowly place a stir bar into the precipitate.
3. Add 1 ml of sulphuric acid, mix using a magnetic stirrer and titrate the liberated iodine against sodium thiosulphate as soon as the precipitate has disappeared.
4. Record the titration volume.

At the start of each set the Titrino unit burette must be fully filled and emptied on a slow speed at least five times, checking for bubbles. This is necessary as the thiosulphate may evaporate or bubbles may form at the top of the piston whilst the unit is left standing.

After the oxygen concentration of each sample was measured, the corresponding value was stored in a Microsoft Excel spreadsheet. The spreadsheet used to calculate the results includes information on the volumes specific to each bottle. At each station the sample titration volumes, temperature data, station number and sample number were added to the file manually. The oxygen values are calculated automatically. Quality flags are applied to the data such as code '2' for good/preferred data, '6' when the sample is a duplicate or '4' for bad measurement. The file is then saved with a reference to the station number, for example `'Cast*_oxygen_analysis.xls'`, where '*' denotes the station number. Subsequently, the spreadsheet was converted to .nc format to enable Matlab processing; the files were renamed under `'oxy_jc103_***'`, where '***' denotes the station number.

Reagent Blank Measurements

The reagent blank was determined both at the start and end of each run; it must be checked in case of contamination of the reagents.

A 5ml automatic burette, or Dosimat unit, should be filled with potassium iodate standard. When both the Titrino and Dosimat units were first switched on we flushed out the exchange burettes three or four times, or until the piston burettes were bubble free. If bubbles do get into the exchange unit they can usually be cleared from the top of the burette by introducing a larger bubble into the system to mop the smaller ones up; it was often necessary to remove the reservoir and invert the whole exchange unit to mop up bubbles on the top of the piston. The Titrino and Dosimat tubing were also prone to filling with air bubbles due to poor connections; this was often a cause of delay with regard to making measurements.

Blank measurements were made using empty sample bottles, which were thoroughly washed in tap water three times, then washed again in distilled water before being filled to about the shoulder with distilled water. 1 ml of sulphuric acid was added before the bottle was placed on the stirrer. Then 1 ml of alkaline iodide was added before stirring again. The solution was checked at this stage to ensure it was clear before adding 1 ml of manganous chloride. Where the solution was not clear, i.e. in the case of manganese contamination, the process was started again. If clear, 1 ml of the iodate standard was injected using the Dosimat before the mixture was titrated against sodium thiosulphate. Once the titration had finished the volume of titrant was recorded and another 1ml of iodate standard added to the same bottle. In total 3ml of iodate standard was added to the bottle in 1ml amounts and titrated each time. This whole procedure was repeated for a minimum of three bottles until they were consistent to within 0.002 ml.

Standardisation of the Thiosulphate Titrant

The thiosulphate molarity is checked against an iodate standard of known molarity. The procedure is similar to that of the Blank measurements except that exactly 5 ml of potassium iodate standard is added to a bottle in one injection and then titrated, rather than 3 additions of 1ml. The results were repeated until they agreed to within 0.5

9 CTD Data Processing

Gerard McCarthy

A total of 25 CTD casts were performed to calibrate the MicroCats and test the acoustic releases. The stations are summarised in Table 9.

The variables and units output from the CTD data conversion were selected as follows: altimeter, conductivity (mS/cm) 1,2, temperature (°C (ITS-90)) 1,2, oxygen ($\mu mol\ kg^{-1}$) 1,2, oxygen raw voltage 1,2, time, pressure (dbar) and scan. The raw data files (`.hex`, `.bl`) are converted with Sea-Bird processing software to ascii format. They are corrected for cell thermal mass effects using an adaptive filter with `alpha = 0.03` and `tau = 7.0`. The oxygen data are aligned with a 5 second offset. Default values of oxygen hysteresis correction were applied using the SBE software (h1 = -0.033, h2 = 5000, h3 = 1450). Using `ctd_linkscript`, this ascii data were symbolically linked to `ctd_jc103_nnn_ctm.cnv`, which is the file naming convention expected by `mexec` (`nnn` is the station number).

Following initial SBE processing of the data, the CTD were processed using a suite of `mexec` programs. The full list of CTD processing steps is listed in Appendix B. The scripts were setup for this cruise by listing required variables in the appropriate csv files in the `M_TEMPLATES` directory. Additional modifications were required to both `ctd_jc103_renamelist.csv` and a number of scripts on JC103 as two oxygen sensors were present on the CTD frame. The sample file template, `sam_jc103_renamelist.csv`, reflected the sampling of salinity and oxygen and all CTD variables.

On JC103, the `mexec` processing was modified to use the software from the 2010 Equation of State IOC & IAPSO (2010) for calculation of salinity from CTD and Autosal conductivity. The most notable changes in the new equation of state relate to the calculation of absolute salinity and conservative temperature in a thermodynamically consistent framework. However, the numerical implementation of the conversion from conductivity to practical salinity is also improved. For example, Figure 14 shows the numerical error that arises when you convert from salinity to conductivity and back to salinity using the old seawater routines and the new Gibbs seawater routines. While the maximum error of approximately 0.0001–that occurs around 15°C–is an order of magnitude smaller than the accuracy with which salinity can be determined, it is an inaccuracy that can be avoided using the new toolbox. The new toolbox is accurate to machine precision of $O(10^{-14})$. Many replacement functions are one-to-one replacements for the previous functions in the seawater library (e.g. `gsw_SP_from_C.m` replaces `sw_salt.m`, `gsw_SP_salinometer.m` replaces `sw_sals.m`). However, most derived properties now must be calculated using absolute salinity as an input e.g. potential temperature. For this reason, absolute salinity and conservative temperature are now carried in the CTD files following `mctd_03`. We note that, in spite of absolute salinity being the prefferred salinity variable for the new equation of state, practical salinity is the salinity variable that should be stored in databases as per the recommendation of IOC & IAPSO (2010). The processing steps that have been modified are `mctd_03, mctd_04` and `msal_01`.

Figure 15 shows the comparison of the primary and secondary sensors for temperature, conductivity (salinity) and oxygen. Both primary and secondary temper-

STN	Start Date	Start Time	End Time	Duration (hh:mm)	Latitude	Longitude	Max Pres.
000[1]	26/04/14	22:35:32	23:15:58	00:40	21.7921	-70.3999	0603
001	27/04/14	02:12:16	06:39:14	04:27	22.0202	-70.7665	4880
002[2]	27/04/14	08:42:33	12:46:14	04:04	22.1425	-70.9635	4878
003	30/04/14	02:48:46	06:33:30	03:45	27.1046	-76.6125	4056
004[3]	30/04/14	23:28:00	30:05:05	06:37	26.5351	-75.7050	4724
005	01/05/14	23:02:17	27:03:24	04:01	26.5365	-75.7039	4749
006	02/05/14	23:34:50	27:16:12	03:41	26.5464	-76.7407	3548
007	04/05/14	00:56:13	04:34:21	03:38	26.5466	-76.7037	3904
008	05/05/14	19:21:49	23:06:54	03:45	26.4923	-76.6763	4622
009	08/05/14	09:25:47	13:54:32	04:29	26.5119	-70.5423	5575
010	13/05/14	13:40:35	18:16:46	04:36	25.1423	-52.0114	5578
011	14/05/14	20:07:02	23:17:37	03:11	24.2164	-49.7334	3545
012	17/05/14	21:26:38	25:45:50	04:19	23.8990	-41.0780	5409
013	18/05/14	19:01:25	23:20:59	04:20	23.8984	-41.0744	5425
014	24/05/14	17:50:30	21:54:34	04:04	23.7991	-24.1163	5163
015	26/05/14	13:39:41	17:25:17	03:46	24.8972	-21.2485	4518
016	31/05/14	14:16:11	15:01:33	00:45	27.8747	-13.5915	1167
017	31/05/14	16:13:59	16:46:01	00:32	27.8441	-13.4705	0744
018	31/05/14	17:32:20	17:47:53	00:16	27.8296	-13.4040	0227
019	31/05/14	18:39:42	18:45:02	00:05	27.8141	-13.3286	0076
020	01/06/14	06:05:27	07:07:47	01:02	27.8728	-13.5924	1219
021	01/06/14	08:07:50	09:10:23	01:03	27.8849	-13.6640	1361
022	01/06/14	10:26:34	11:44:15	01:18	27.9266	-13.8067	1615
023	02/06/14	05:04:56	08:22:25	03:17	28.4544	-15.6666	3566
024	02/06/14	08:53:51	12:09:53	03:16	28.4553	-15.6661	3568

[1] test cast

[2] primary oxygen sensor changed following this cast

[3] 30 minute bottle stops

Table 9: CTD Summary. Pressure is in dbar.

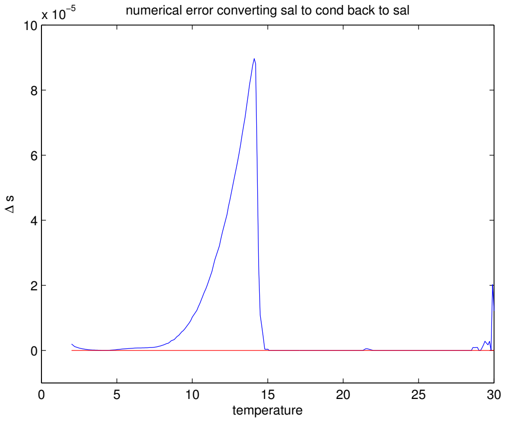


Figure 14: Numerical inaccuracy when calculating conductivity from salinity and back again in both the old sewater library (blue) and the new Gibbs seawater library (red). T, S, P triplets are selected from the World Ocean Database from the North Atlantic for this calculation.

ature sensors showed excellent agreement, disagreeing by less than a millidegree in the deep water. There was a small pressure offset between the two conductivity sensors. This had a maximum equivalent to 0.002 in salinity, which is quite small. The primary oxygen sensor was changed following Station 2 due to large spikes in the data. Disagreement between both oxygen sensors following this was quite large in warm waters, nearing 80 $\mu mol\ kg^{-1}$ difference near the surface. Spikes were frequently present in the deep oxygen of the secondary sensor. This is generally associated with the `tau` correction applied to the oxygen data. This correction improves performance in regions of high oxygen gradients but has the side effect of spikes in deep water. These spikes were manually edited from the data on casts 4, 5, 8, 9, 10, 13.

9.1 Calibration of the conductivity sensor

A Guideline Autosal 8400B Salinometer (s/n: 65764) was used for salinity measurements. Salinity samples were taken on stations 1-15 to calibrate the conductivity sensors on the CTD. The Salinometer was located in the electronics workshop, which is a constant temperature environment, with the bath temperature set at 21 °C. The ambient air temperature was checked every 4 hours during daylight and varied from 17 to 20 °C. A bespoke Labview program was used for recording the conductivity values.

The Salinometer was standardised once at the beginning of the cruise. Following this, a seawater standard was run before and after each CTD/TSG crate was analyzed. Adjustments to the calibration of the Autosal were derived from these data. Standard seawater batch P156 (2K15=1.99968, salinity=34.994) was used throughout the cruise.

Figure 16 shows the variation in the standards throughout the cruise relative to the standard seawater salinity. A drift towards freshness was observed over the course of the cruise. A number of anomalous standards were observed (e.g. nos. 1,

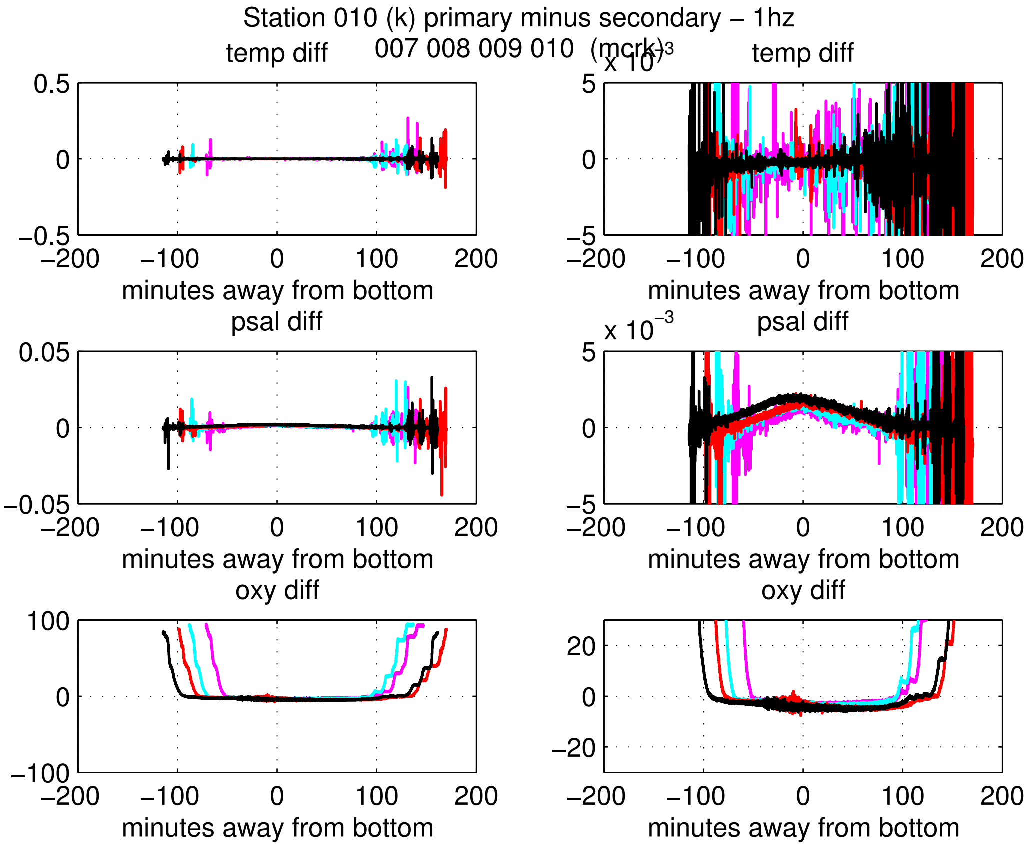


Figure 15: Comparison of the primary and secondary, from top to bottom, temperature, conductivity and oxygen sensors. Stations 7-10 shown.

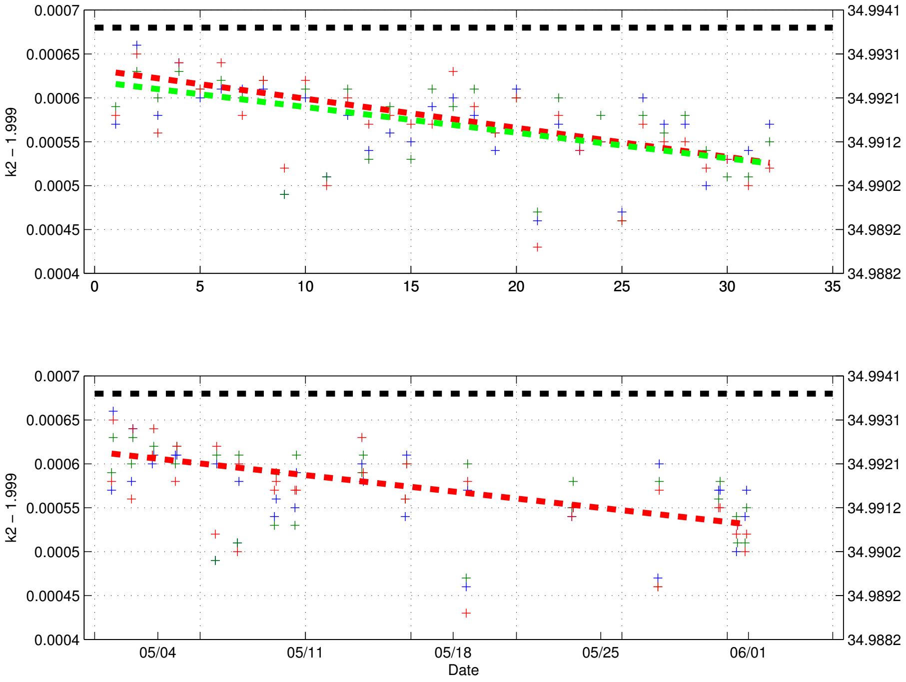


Figure 16: Drift of the Autosal over the course of the cruise plotted against (top) incremental sample number and (bottom) date. The black dashed line shows k2 = 1.99968 for standard salinity batch P156. Each cross represents an individual run for each standard. Values of k2 are shown on the left hand axis and equivalent salinity on the right hand axis. Red, dashed lines are trends fitted to bottles excluding bad bottles. Green, dashed lines are trends fitted excluding bad bottles and the next bottle.

3, 9, 11, 21, 25). These were flagged as bad bottles. These were the first standards run after the Autosal had been stored in millicue, hence contamination from millicue was supposed to be the cause of the anomalously fresh standards. This issue was reduced by extra flushes of the first standard. An alternative explanation was that the pumps took some time to reach a working equilibrium. To avoid this, the pumps were ran continuously. As most of the first standards (good and bad) run were fresh, when a bad bottle occurred, the next bottle was excluded from trend analysis to avoid a saline bias in the trend analysis.

The processing of salinity data proceeds as follows. Conductivity measurements from the salinometer are output into excel files and transferred to the Banba in `/ctd/BOTTLE_SALTS/`. These are converted to comma-separated value files for reading into Matlab. Two additional columns of data are manually added: `sampnum` relates the salinity sample to the Niskin it was drawn from: the CTD cast followed by the bottle location on the frame (e.g. 105 for bottle in position 5 on cast 1); and `flag`. The value of `flag` was either 2, for a good measurement, 4, for a bad measurement, or 6, for a duplicate.

Each `csv` file, corresponding to a single salinity crate, is then read into `mstar` format using `msal_01`. At this stage the adjustment to standard salinity values are applied as detailed in Table 10. The salinity values for each crate are read into the corresponding sample file for each station using `msal_02`. Here the user is prompted

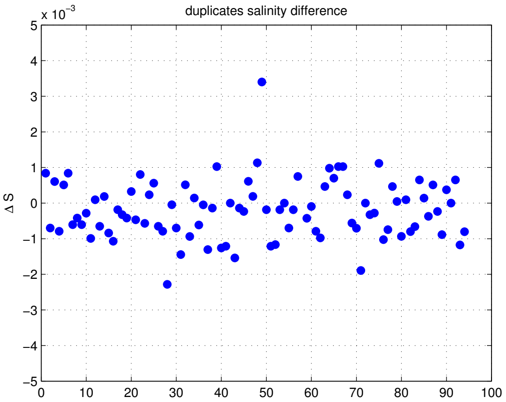


Figure 17: Salinity difference between duplicate samples.

Stn	Sal. Crate	Adj $\times 10^{-5}$
1,2	1	5
3	2	6
4	3	6
5	4	7
6	5	8
7	6	9
8	7	9
9	8	10
TSG	1	11
10	9	12
TSG	2	12
11,12	10	13
13,14	11	13
TSG	3	14
15	12	15
TSG	4	15

Table 10: Autosal adjustments.

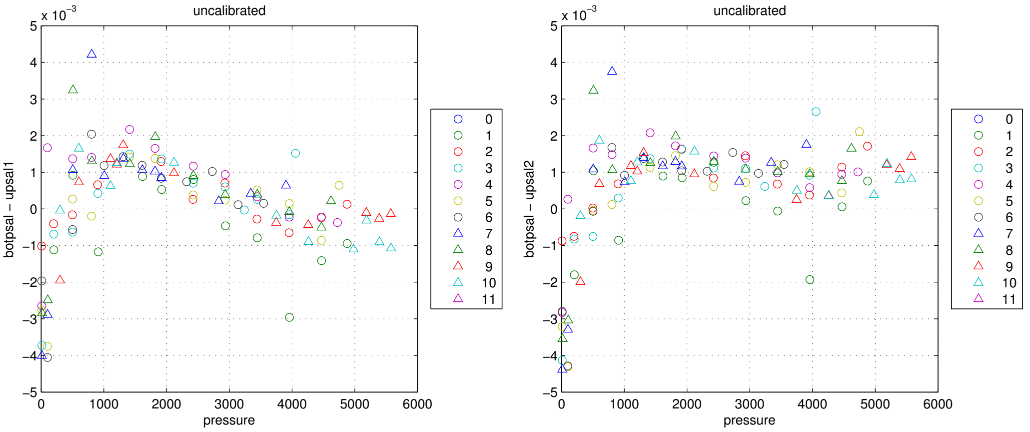


Figure 18: Bottle salinity minus uncalibrated CTD salinity for (left) sensor 1, and (right) sensor 2.

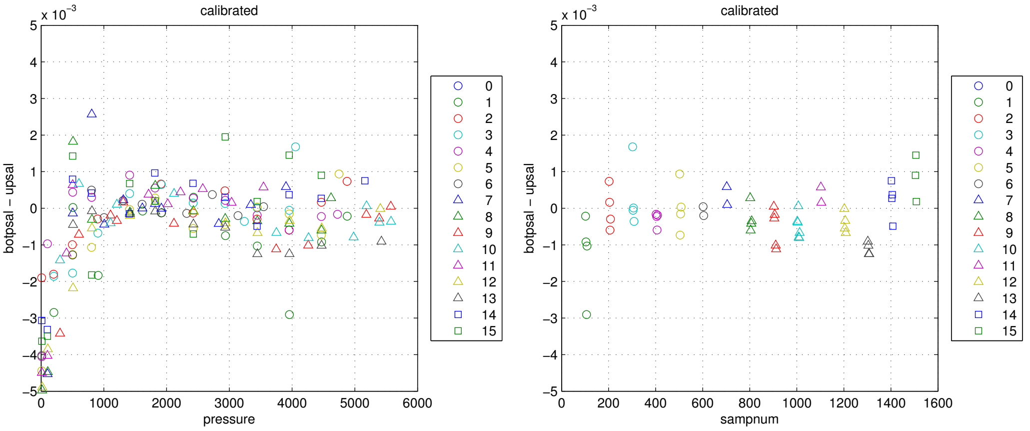


Figure 19: Calibrated CTD derived salinities difference from bottle salinities against pressure and (left) sample number (right).

for station number and corresponding salinity crate number. This amendment to the `mexec` processing allows multiple stations to be contained in a single salinity crate, which occurs frequently on RAPID trips where there are only 12 Niskin bottles.

Duplicate samples were taken on casts 3-10 to test the stability of the autosal. The difference in salinity between the two standards was generally less than 0.001 in salinity, highlighting the stability of the instrument.

The residual salinity when comparing the bottle salinities against both CTD sensors is shown in Figure 18. Both sensors are well calibrated and the residuals are within 0.002 to -0.001 in salinity for sensor 1 and 0.002 to 0.000 for sensor 2. Sensor 1 shows a dependence on pressure. As we know there is a pressure dependent difference between the two sensors from Figure 15, sensor 2 is chosen as the preferred sensor. This sensor was chosen in `mctd_sensor_choice.m`.

The calibration of this sensor was a simple matter. A scaling in conductivity of 1.00002 was applied to sensor 2. This calibrated the instrument to within ±0.001 in salinity as seen in Figure 19.

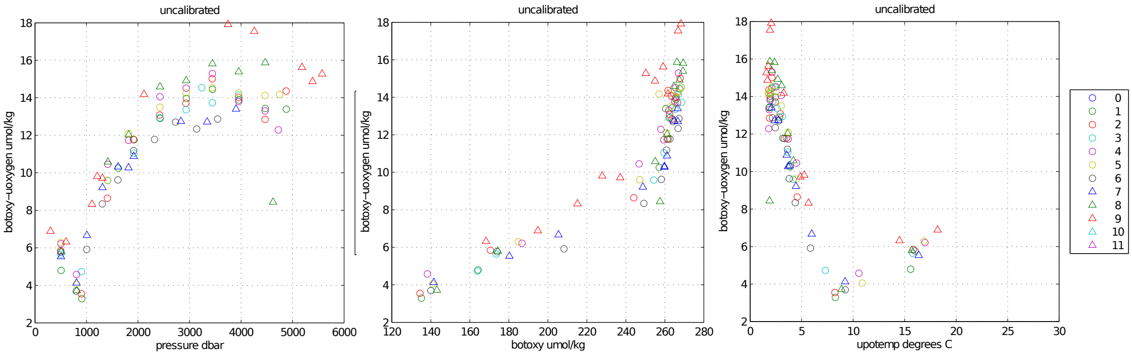


Figure 20: Uncalibrated CTD derived oxygen against bottle oxygen data.

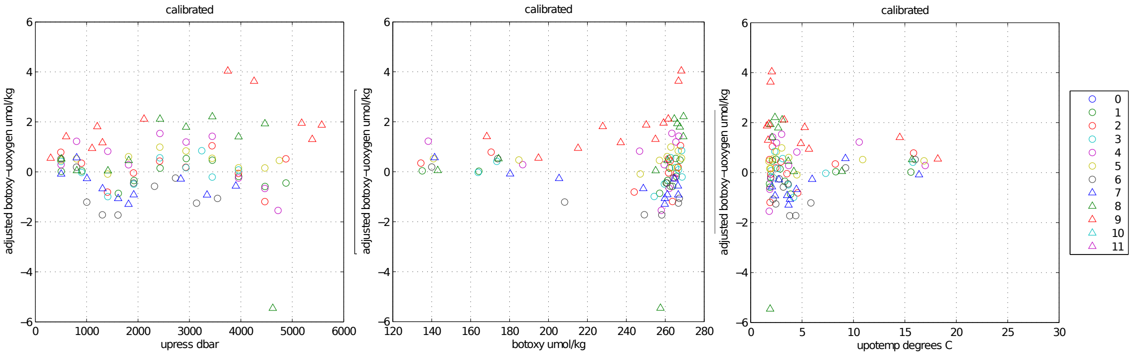


Figure 21: Calibrated CTD derived oxygen against bottle oxygen data.

9.2 Calibration of the oxygen sensor

Spikes in the primary oxygen sensor that lead to it being changed following cast 2. The secondary sensor was stable throughout and was the sensor of choice. The SBE default hysteresis correction kept the disagreement between the up and down casts less than 2 $\mu mol\ kg^{-1}$. Disagreement between up and down casts was more notable on the deepest casts (9 & 10). The application of the hysteresis correction was not adjusted for these casts as an adjustment of these parameters changes the output oxygen and, hence, these stations would have required an individual calibration.

While the sensor was stable, the absolute accuracy was typically poor. Figure 20 shows the raw oxygen data disagreement with the bottle samples. An adjustment in oxygen and temperature was applied of the form

$$\begin{array}{llllll} \texttt{oxygen} = & 1.055 \times \texttt{oxygen} & - 4; & & & \texttt{temp} \leq 5; \\ & 1.055 \times \texttt{oxygen} & - 1.55 \times \texttt{temp} & + 3.75; & & \texttt{temp} > 5. \end{array}$$

This adjustment reduced the disagreement between CTD oxygen and bottle oxygen to below ± 2 $\mu mol\ kg^{-1}$ (Figure 21).

10 Mooring Design Changes

Darren Rayner, David Smeed

10.1 Movement of WBAL3 and WBAL4

On D382 the recovered lander at the inshore western boundary site (WBAL2) was found to have moved slightly during the deployment due to strong currents. The design was updated to use a heavier anchor (1200kg instead of 600kg) for deployment on this cruise, but the change was implemented after the deployment of WBAL3 on cruise RB1201 and WBAL4 on D382. These were both recovered on this cruise and both had also moved slightly during the deployment. For data processing purposes the records were split into two parts (a and b) with info.dat files and directories in the proc path created for both.

10.2 Release link problem on WBAL4

The release link in the doubled-up releases on WBAL4 jammed in the jaws of one release meaning the other had to be fired too. This jamming of the link was only apparent once the mooring had surfaced and was recovered to the deck. A slight pull was enough to free the link as the release had operated correctly, but this is a fundamental problem that needs addressing for future deployments. Possibly larger diameter links or bevelled edges are needed to reduce the risk of the square edges jamming. This problem could have been worsened by the relatively small amount of buoyancy on the lander moorings meaning there is little tension on the release link, whereas the larger moorings have more upwards pull to free the link when the release is triggered.

10.3 Implosion of glass on WB6

On recovery it was found that the top 3-pack of glass on WB6 imploded causing the mooring to collapse. This mooring was not designed with a backup support depth that prevents total collapse of the mooring as per the tall moorings, but it was decided to improve the support buoyancy should this happen to the top pack of glass again. The design was changed for MAR0, which is essentially the same mooring design, but this change was implemented after the deployment of the replacement WB6 mooring. This change therefore needs to happen for the next deployment in Autumn 2015.

10.4 Corrosion of inshore western boundary landers

Corrosion of mild and galvanised steel

Corrosion has been found to be a major problem at the WBAL site. On D382 in 2012 the recovered lander (WBAL2) had been in the water for 18 months, since Spring 2011, and was recovered with the releases cocked in the frame as the holes in the clamps had corroded due to contact with the stainless steel bolts (Figure 22).

This lead to a design change for the inshore lander with a super-duplex stainless steel frame made for deployment during JC103. This wasnt an option for D382 and to mitigate against the potential loss of clamping between the frame and the releases the BPRs were secured to the top of the releases by a safety line. This was used on WBAL4. There was however another lander, WBAL3, already in the water that was deployed in Spring 2012 from cruise RB1201.

WBAL3 was recovered on this cruise. Initially the mooring would not rise from the seabed despite confirmed release operation on both acoustic releases. This was abandoned and we headed to other sites. Subsequently an Argos transmission was received and we were able to go back and find the mooring that surfaced about 15 hours after the release was triggered. On recovery the tripod could be seen to be slipping down the releases so the mooring was hauled on as fast as possible and the frame dropped to the deck just inboard. We were lucky to recover these instruments as the tripod could have slipped off the releases at any point during the recovery or even the period when it was floating southwards between initial release and relocation. Inspection of the bottom of the tripod frame showed strong corrosion of the anchor/frame base with the blistering paint and rust probably providing sufficient force to hold the frame to the anchor despite the releases having let go. It is thought the change in the tide may have produced sufficient movement of the tripod to allow it to separate from the anchor, hence the much later surfacing.

After recovery of WBAL3 there was then concern over the durability of WBAL4 and it was deemed better to recover the mooring 18 months early on JC103 and lose the overlap with the WBAL5 lander, rather than risk complete loss of the equipment.

The frame on WBAL4 exhibited less corrosion than on WBAL3 as it had been in the water 6 months less, but it was supposed to be in the water for a further 18 months.

Figure 22 shows the corrosion of the galvanized short link chain from WBAL3, WBAL4 and WBADCP. This is isolated from the stainless release links by plastic bushing and the middle of the chain is in contact with the large diameter galvanized release link that is attached to the anchor. The chain from WBAL3 displayed significantly more corrosion than WBAL4 and WBADCP which were similar again this is to be expected as these were both in the water for 18 months compared to 24 months for WBAL3.

Crevice corrosion of acoustic releases

The acoustic releases from the WBAL3 mooring had significant indentations from crevice corrosion where the lander clamps were fitted. The compression of rubber on these points has seemingly created a region of stagnant water in which the passivation of the stainless steel surface has been broken down allowing the metal to corrode.

There was also a large amount of staining of the acoustic releases from WBAL3 with the rust from the mild steel frame appearing to coat itself around the joints of the stainless steel release.

On servicing the acoustic releases from the two recovered WBAL landers and the WBADCP mooring, crevice corrosion was found between the hook plate and the base of the main pressure housing. This hook plate is bolted to the main body of

Figure 22: Photographs of corrosion on WBAL landers. (a) Lander bracket on WBAL2 recovered on D382, (b) WBAL3 frame as recovered on JC103, (c) Close up of WBAL3 release clamps showing trough worn in frame (d) Corrosion of galvanised chain from WBAL3 (top of picture), WBAL4 (middle) and WBADCP (bottom), (e) Staining of stainless steel release from WBAL3. This staining rubs off and is thought to have come from the corrosion of the nearby frame, (f) Crevice corrosion on hook plate of acoustic release from inshore WBAL lander site.

the acoustic release and creates a large area where there is an apparent gap between the two parts sufficient to allow water ingress but insufficient to prevent stagnation of the water and cause the break down of the passivation of the stainless steel.

This type of crevice corrosion has not been seen on the deeper sites through years of use. Could it be that the staining caused by the corrosion of the lander frame is effectively sealing the crevice off from the surrounding seawater and creating the stagnant conditions favourable to crevice corrosion?

If this is the case then we need to think about why the staining is building up around the joins in the releases. It could just be because of the ridge causing increased accumulation of rust deposits, or could there be a galvanic cell being setup with the stainless release and steel frame so that the release acts as a cathode attracting the positively charged iron ions? The galvanic cell should not be possible as the acoustic releases and steel frame are isolated from each other by rubber, but it may be that this rubber is not sufficiently effective. However the WBADCP releases are not clamped in the same way and instead the releases are isolated from the galvanised anchor chain through bushing of the super-duplex release links.

10.5 Hooking and movement of WB2

On 17th March 2014 the WB2 mooring was accidentally hooked by a CTD conducted on the USA western boundary service cruise. The mooring was recovered intact on this cruise (JC103) and no significant damage to either the instruments or the buoyancy was noticed.

In the table below are estimates of the time and location of the significant events as deduced from the tilt record of the LADCP on the CTD and from the wire tension.

Event	Time (GMT)	Ship's location	Length of CTD wire out (m)	Distance to anchor (km)
First contact	07:22	26°30.54N, 76°43.94'W	1722	1.28
Anchor lifted	07:46	26°30.36N, 76°43.94W	1506	1.58
Anchor landed	08:22	26°30.14N, 76°43.80W	1629	2.04
Untangling:	09:17	26°30.59N, 76°43.92W	1640	1.23

Table 11: Estimates of time and locatio of tangling of WB2 with CTD wire. Distance to anchor refers to the distance form the ship to the initial mooring anchor location.

Before the mooring was recovered a new triangulation was conducted as there were concerns the mooring had been moved during the tangling with the CTD. The newly triangulated mooring position was 1.6km from the position determined immediately after deployment in 2012. The new site was 3857m deep compared to 3920m for the deployment position. This is consistent with the change in pressure recorded by the microcats (see below).

The mooring was modelled using the current profile taken from the current meters for the few hours before the CTD cast. The currents were fairly weak and the model predicts the mooring was leaning slightly to the northwest with the top buoyancy package about 40m away from the central position above the anchor. The initial contact therefore would have been when the ship and CTD were passing just to the north of the mooring, and a lot sooner than the initial estimates above. This contact may have just been the CTD wire rubbing along the mooring as opposed to the package, so the time taken from the LADCP tilt is probably accurate for when the package became hooked more strongly.

The only visible damage to the mooring was some scrapes to the wire between 700 and 800m depth, a missing conductivity guard (with the bolts sheared) on the MicroCAT at 500m, and a top guide clamp that had slid down the wire from the MicroCAT at 900m, however there was no evidence of the screws being sheared on this so it may not be related.

The mooring was lifted at least 450m and when lowered back to the seabed it was at a site about 56m shallower. The shallowest MicroCAT was deployed slightly shallow at 12m (possibly overlength wires) but the record stopped early due to flat batteries. However the depth change suggests the top of the mooring would have been on the surface during periods of low currents following the moving of the mooring (and possibly even before the move for the top pickup float).

10.6 Mooring MAR0

On 13th May we failed to recover mooring mar0_2012. Recovery of the prvious deployment of this mooring also failed in autumn 2012. Before deploying mar0_2014 a meeting of scientific and technical staff on board was held to assess the possible causes for non-recovery and to decide whether it was reasonable to proceed with the deployment of mar0_2014. An assessment was made after followiing an analysis very similar to that described by Brito et al. (2014) This section describes the outcome of the meeting.

The information available was:

- A very similar mooring at the same location, mar0_2011, failed to surface in 2012. On that occasion we received 'release ok' but the mooring did not move.
- The design of mar0_2012 was modified so that would still surface if one set of buoyancy imploded. A slightly different position was attempted but not triangulated at the time of deployment.
- When we tried to recover mar0_2012 we were able to determine a range to release 1 ok on the 2nd try and received 'release ok' but 10 minutes later the range was exactly the same. No reply at all was received from release 2.
- We then attempted to communicate with the second release from a number of other locations but received no reply from either release. However, replies were received from mar0_2011 mooring on each try.
- We made several other attempts to communicate with mar0_2012 during the day as we completed other operations. Attempts were made from each of four quadrants and at ranges from directly over the drop site to 5 nm off but no further ranges received (except for a couple of of bad ranges which were clearly not correct).

- prior to 2012 three previous deployments of mar0 with similar designs were successful and six deployments of wb6 with very similar design have all been successful. In contrast to mar0 the terrain at wb6 is very flat.

Thus there were two issues with the attempted recovery. Firstly, why did the mooring not surface when the release had apparently released? and secondly, why was it not possible to communicate with either release after the initial try? In our discussion we attempted to identify all of the possible causes for each of these problems and to determine which of the possible answers were most likely.

Two main hypotheses for not surfacing were identified:

- A1 Although we received 'release ok' signal from Release 1 it did not release.
    - A1.1 Examination of a previously recovered lander on this cruise suggests jamming of release link is possible but has only been seen once.
- A2 Release worked but
    - A2.1 There is not sufficient buoyancy to lift the mooring, i.e. implosions have reduced buoyancy. This would need two sets of glass to go but this seems most likely option.
    - A2.2 The lander remains attached to the anchor by other means e.g. snared on rock or sunk in mud. Thought to be unlikely. If all buoyancy is ok then there would be 50kg of lift.

Two possible hypotheses to explain the lack of acoustic communications were proposed:

- B1 There is a fault with both releases
    - B1.1 Very few releases (though the number is not yet quantified) have issues and so it seems very unlikely that both would be affected.
- B2 Environmental conditions are inhibiting communication
    - B2.1 The mooring may have fallen back to steeper ground when deployed. But it is not known to what extent this would have affected communications.
    - B2.2 Could have sunk into mud. Not much information to go on but not known to have happened elsewhere in the array and seems unlikely.

Conclusion Whilst each of the hypotheses is unlikely we do not think there are any other possibilities to explain the events. The consensus was that implosions of glass buoyancy was the most likely cause for failing to surface. Although other possibilities could not be ruled out. Similarly the consensus was that inhibition of communications by the terrain at the landing site was the most likely reason for the lack of communication with the releases.

The options considered were:

- Deploy new mooring at the usual site
- Deploy new mooring at another site
- Deploy a mooring without lander
- Do not deploy this time - seek further analysis before redeploying next time

Action taken: The mooring mar0_2014 was deployed but the risks of further losses at this site were reduced by:

- Using a new design that has mostly syntactic buoyancy with no risk due of implosions (this design change was made after the last cruise). The new design was modifiied to add chain between releases and syntactics and between syntactics to make deployment and recovery easier.
- New swath data indicates larger landing site a little to north the of the one used previously
- Do not use lander (the lander is only needed for the BPRs)
  - Mitigates against possible issue releasing lander
  - With a conventional anchor the release will be 10m above bottom instead of c. 1m when deployed on lander. Thus it is less likely to be shielded.
  - BPRs are not a high priority at this site and not using them reduces the value of equipment on the mooring.

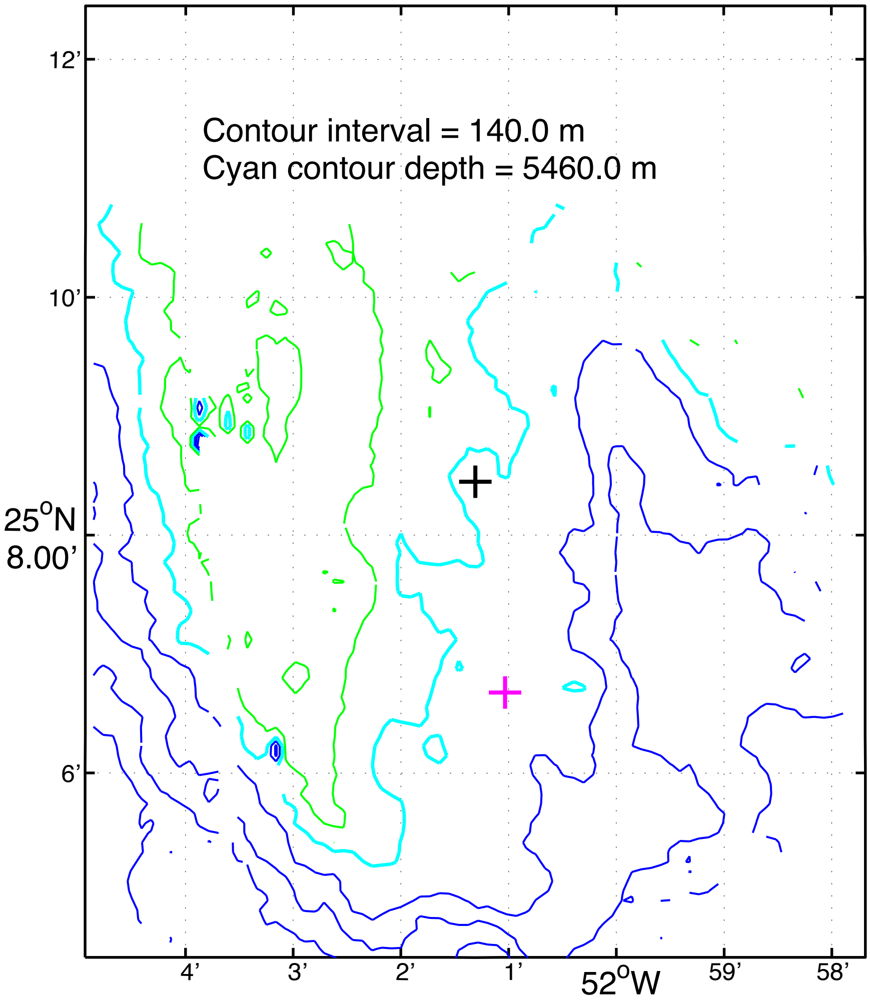


Figure 23: Deployment site for mooring MAR0. Previous site shown by magenta cross and and new site is shown by the black cross. Contour interval is 140m, green contours are shallowr and blue are deeper. The topography is derived from swath data collected during the cruise. See 5.2.

11 Mooring Operations

Dave Childs

During the cruise both moorings and landers were either recovered or deployed using either the double barrel winch system, or by hand using rope in baskets, depending on the mooring design.

At each stage of both deployments and recoveries members of the science party collated timing and serial number information onto their own log sheets.

Our winch system consists of a reeling winch, the double barrel winch, deck diverters and a block suspended from one of the aft cranes. This system makes use of the ship's deck hydraulics, and is used for both recovery and deployment operations. For the vast majority of deployments and recoveries we had no issues with the hydraulics, however we suffered from a loss of hydraulics on two different occasions, both times the fault was quickly dealt with by the ship's engineers and had no impact on science time. For our winch operations Howard King drove the double barrel winch from the control pedasol, whilst Colin Hutton operated the reeling winch ensuring the scrolling was maintained, and that the wire or rope passed through without incident. Steve Whittle worked in the Red Zone on the ships stern, along with the Martin Harrison, the ships CPOS. Between them they connected or disconnected all the glass and buoyancy and instruments, ensuring everything came in board or went overboard in a safe, controlled manner.

For deployments the wire or rope is pre wound and stored on drums prior to use, the drums are then loaded into position using the ships cranes. Once secure the wire or rope is passed through the reeling winch scrolling, round a diverter sheave when required, round the double barrel winch, through a counting sheave and up and through the block before going over the ships stern. At joins in the mooring line where there is a shackle link shackle a cover is fitted to protect the wire or rope. This protective cover is removed past the diverter, prior to passing through the block. Once through the block, the link in the wire or rope can be connected to either glass buoyancy or an instrument before being deployed over the side.

To connect buoyancy or instrumentation the link is veered outboard slowly to allow a deck connected stopper to be attached. Once the stopper is connected veering continues until the outboard tension is transferred through the stopper and no longer on the mooring line. The shackle on the inboard side of the link is then undone, and connected to the bottom of the buoyancy or instrument to be fitted. The top of the instrument or buoyancy is connected to the bottom of the link in the shackle link shackle join. Once everything is connected, the wire or rope is hauled back inboard slowly, to allow the tension to return to the mooring line, so that the deck stopper can be disconnected.

Veering then continues and the process is repeated for each instrument or buoyancy package that is connected at a join. For instruments that arent connected at a join, the winch is brought to a stop, and the instrument fitted using its own wire clamps, on the outboard side of the block.

Once everything has been deployed, the releases are connected into the mooring line, and they are in turn connected to the anchor. When close to the mooring deployment site, the anchor is picked up via the ships crane or via a deck fitted winch. For anchors picked up using the crane, the anchor is slewed overboard and then lowered to the waterline. A quick release is used to disconnect the anchor from the crane, allowing it to fall into the water and subsequently to the seabed. All anchors over a tonne are deployed with the deck winch and are picked up via the winch whilst the A-Frame is moved aft, allowing the anchor to become clear of the ship's stern, veering on the deck winch lowers the anchor weight to the waterline, and a quick release is used to free the anchor.

For mooring and lander recoveries, members of the technical party worked with the scientific party to range the releases to establish communication. Once a response from the release was confirmed the Bridge were asked for permission to release the mooring or lander, and once they were happy a release command was sent to the releases. Several further interrogations were made at timed intervals in order to establish a rise rate and to calculate an approximate time to the surface. Members of the scientific party then went to the Bridge to assist with lookout duties, in order to spot the first packages of buoyancy as they surface.

Once enough buoyancy has surfaced, the ship then repositioned to allow the recovery line and top buoyancy to be brought on board by the use of a grapnel by the ships crew along the starboard side of the vessel. A recovery line is then used to bring the top buoyancy along the starboard side of the ship and around the aft starboard quarter so that it can be winched on board. With the top buoyancy on board and stopped off using a deck stopper, the recovery line was removed by paying out on the winch and stowed for future recoveries. Buoyancy is then removed from the mooring line and moved out of the way, off the Red Zone. To continue with the recovery the wire or rope is then reconnected at the joins, and hauled on board by the double barrel winch and then on to the reeling winch.

Full drums are removed from the reeling winch by use of the ship's crane, and are then stowed in drum stands on the back deck for offloading once in port. All buoyancy is broken down upon recovery, and stowed in cages on the back deck ready for inspection and subsequent redeployment.

Short lander deployments can be made by hand, with mooring rope contained in baskets. Prior to deployment every item of the lander is laid out on the Red Zone and pre connected, all instrumentation is fitted before deployment starts. Once the okay is given by the bridge to commence deployment the top buoyancy is lowered to the surface by hand, rope is then slowly fed out of the baskets, until either instrumentation or buoyancy is ready to be deployed. At this point, many hands take the load and slowly lower the package over the side until it reaches the water line. Once in the water rope is again slowly fed out by hand. This process continues until everything is outboard and in the water. A crane is then used to pick up the lander frame and anchor weight, this then being slewed outboard and lowered to the water line.

Once on deployment position, a quick release is used to release the lander frame away from the crane and on its journey to the seabed.

12 Mooring Instrumentation and Data Processing

Darren Rayner and Ben Moat

12.1 instrument issues

MicroCATs

Several MicroCATs had a noticeable lag in the pressure record for the shallower bottle stops during the cal dips (see details in cal dip section). These are likely caused by the thermal lag of the pressure sensor, and tend to be more pronounced for those instruments with a Paine pressure sensor. These should be upgraded to Kistler sensors as part of the planned regular servicing of instruments, but are ok to use at depths where the thermal lag will not be an issue.

MicroCAT 6333 had some time jumps and random values in the data from cal dip cast 1. The remaining data were ok so this instrument was deployed, but when recovered the resultant timeseries should be checked to see if this error has persisted.

MicroCAT 5775 has a bad pump, as evident from the conductivity record from cast 1.

MicroCAT 5781 was over-reading pressure by approximately 1500dbar on cast 1. The previous deployment was on WB2 recovered in Autumn 2012 and looking at the cal dip data following this recovery the pressure offset was only 10dbar, so there appears to have been a significant change in either the sensor or the calibration in this time.

MicroCAT-ODO 10518 was over-reading pressure by approximately 1400 dbar on cast 4. This instrument has not been used since purchased in 2013 so as with 5781 there is either a problem with the pressure sensor or the calibration. There were no alternative oxygen-sensor-equipped MicroCATs that could be deployed in place of this instrument, but it was deployed adjacent to another MicroCAT without oxygen sensor so the depth can be corrected from this other instrument.

The fastest that the SMP-ODOs can sample at is 30 seconds, so cal-dip bottle need to be extended when including these instruments on a cast.

MicroCAT SMP 10716 would not communicate when being setup for the mooring deployment unless it was connected to external power. New batteries were fitted, but still no connection could be established without external power. It worked ok on the cal dip, but on checking the voltage of the battery (and also the power supply) when trying to connect to the instrument there was a noticeable drop in voltage of a couple of volts. The capture file from the cal dip setup showed the battery voltage was 13.30V. The .xml file from the cal dip download shows the voltage has dropped to 11.58V. Although care has to be taken when interpreting the voltage of lithium batteries this seems quite a large drop considering only the one cal dip had been completed. This instrument has not been used before and it needs assessing by SeaBird as it may be drawing too much power.

MicroCAT 6819 had a jump in pressure of approximately 10 dbar partway through the 100 dbar bottle stop on cast 15. This instrument was redipped on cast

23 where it was significantly over-reading pressure at all depths (over 500dbar higher at 3500m). This suggests a change in the pressure sensor calibration or a physical change to the sensor occurred during the previous cast and is similar to the problem found for MicroCAT 5781. Further investigation is required.

MicroCAT 5242 on cast 11 did not log at the intended 10 second interval it sampled at 58-59 seconds instead. On inspection of the data header it seems the pump had been disabled. This is usually only achieved through sending a specific command, but the capture file from setting up the instrument on the previous cruise suggests the pump was enabled correctly. It is therefore unclear when the pump became disabled, but there is evidence of fouling of the conductivity cell during the deployment on MAR1 at about 50m. The pump was re-enabled and the instrument was lowered for a second time on cast 14.

Current Meters

The ADCP from mooring WBADCP stopped logging early due to battery depletion. The settings were checked and the endurance calculation revisited for the 18-month deployment duration both were fine. Instead it appears that either there was a fault with some or all of the cells in the battery pack, or old batteries were incorrectly used as the starting battery count was significantly lower than usual. This could be inspected for in the future by collected a short record on deck, downloading this data and checking the data prior to resetting the deployment parameters and deploying the instrument.

RCM11 serial number 399 suffered a low-pressure flood, which shorted the battery and halted data collection after only 1000 words on the DSU.

A second RCM11 (serial number 306) suffered a high-pressure flood and was safely disposed of.

Of the remaining 12 RCM11s that were recovered 7 had short data records due to depleted batteries. Typically a month of data was lost each time and suggests that these instruments are on their endurance limits if we wish to maintain at least an hourly sampling rate. For the important current meter moorings in the west it is recommended to only use Norteks now.

Sontek D332 had a low-pressure flood causing a battery short with no data being collected.

A problem with Nortek blanking distances was expected for some of the recovered instruments on this trip as we had had prior warning from our colleagues in Miami who had encountered the same issue. The problem arises from using a deployment file created in a previous version of the software to the one which is used to send the file to the instrument. The intended blanking distance is ignored and instead set to something much greater (3.48m). The problem with this is that if the backscatter concentration is low then the quality of data will be greatly reduced for a cell further from the instrument. On first inspection of the data the short-term variability can be seen to be higher than usual, but the mean looks reasonable so it should be ok. Although this problem was identified prior to the cruise and explained to others with instructions on how to remedy it (save the deployment file in the new software prior to sending it to the instrument) this was not done. All Norteks deployed on this cruise are therefore also likely to suffer from a change to the intended blanking distance.

12.2 Mooring instrument processing

All data from recovered moored instrumentation were downloaded to PCs, transferred to the networked file system and processed on the workstation banba using the RAPID Matlab processing scripts.

The directory structure used on the NOCS network is mimicked onboard so that under ./rapid/data/moor/ there is a raw directory containing the data copied from the download PCs, and a proc directory containing the processed data arranged by mooring name.

For this cruise the absolute paths on banba were:

- /local/users/pstar/rpdmoc/rapid/data/exec/jc103/
  For the processing scripts arranged by instrument type in subdirectories
- /local/users/pstar/rpdmoc/rapid/data/moor/raw/jc103/
  For the raw data downloaded from the instruments arranged by instrument type e.g. microcat, nor, adcp etc. subdirectories
- /local/users/pstar/rpdmoc/rapid/data/moor/proc/
  For the processed rodb format data arranged in subdirectories by mooring name e.g. wb2_9_201114, with subdirectories under this by instrument type.

Individual scripts are used for each instrument type and are written so that Stage 1 scripts convert the data into rodb ASCII format from the raw files as downloaded from the instruments. Stage 2 scripts remove the launch and recovery periods as defined in the accompanying _info.dat files in the mooring proc directory. If appropriate further processing during stage 3 routines is used to apply corrections for magnetic declination and speed of sound assumptions for currents meters. More details of the processes can be found in previous cruise reports and will not be duplicated here.

13 Argo Float Deployments

David Smeed

During the cruise 6 Navis Argo floats supplied by the UK Met Office were deployed. These floats were fully prepared before delivery to the ship and were pressure activated. It was only necessary to remove the plugs from the CTD before deployment.

Deployments were made from the aft starboard quarter when the ship speed was slowed to 2 knots. The floats were lowered into the sea using a line that passed through a hole in the plastic damper plate. One end of the line was then released and the other end was pulled back to release the float.

Table 12 below gives the times and locations of each deployment.

Float ID	Date	Time	Latitude	Longitude
0244	2014-05-19	20:58	23°46.3 N	39°58.7 W
0241	2014-05-21	11:00	23°45.9 N	33°22.3 W
0247	2014-05-22	10:04	23°45.6 N	29°21.5 W
0242	2014-05-23	08:00	23°45.8 N	25°28.8 W
0250	2014-05-24	17:06	23°47.5 N	24°06.5 W
0249	2014-05-25	15:57	24°36.4 N	22°05.6 W

Table 12: Details of Argo floats deployed during cruise JC103.

14 Mooring Tables

14.1 Mooring recovery table

Mooring	**Sequential mooring number**	**UKORS number**	**Deployment cruise**	**Deployment date**	**Recovery date**
WBP1	1	2012/56	D382	2012-11-23	2014-04-30
WBADCP	10	2012/54	D382	2012-11-22	2014-05-03
WBAL3	3	2012/09	RB1201	2012-02-28	2014-05-03
WBAL4	4	2012/55	D382	2012-11-22	2014-05-04
WB1	10	2012/48	D382	2012-11-17	2014-05-03
WB2L8	8	2012/07	RB1201	2012-02-27	2014-05-02
WB2	11	2012/51	D382	2012-11-20	2014-05-02
WBH2	7	2012/53	D382	2012-11-22	2014-05-04
WB4L8	8	2012/03	RB1201	2012-02-23	2014-05-01
WB4	10	2012/50	D382	2012-11-19	2014-04-30
WB6	7	2012/47	D382	2012-11-14	2014-05-08
MAR0	6	2012/46	D382	2012-11-10	Not recovered
MAR1	9	2012/43	D382	2012-11-08	2014-05-14
MAR1L7	7	2011/35	JC064	2011-09-25	2014-05-14
MAR2	9	2012/45	D382	2012-11-09	2014-05-15
MAR3	9	2012/40	D382	2012-11-05	2014-05-18
MAR3L7	7	2011/38	JC064	2011-09-22	2014-05-18
NOG		2012/42	D382	2012-11-05	2014-05-19
EB1	11	2012/37	D382	2012-10-25	2014-05-23
EB1L8	8	2011/23	JC064	2011-09-17	2014-05-24
EBHi	9	2012/35	D382	2012-10-23	2014-05-26
EBH1	9	2012/30	D382	2012-10-16	2014-05-29
EBH1L8	8	2011/26	JC064	2011-10-06	2014-05-29
EBH2	9	2012/32	D382	2012-10-16	2014-05-30
EBH3	9	2012/33	D382	2012-10-17	2014-05-30
EBH4	10	2012/39	D382	2012-10-28	2014-05-31
EBH4L3	3	2011/30	JC064	2011-10-05	2014-05-31
EBP2	2	2011/11	D359	2011-01-13	2014-05-31

14.2 Mooring deployment table

Mooring	UKORS Number	Latitude °N	Longitude °W	Fallback (m)	Depth (m)	Date	Time (GMT)	Duration (includes towing) (hh:mm)	Beacon ID(s)	Release 1	Release 2
WBADCP	2014/13	26°31.81’	76°52.02’	not meas.	581	2014-05-03	23:04	0:06	IMEI 300234061661040	1352	1349
WBAL5	2014/14	26°32.19	76°52.35	not meas.	496	2014-05-04	13:56	0:04	111852	1406	1464
WB1	2014/15	26°30.45’	76°48.92’	132	1375	2014-05-04	17:29	1:25	IMEI 300234061660210, 42745	1461	324
WB2	2014/12	26°30.97’	76°44.30’	512	3910	2014-05-03	15:43	3:29	IMEI 300234061666230, 22442	325	1405
WB2L10	2014/11	26°30.74’	76°44.81’	222	3900	2014-05-02	17:28	0:03	46502	1730	916
WBH2	2014/16	26°28.97’	76°37.88’	305	4729	2014-05-05	14:54	2:25	IMEI 300234061665220	1733	918
WB4	2014/09	26°28.73’	75°42.24’	279	4960	2014-05-01	18:24	5:35	129571, 111853	1731	1463
WB4L10	2014/10	26°29.06’	75°42.50’	219	4690	2014-05-01	18:56	0:01	111850	358	1732
WB6	2014/17	26°29.69’	70°31.42’	not meas.	5494	2014-05-08	18:20	0:25	129404	1201	364
MAR0	2014/18	25°08.22’	52°01.58’	579	5462	2014-05-13	19:24	0:25	111849	281	819
MAR1	2014/20	24°09.98’	49°44.97’	557	5214	2014-05-15	15:04	5:00	IMEI 300234061662220, 82895	917	370
MAR1L9	2014/19	24°11.89’	49°44.04’	69	5227	2014-05-14	18:40	0:06	46485	1194	823
MAR2	2014/21	24°10.96’	49°45.64’	218	5217	2014-05-15	19:31	1:23	53153	910	316

MAR3	2014/22	23°52.12’	41°05.52’	213	5060	2014-05-18	17:37	2:25	IMEI 300234061667220	1200	498
MAR3L9	2014/23	23°51.72’	41°05.94’	66	5038	2014-05-18	18:06	0:05	46499	1383	323
NOG	2014/24	23°46.28’	41°05.82’	not meas.	4257	2014-05-19	13:55	1:08	n/a	318	n/a
EB1	2014/25	23°45.39’	24°09.51’	317	5087	2014-05-24	16:33	4:25	IMEI 300234061664230, 74027	1197	319
EB1L10	2014/26	23°47.48’	24°06.55’	133	5087	2014-05-24	17:14	0:06	121984	264	921
EBHi	2014/27	24°56.05’	21°16.04’	199	4489	2014-05-26	11:41	0:46	IMEI 300234061669220	821	1465
EBH1	2014/28	27°13.33’	15°25.39’	168	2997	2014-05-29	11:05	0:19	IMEI 300234061661230	1202	827
EBH1L10	2014/29	27°12.24’	15°25.01’	0	3032	2014-05-29	12:01	0:06	53157	925	262
EBH2	2014/30	27°36.86’	14°12.68’	not meas.	2004	2014-05-30	9:11	0:11	IMEI 300234061668230	1198	1350
EBH3	2014/31	27°48.36’	13°44.91’	203	1414	2014-05-30	16:48	1:11	IMEI 300234061662230	1535	930
EBH4	2014/33	27°50.98’	13°32.45’	149	1052	2014-05-31	13:26	1:04	IMEI 300234061660230	253	1536
EBH4L5	2014/32	27°51.99’	13°30.84’	195	993	2014-05-31	9:15	0:04	121990	1533	1348

14.3 Details of instruments on the calibration CTD profiles

Cast	MicroCAT serial numbers																
1	4307	5762	5773	3931	5779	6820	6806 P	5768 T	4305	5763	6124	6333	5780		3248	6825	5775	6323
2	6125	6129	6327	3933	7363	5786 C	6126	6321	7468	6828	3902 P	6840	5785 T	4306	5240	3928	3209	5781
3	6115	3911	3486	3483	4472	4470	4180	3223	5767	6808	5787	5782	3270	3910		6115		
4	10517	10518 Pp	10519 P	10520	10542	10543	10544	10545	10547	10555	10556	10564	6335 P					
5	3934 t	5247		3219 P	6810	3891 P	3233	5789	6807	3234	3232	6114	6804	5486	6801	6802	6326	6828
6	4072		4068	3239	4471	3282	6117	5981	4723 P	4724 P	4722	6826	3231	6814	6331	5485	5484	4549
7	6119	3932 C	7723	6830 P	4717 t	4721	6836	5774	3228	3206	3221	3269	6113	6813	6805	6815		
8	3905	6799	6800	6824	6822	5982	5983	5778	5783	6835	5776	5770	6322	5784	6127	4464	4461	4184
9	5239	5243	6320	6128	3919	6121 c	6123 C	6137	6120	6803	6325	6821	5985	5246 P	6116	10716 t	4475	4719
10	4708	5978	4797	4800	6812	4795	4714	4725	9477									
11	4071	4070	4060	4062	5242 Cc	5244	6834	6839	6838	6833	3901 T	3904	7681	3229	6112			
12	3281 CP	3254	3225	4468	6798	6811	3266 P	3222	3913									
13	6841	6832	5245	5241	3268	4718	3900											
14	5242 C	7300	5238	3916	3256	6829	6817	3259	5765									
15	4713	4720	4718 P	4474	4473	4466	4462	3247 c	3484	6819	3257	3255	3271					
23	4066 C	3251	5766	3207	3252	3220	5777	4710	3213	3912	3893	3249	5772	3214	3253	6819 P		
24	3212	3277	6823	4712 p	6816	3230	3215	6818	3244 c	3224	3265 p	3264 c	6831	3216	3907			

14.4 Instrument record lengths

Mooring	Nominal Depth (m)	Inst. code	Ser. No.	Mean Pres. (dbar)	Start date	End date	No. records	Comments
wbp1_1_201256	4102	316	136	4178.1	2012-11-23	2014-04-30	75211	
wb4_10_201250	50	337	5247	114	2012-11-19	2014-04-30	12647	
	100	310	399					Shallow pressure flood. No data.
	105	337	5484	159.5	2012-11-19	2014-04-30	12646	
	250	337	3219	307.2	2012-11-19	2014-04-30	12647	
	400	370	5590	458.3	2012-11-19	2014-04-30	25294	
	405	337	6810	453.5	2012-11-19	2014-04-30	12647	
	600	337	3891	657.9	2012-11-19	2014-04-30	12647	
	800	370	5611	858.9	2012-11-19	2014-04-30	25294	
	805	337	3233	859.3	2012-11-19	2014-04-30	12647	
	1000	337	5789	1061.7	2012-11-19	2014-04-30	12647	
	1200	370	5831	1275.9	2012-11-19	2014-04-30	25292	
	1205	337	6807	1258.2	2012-11-19	2014-04-30	12647	
	1500	370	5893	1571.6	2012-11-19	2014-04-30	25294	
	1600	337	3234	1662.2	2012-11-19	2014-04-30	12647	
	2000	370	5896	2081.5	2012-11-19	2014-04-30	25294	
	2005	337	3232	2061.8	2012-11-19	2014-04-30	12647	
	2500	337	6114	2565.1	2012-11-19	2014-04-30	12647	
	3000	370	5899	3097.5	2012-11-19	2014-04-30	25294	
	3005	337	6804	3079.8	2012-11-19	2014-04-30	12647	
	3505	337	5486	3591.3	2012-11-19	2014-04-30	12647	
	4000	370	5955	4113.8	2012-11-19	2014-04-30	25294	
	4005	337	6801	4097.2	2012-11-19	2014-04-30	12647	
	4500	337	6802	4599.2	2012-11-19	2014-04-30	12647	
	4600	370	6049	4725.4	2012-11-19	2014-04-30	25294	

wb4l8_8_201203	4700	465	38	4784.9	2012-02-24	2014-05-01	38233	
	4700	465	391	4784.9	2012-02-24	2014-05-01	38233	
wb2L8_8_201207	3890	465	414	3957.3	2012-02-29	2014-05-02	38067	
	3890	465	30	3956.9	2012-02-29	2014-05-02	38067	
wb2_11_201251	50	337	6119	32.1	2012-11-20	2013-10-30	8148	Short record. Battery depleted.
	100	310	306	-	-	-	-	Flooded
	105	337	3932	102.5	2012-11-20	2014-05-02	12665	
	175	310	395		2012-11-20	2014-05-02		
	180	337	7723	205.8	2012-11-20	2014-05-02	12665	
	325	337	6830	309.1	2012-11-20	2014-05-02	12665	
	400	370	6747	391.1	2012-11-20	2014-05-02	25330	
	500	337	4717	491.6	2012-11-20	2014-05-02	12664	
	700	337	4721	695	2012-11-20	2014-05-02	12665	
	800	370	5889	798.6	2012-11-20	2014-05-02	25330	
	900	337	6836	891.2	2012-11-20	2014-05-02	12665	
	1100	337	5774	1098.9	2012-11-20	2014-05-02	12665	
	1200	370	6805	1204.1	2012-11-20	2014-05-02	25330	
	1300	337	3228	1305.2	2012-11-20	2014-05-02	12665	
	1500	370	8052	1513	2012-11-20	2014-05-02	25330	
	1500	337	3206	1511.4	2012-11-20	2014-05-02	12665	
	1700	337	3221	1716.3	2012-11-20	2014-05-02	12665	
	1900	337	3269	1914	2012-11-20	2014-05-02	12665	
	2050	370	8120	2061.9	2012-11-20	2014-05-02	25330	
	2300	337	6113	2319.9	2012-11-20	2014-05-02	12665	
	2800	337	6813	2834.2	2012-11-20	2014-05-02	12665	
	3000	370	9204	3046	2012-11-20	2014-05-02	25330	
	3300	337	6805	3350	2012-11-20	2014-05-02	12665	
	3850	337	6815	3896.7	2012-11-20	2014-05-02	12665	
wb1_10_201248	100	370	6723	74.5	2012-11-17	2014-05-03	25530	

	105	337	5778	74.3	2012-11-17	2014-05-03	12764	
	400	370	6088	382.5	2012-11-17	2014-05-03	25530	
	405	337	5783	384.9	2012-11-17	2014-05-03	12764	
	800	370	6765	798.8	2012-11-17	2014-05-03	25530	
	805	337	6835	790.8	2012-11-17	2014-05-03	12765	
	1200	370	6534	1206.3	2012-11-17	2014-05-03	25530	
	1205	337	5776	1207.2	2012-11-17	2014-05-03	12765	
wbal3_3_201209	500	465	395	501.3	2012-03-02	2014-05-02	37981	
	500	465	419	511.8	2012-03-02	2014-05-02	37980	
wbadcp_9_201206	614	324	10311	604.5	2012-11-22	2013-10-05		Battery failure
wbal4_4_201255	500	465	398	514.4	2012-11-22	2014-05-01	12588	
	500	465	399	515.2	2012-11-22	2014-05-01	12585	
wbh2_7_201253	1500	370	9210	1376.6	2012-11-22	2014-05-04	25353	
	2200	370	9213	2082.7	2012-11-22	2014-05-04	25353	
	3000	370	9435	2923.3	2012-11-22	2014-05-04	25353	
	3800	370	5490	3784.9	2012-11-22	2014-05-04	25353	
	3805	337	3905	3788.1	2012-11-22	2014-05-04	12676	
	4300	337	6799	4350.4	2012-11-22	2014-05-04	12676	
	4600	310	426	4678.4	2012-11-22	2014-05-04	12607	
	4695	337	6800	4767.1	2012-11-22	2014-05-04	12676	
wb6_7_201247	5100	337	4708	5591.3	2012-11-14	2014-05-08	12957	Below target depth due to buoyancy failure.
	5200	337	5978	5489.4	2012-11-14	2014-05-08	12957	Below target depth due to buoyancy failure.
	5300	337	4797	5363.9	2012-11-14	2014-05-08	12957	
	5400	370	6050	5494.3	2012-11-14	2014-05-08	25913	
	5400	337	4800	5471.7	2012-11-14	2014-05-08	12957	
	5491	337	6812	5574.1	2012-11-14	2014-05-08	12957	
	5500	465	81	5608.5	2012-11-14	2014-05-08	12956	

	5500	465	394	5609.8	2012-11-14	2014-05-08	12933	
mar1_9_201243	50	337	5242	66.7	2012-11-09	2014-05-14	13237	
	100	337	5244	113.9	2012-11-09	2014-05-14	13237	
	175	337	4060	199.1	2012-11-09	2014-05-14	13237	
	250	337	3281	274.5	2012-11-09	2014-05-14	13234	Fouled conductivity cell after day 505.2.
	325	337	6834	351.5	2012-11-09	2014-05-14	13237	
	400	337	6839	428.2	2012-11-09	2014-05-14	13237	
	600	337	6838	630.6	2012-11-09	2014-05-14	13237	
	800	337	4062	830.8	2012-11-09	2014-05-14	13237	
	1000	337	6833	1028.1	2012-11-09	2014-05-14	13237	
	1200	337	3901	1226.7	2012-11-09	2014-05-14	13237	
	1500	310	519	1541.1	2012-11-09	2014-05-14	13235	
	1600	337	3904	1633.5	2012-11-09	2014-05-14	13237	
	2000	337	7681	2051.1	2012-11-09	2014-05-14	13237	
	2500	337	3229	2563.5	2012-11-09	2014-05-14	13237	
	3000	337	6112	3080.3	2012-11-09	2014-05-14	13237	
	3500	337	3254	3794.2	2012-11-09	2014-05-14	13237	
	4000	337	3225	4124.4	2012-11-09	2014-05-14	13238	
	4500	337	4468	4635.5	2012-11-09	2014-05-14	13237	
	5000	302	35612565	5142.7	2012-11-09	2014-05-14	13238	
	5000	337	6798	5161.1	2012-11-09	2014-05-14	13237	
mar1l7_7_201135	5220	465	33	5324.4	2011-09-25	2014-05-14	46154	
	5220	465	34	5324.1	2011-09-25	2014-05-14	46154	
mar2_9_201245	3790	337	6811	3883.7	2012-11-09	2014-05-15	13248	
	4290	337	3266	4383	2012-11-09	2014-05-15	13248	
	4790	337	3222	4888.9	2012-11-09	2014-05-15	13248	
	5170	337	3913	5280	2012-11-09	2014-05-15	13248	
	5185	302	35612576	5274.8	2012-11-09	2014-05-15	13249	

mar3_9_201240	2010	337	6841	2016.4	2012-11-05	2014-05-18	13408	
	2500	337	6832	2505.5	2012-11-05	2014-05-18	13408	
	3000	337	5245	3019.1	2012-11-05	2014-05-18	13408	
	3500	337	5241	3533.1	2012-11-05	2014-05-18	13408	
	4000	337	3268	4045.1	2012-11-05	2014-05-18	13408	
	4500	337	4178	4565	2012-11-05	2014-05-18	13408	
	4995	337	3900	5064	2012-11-05	2014-05-18	13408	
	5025	302	35612577	5110	2012-11-05	2014-05-18	13408	
mar3l7_7_201138	5050	465	35	5154.5	2011-09-22	2014-05-18	46513	
	5050	465	36	5155.6	2011-09-22	2014-05-18	46513	
eb1_11_201237	50	337	4066	53.1	2012-10-25	2014-05-23	13802	
	105	337	4713	110.7	2012-10-25	2014-05-23	13802	
	175	337	4720	183.9	2012-10-25	2014-05-23	13802	
	250	337	4718	257.6	2012-10-25	2014-05-23	13802	
	325	337	6817	333.4	2012-10-25	2014-05-23	13802	
	400	337	5765	410.6	2012-10-25	2014-05-23	13802	
	600	337	4474	610.1	2012-10-25	2014-05-23	13802	
	800	337	4473	816	2012-10-25	2014-05-23	13802	
	1000	337	4466	1012.7	2012-10-25	2014-05-23	13802	
	1200	337	4462	1220.3	2012-10-25	2014-05-23	13802	
	1500	310	518	1527	2012-10-25	2014-04-24	13102	Battery depleted
	1600	337	3259	1626.4	2012-10-25	2014-05-23	13802	
	2000	337	3257	2047.1	2012-10-25	2014-05-23	13802	
	2500	337	3255	2537.4	2012-10-25	2014-05-23	13802	
	3000	337	3271	3051.6	2012-10-25	2014-05-23	13802	
	3500	337	5238	3569.8	2012-10-25	2014-05-23	13802	
	4000	337	3919	4077.2	2012-10-25	2014-05-23	13802	
	4500	337	3256	4608.6	2012-10-25	2014-05-23	13802	
	5000	310	507	5108.6	2012-10-25	2014-04-21	13015	Battery depleted

	5000	337	6829	5109.1	2012-10-25	2014-05-23	13802	
eb1l8_8_201123	5100	465	12	5194	2011-09-17	2014-05-24	46656	
	5100	465	58	5195	2011-09-17	2012-08-10	15716	Depleted battery
ebhi_9_201235	3500	337	3247	3448.2	2012-10-23	2014-05-26	13918	
	4000	337	3484	4008.9	2012-10-23	2014-05-26	13918	
	4400	310	451	4469.1	2012-10-23	2014-05-26	13919	
	4500	337	6819	4569.5	2012-10-23	2014-05-26	13918	
ebh1l8_8_201126	3012	465	396	3059.8	2011-10-07	2014-05-29	46316	
	3012	465	397	3060.1	2011-10-07	2014-05-29	46317	
ebh1_9_201230	2500	337	3251	2537.6	2012-10-16	2014-05-29	14157	
	2900	310	450	2980.3	2012-10-16	2014-05-29	14157	
	3000	337	5766	3080.4	2012-10-16	2014-05-29	14157	
ebh2_9_201232	1600	337	3207	1617.2	2012-10-16	2014-05-30	14171	
	1800	337	3252	1830.8	2012-10-16	2014-05-30	14171	
	1900	310	516	1937.6	2012-10-16	2014-04-30	13224	Battery depleted.
	2000	337	3220	2035.8	2012-10-16	2014-05-30	14171	
ebh3_9_201233	55	337	3212	51.4	2012-10-17	2014-05-30	14156	
	110	337	3277	101.5	2012-10-17	2014-05-30	14156	
	185	337	6823	176.3	2012-10-17	2014-05-30	14156	
	250	337	4712	246.9	2012-10-17	2014-05-30	14156	
	342	337	6816	332.2	2012-10-17	2014-05-30	14156	
	418	337	5777	411.6	2012-10-17	2014-05-30	14155	
	500	310	428	501.9	2012-10-17	2014-05-01	13460	Battery depleted
	500	337	4710	496.2	2012-10-17	2014-05-30	14156	
	607	337	3213	596.1	2012-10-17	2014-05-30	14156	
	704	337	3912	693.5	2012-10-17	2014-05-30	14156	
	805	310	443	805	2012-10-17	2014-05-01	13464	Battery depleted
	805	337	3893	808.5	2012-10-17	2014-05-30	14156	
	950	337	3249	948.4	2012-10-17	2014-05-30	14156	

	1000	310	444	1007.5	2012-10-17	2014-05-01	13463	Battery depleted
	1090	337	5772	1095	2012-10-17	2014-05-30	14156	
	1200	337	3214	1203.5	2012-10-17	2014-05-30	14156	
	1300	310	515	1316.1	2012-10-17	2014-05-01	13464	Battery depleted
	1400	337	3253	1420.5	2012-10-17	2014-05-30	14156	
ebh4l3_3_201233	1009	465	3	1015.5	2011-10-08	2014-05-31	46344	
	1009	465	13	1015.8	2011-10-07	2014-05-31	46391	
ebh4_10_201239	100	337	3230	100.5	2012-10-28	2014-05-31	13914	
	175	337	3215	173.4	2012-10-28	2014-05-31	13914	
	250	337	6818	260.7	2012-10-28	2014-05-31	13914	
	325	337	3244	327.5	2012-10-28	2014-05-31	13914	
	400	337	3224	409.3	2012-10-28	2014-05-31	13914	
	500	337	3265	502.7	2012-10-28	2014-05-31	13914	
	600	337	3264	611	2012-10-28	2014-05-31	13914	
	700	337	6831	710.5	2012-10-28	2014-05-31	13914	
	800	337	3216	817.4	2012-10-28	2014-05-31	13914	
	950	366	D332	-	-	-	-	No data. Low pressure flood.
	1000	337	3907	1008.6	2012-10-28	2014-05-31	13914	
ebp2_2_20111	1000	316	131	1036.5	2011-01-13	2014-05-31	177631	

14.5 Current meter summary sheet

Sound speed was calculated using a measured temperature and salinity of 35 for each instrument except the RCM11s for which a constant `1500m/s` was used. please note unusual date format in this table. All dates are in MM/DD/YY format.

Mooring	Nominal Depth (m)	Inst. type	Serial number	Mean Pressure (dbar)	Start date	End date	No. records	Comment and filenames
`wb4_10_201250`	100	RCM11	399					Shallow pressure flood. No data.

	400	Nortek	5590	458.3	11/19/12	4/30/14	25294	`wb401_5590_data.dat`
								`wb401_5590_data.hdr`
								`wb401_5590_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.,

	800	Nortek	5611	858.9	11/19/12	4/30/14	25294	`wb4_c_01_5611_data.dat`
								`wb4_c_01_5611_data.hdr`
								`wb4_c_01_5611_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.,

	1200	Nortek	5831	1275.9	11/19/12	4/30/14	25292	`wb401_5831_data.dat`
								`wb401_5831_data.hdr`
								`wb401_5831_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.,

	1500	Nortek	5893	1571.6	11/19/12	4/30/14	25294	`wb401_5893_data.dat`
								`wb401_5893_data.hdr`
								`wb401_5893_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.,

	2000	Nortek	5896	2081.5	11/19/12	4/30/14	25294	`wb401_5896_data.dat`
								`wb401_5896_data.hdr`
								`wb401_5896_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.,

	3000	Nortek	5899	3097.5	11/19/12	4/30/14	25294	`wb401_5899_data.dat`
								`wb401_5899_data.hdr`
								`wb401_5899_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.,

	4000	Nortek	5955	4113.8	11/19/12	4/30/14	25294	`wb401_5995_data.dat`
								`wb401_5995_data.hdr`
								`wb401_5995_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.,

	4600	Nortek	6049	4725.4	11/19/12	4/30/14	25294	`wb401_6049_data.dat`
								`wb401_6049_data.hdr`
								`wb401_6049_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.,

`wb2_11_201251`	100	RCM11	306					Flooded
	175	RCM11	395	171.3	11/20/12	5/2/14		`wb2_11_201251_395.use` (rodb ASCII format)

	400	Nortek	6747	391.1	11/20/12	5/2/14	25330	`wb201_6747_data.dat`
								`wb201_6747_data.hdr`
								`wb201_6747_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.,

	800	Nortek	5889	798.6	11/20/12	5/2/14	25330	`wb201_5889_data.dat`
								`wb201_5889_data.hdr`
								`wb201_5889_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.,

	1200	Nortek	6805	1204.1	11/20/12	5/2/14	25330	`wb201_6805_data.dat`
								`wb201_6805_data.hdr`
								`wb201_6805_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.

	1500	Nortek	8052	1513	11/20/12	5/2/14	25330	`wb201_8052_data.dat`
								`wb201_8052_data.hdr`
								`wb201_8052_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.

	2050	Nortek	8120	2061.9	11/20/12	5/2/14	25330	`wb201_8052_data.dat`
								`wb201_8052_data.hdr`
								`wb201_8052_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.

	3000	Nortek	9204	3046	11/20/12	5/2/14	25330	`wb201_9204_data.dat`
								`wb201_9204_data.hdr`
								`wb201_9204_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.

`wb1_10_201248`	100	Nortek	6723	74.5	11/17/12	5/3/14	25530	`wb101_6723.dat`
								`wb101_6723.hdr`
								`wb101_6723.dia`
								Blanking distance as intended (1.5m).

	400	Nortek	6088	382.5	11/17/12	5/3/14	25530	`wb101_6088.dat`
								`wb101_6088.hdr`
								`wb101_6088.dia`
								Blanking distance as intended (1.5m).

	800	Nortek	6765	798.8	11/17/12	5/3/14	25530	`wb101_6765.dat`
								`wb101_6765.hdr`
								`wb101_6765.dia`
								Blanking distance as intended (1.5m).

	1200	Nortek	6534	1206.3	11/17/12	5/3/14	25530	`wb101_6534.dat`
								`wb101_6534.hdr`
								`wb101_6534.dia`
								Blanking distance as intended (1.5m).

`wbadcp_9_201206`	614	ADCP 75kHz	5817		2/28/1	11/21/12		`10311_data.mat` Short record due to battery failure.

`wbh2_7_201253`	1500	Nortek	9210	1376.6	11/22/12	5/4/14	25353	`wbh201_9210_data.dat`
								`wbh201_9213_data.hdr`
								`wbh201_9435_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.

	2200	Nortek	9213	2082.7	11/22/12	5/4/14	25353	`wbh201_9213_data.dat`
								`wbh201_9213_data.hdr`
								`wbh201_9213_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.

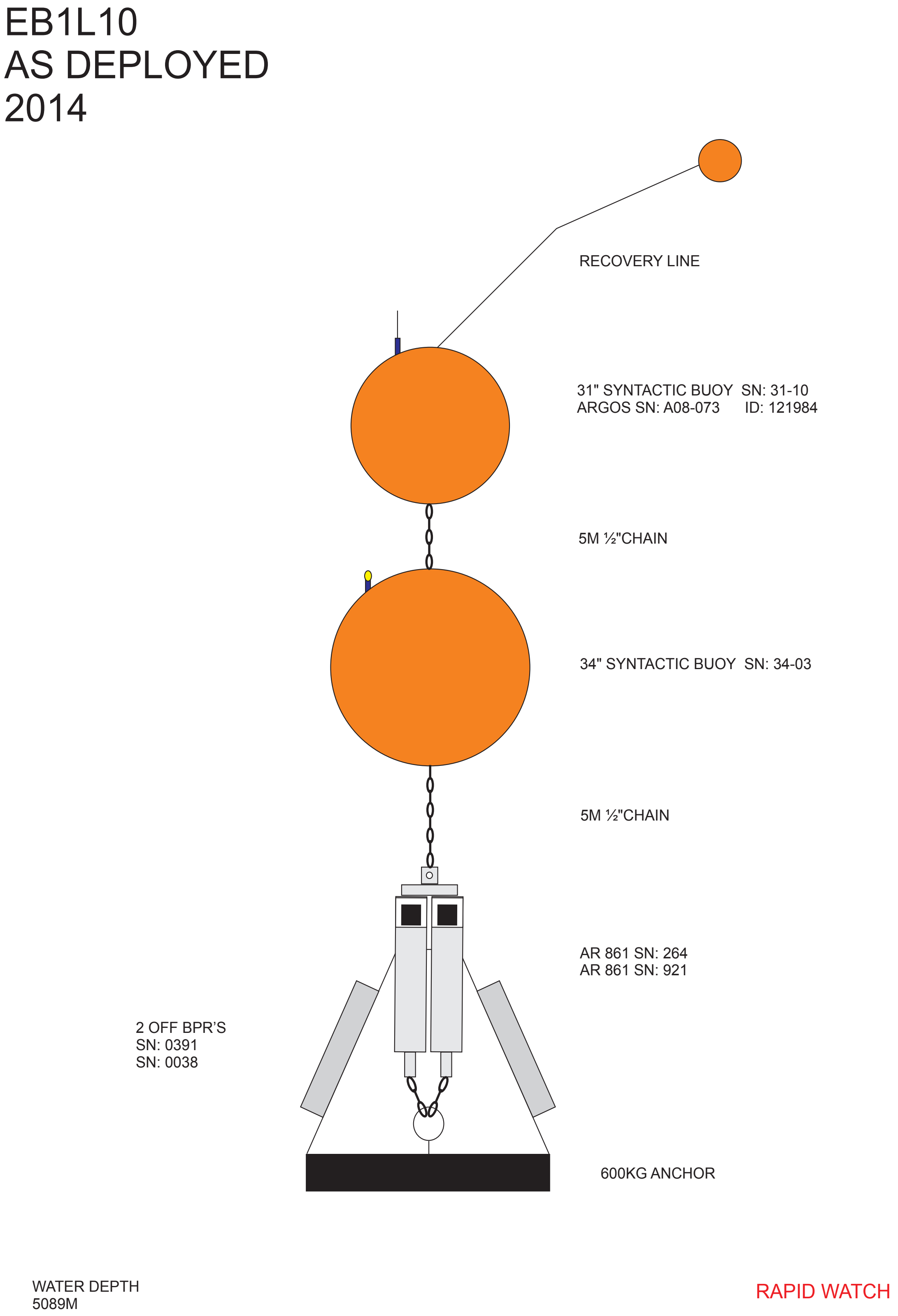
	3000	Nortek	9435	2923.3	11/22/12	5/4/14	25353	`wbh201_9435_data.dat`
								`wbh201_9435_data.hdr`
								`wbh201_9435_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.

	3800	Nortek	5490	3784.9	11/22/12	5/4/14	25353	`wbh201_5490_data.dat`
								`wbh201_5490_data.hdr`
								`wbh201_5490_data.dia`
								Blanking distance problem (intended 1.5m, instrument says 3.48m). Bias in w velocity.

	4600	RCM11	426	4678.4	11/22/12	5/4/14	12607	`wbh2_7_201253_426.use` (rodb ASCII format)

`wb6_7_201247`	5400	Nortek	6050	5494.3	11/14/12	5/8/14	25913	`wb601_6050_data.dat`
								`wb601_6050_data.hdr`
								`wb601_6050_data.dia`
								Blanking distance as intended (1.5m).

15 Deployed Mooring Diagrams



EB 1
AS DEPLOYED
2014

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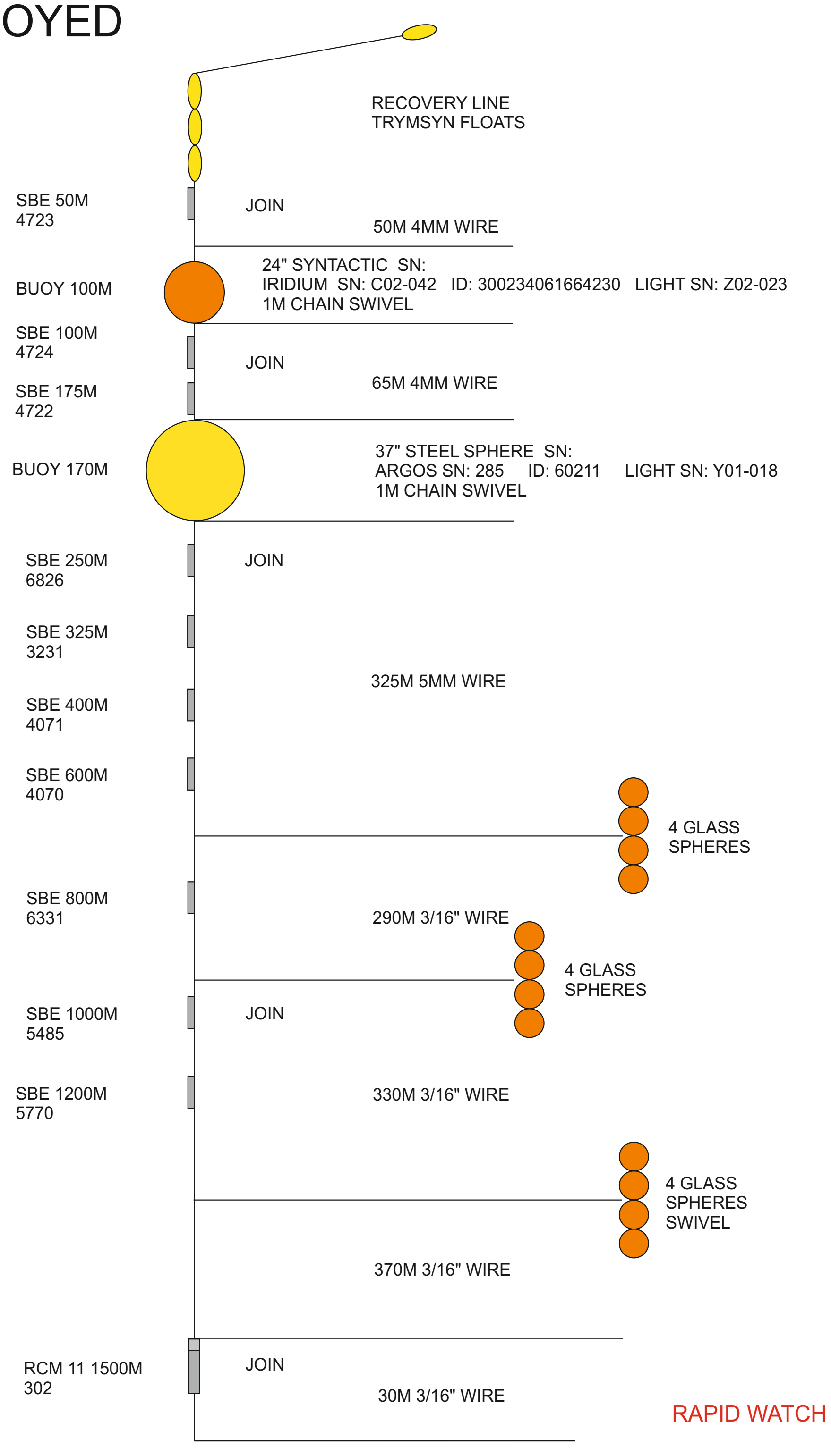

EB 1
AS DEPLOYED
2014

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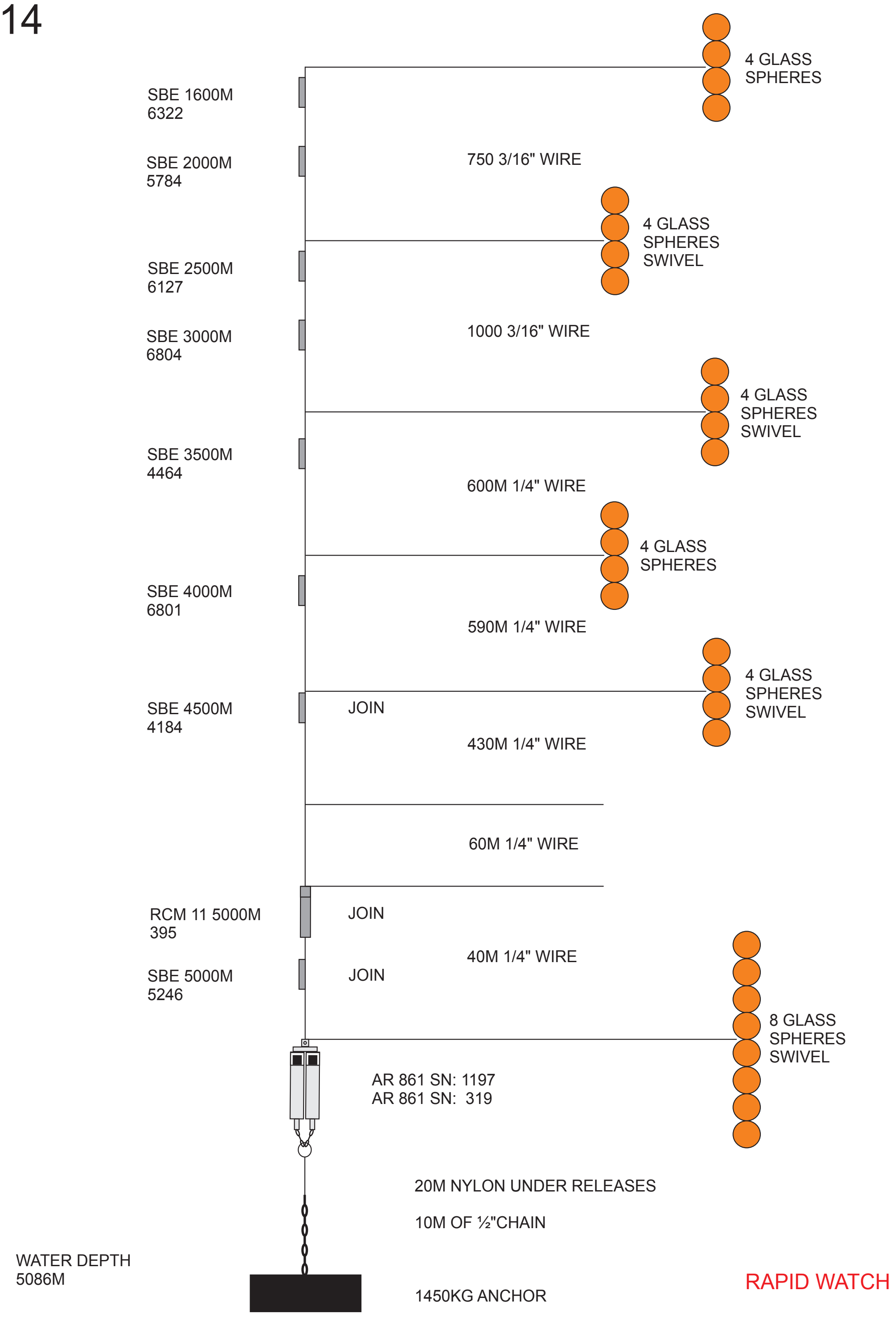
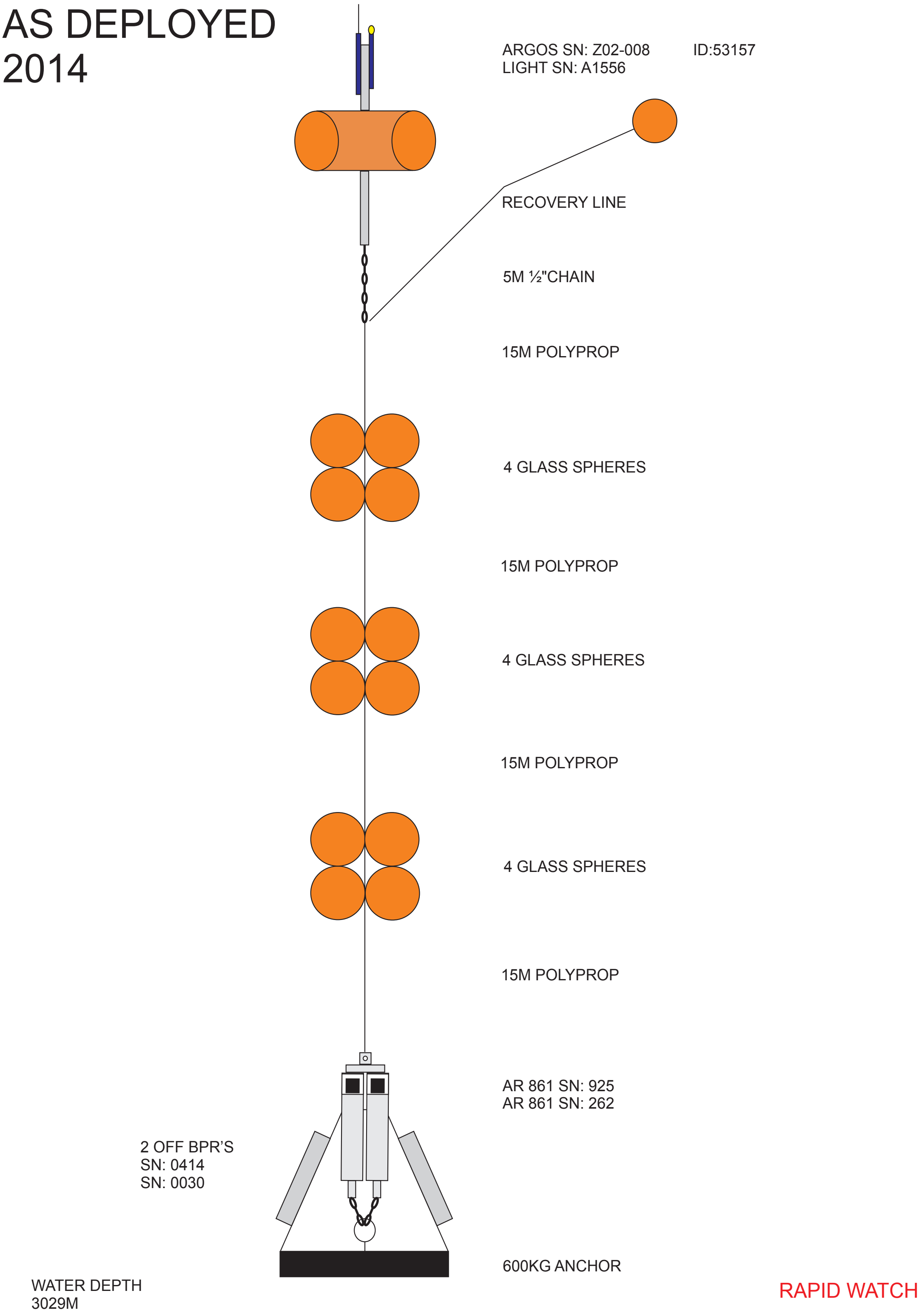
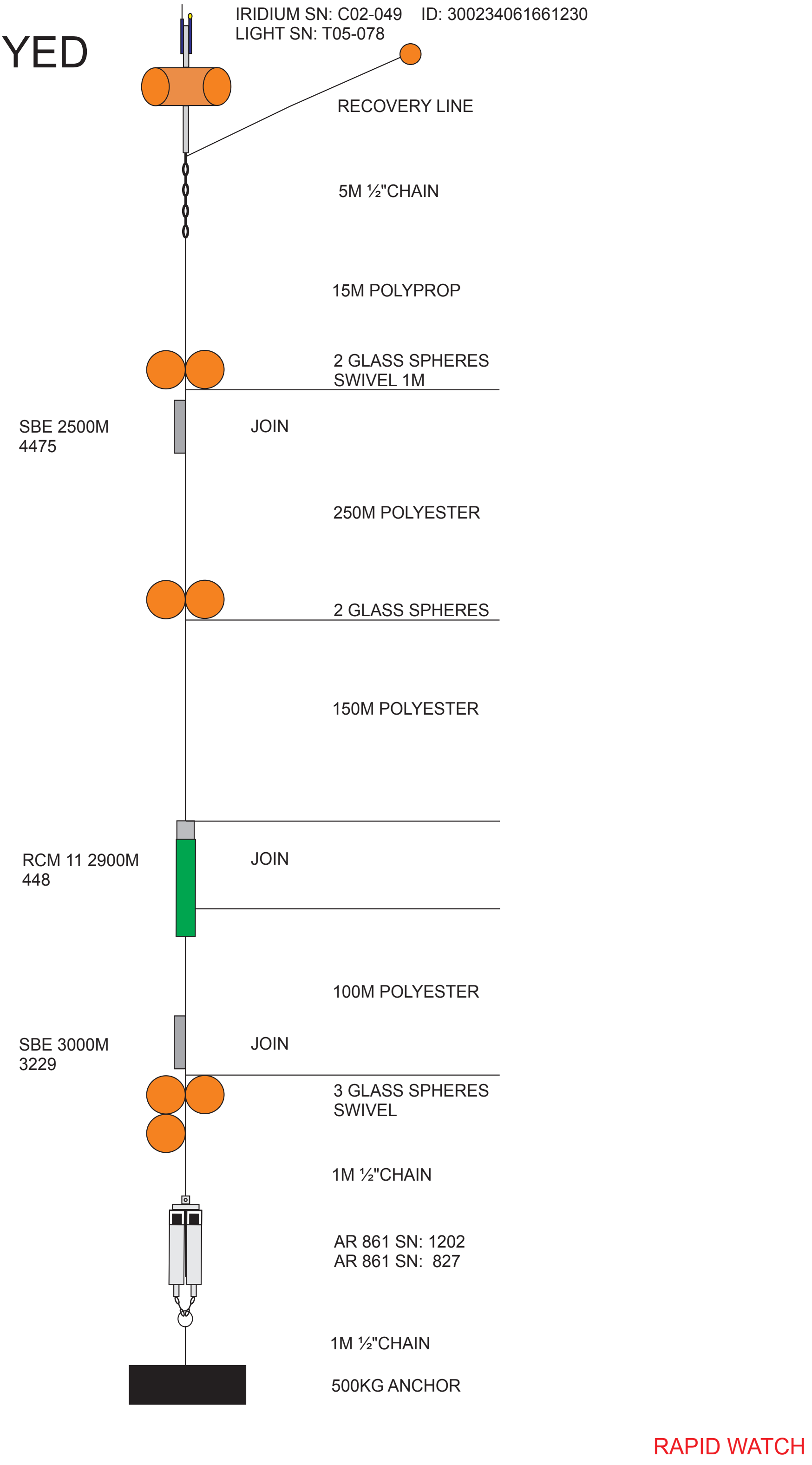


EBH1L10
AS DEPLOYED
2014

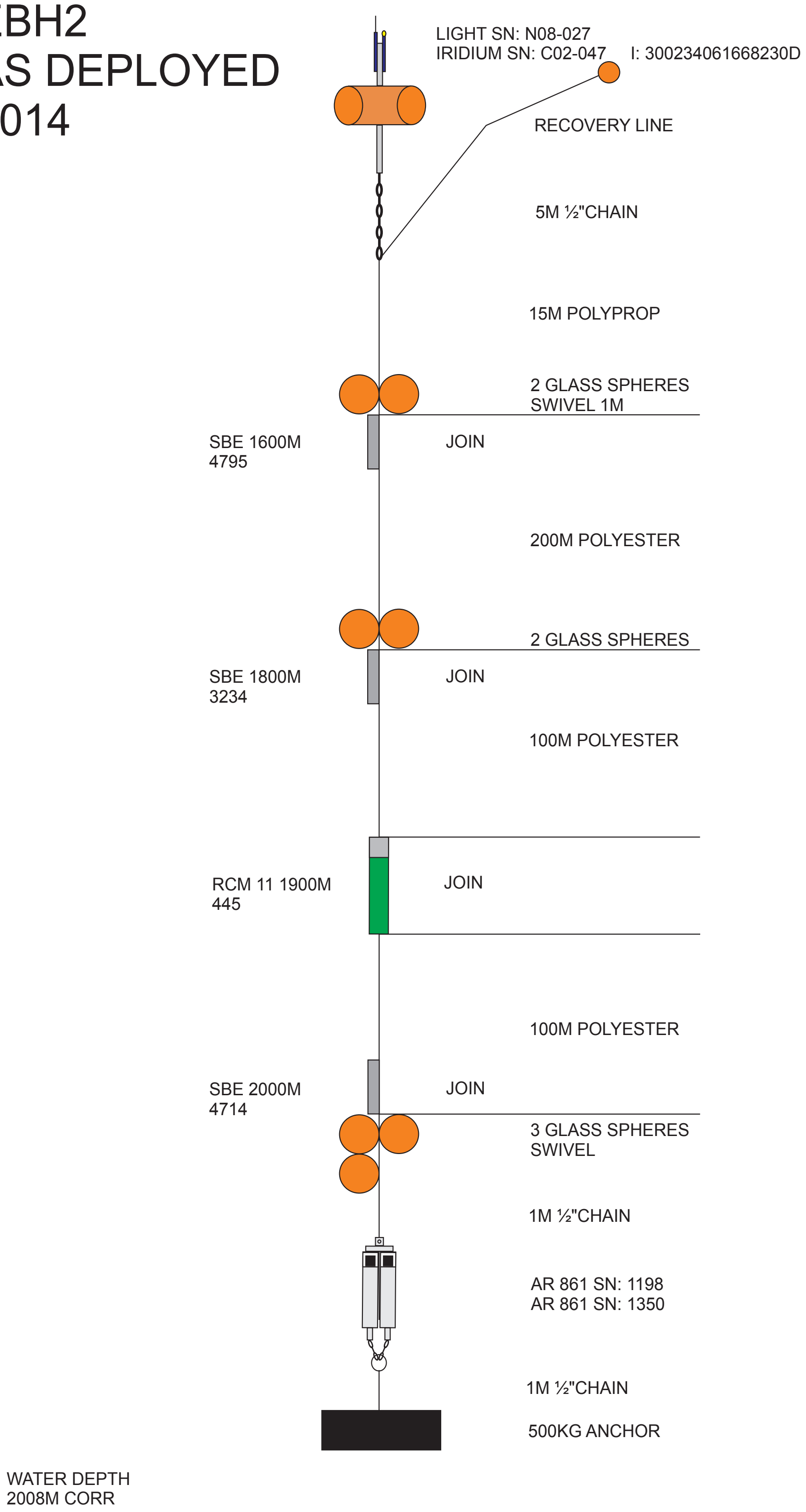


EBH1
AS DEPLOYED
2014



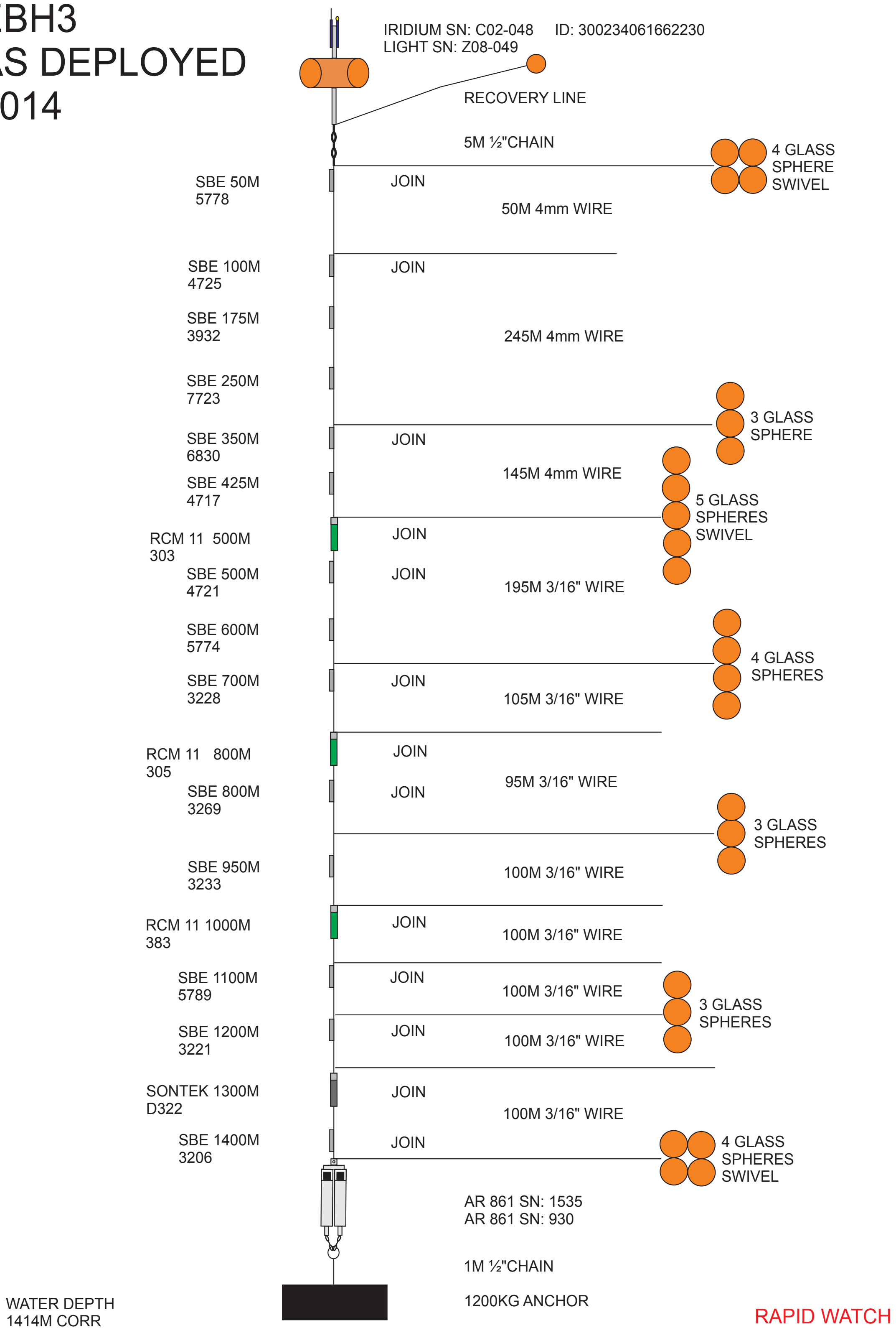
WATER DEPTH
2977M CORR

EBH2
AS DEPLOYED
2014

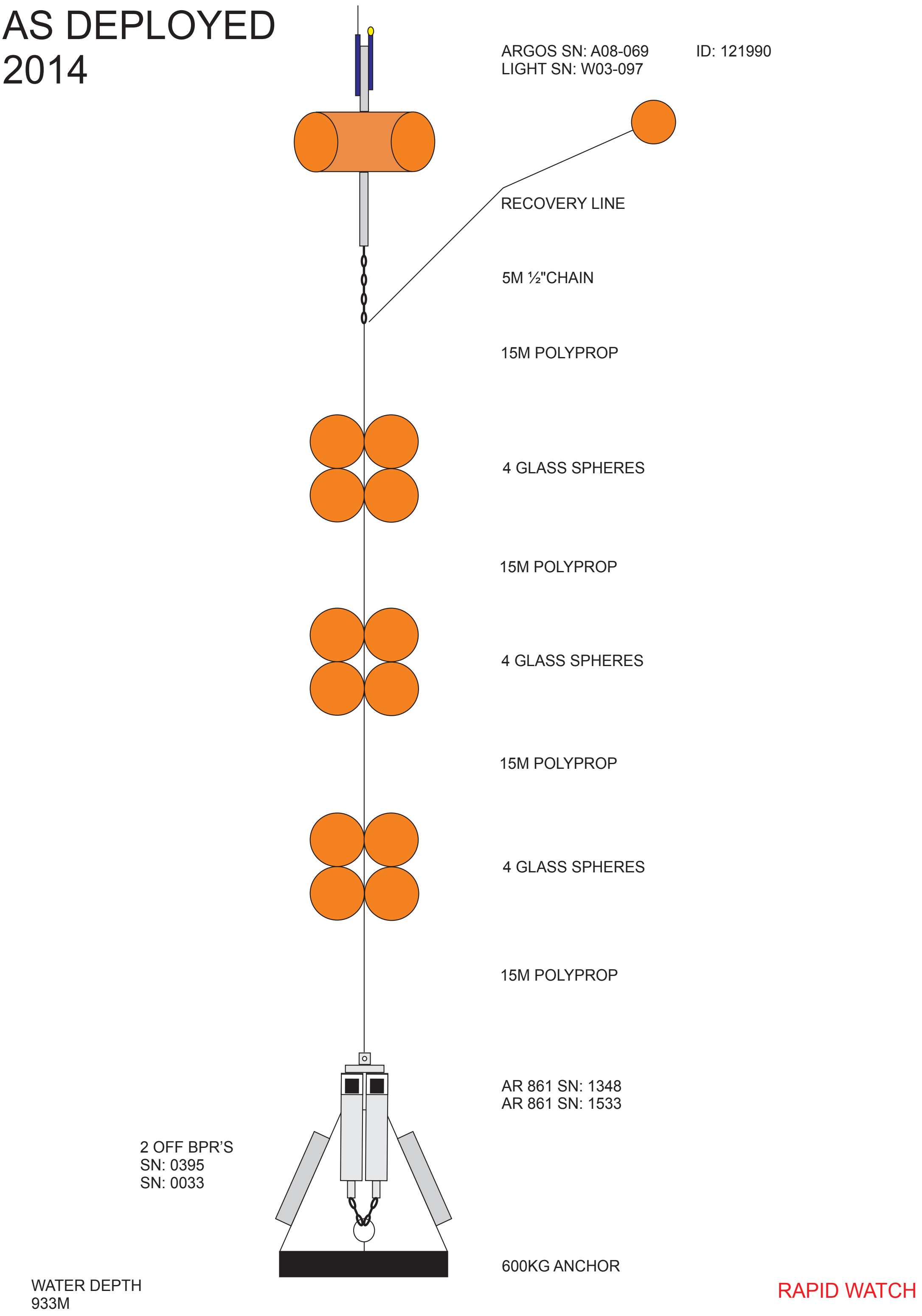


RAPID WATCH

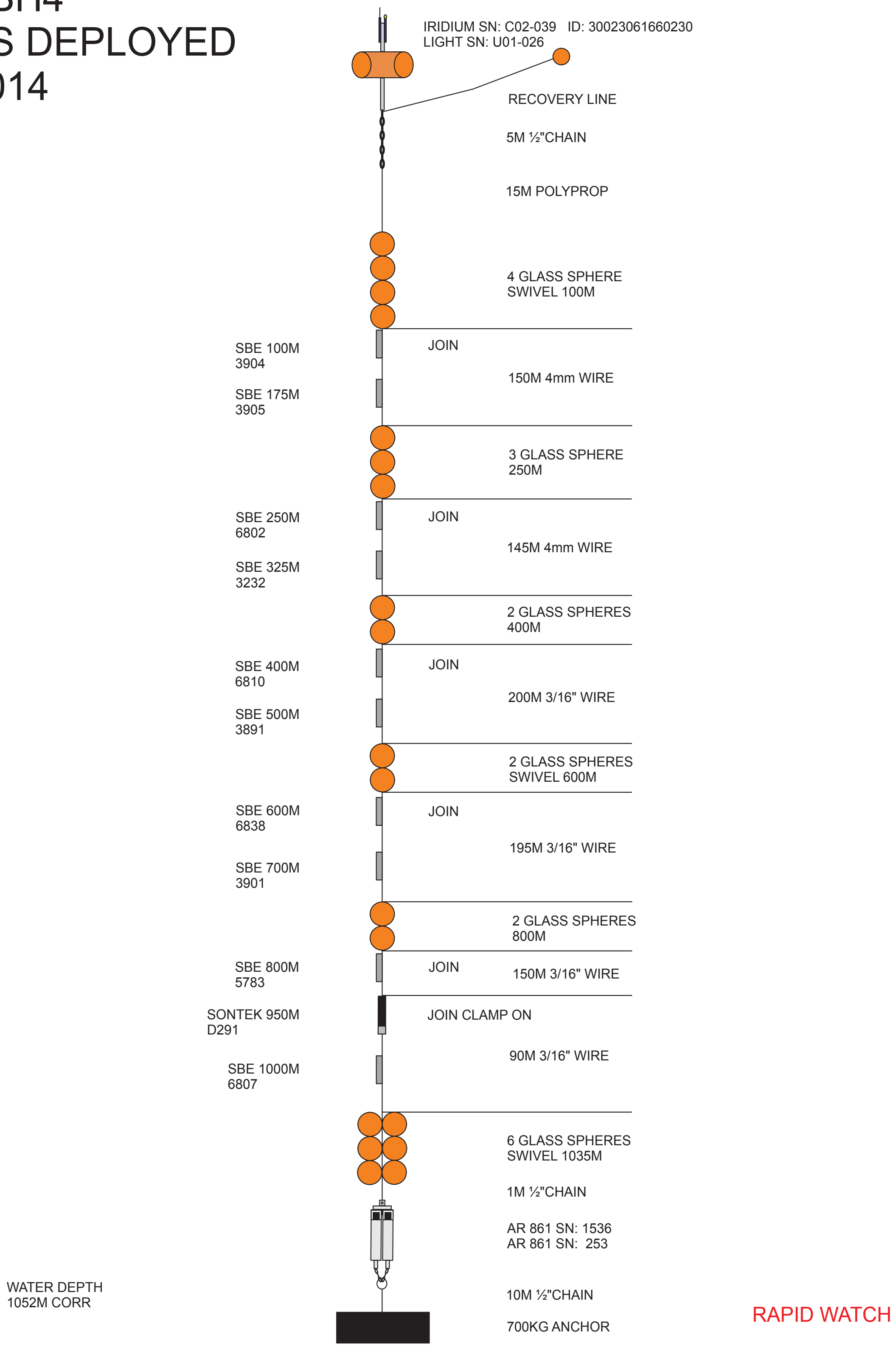
EBH3
AS DEPLOYED
2014



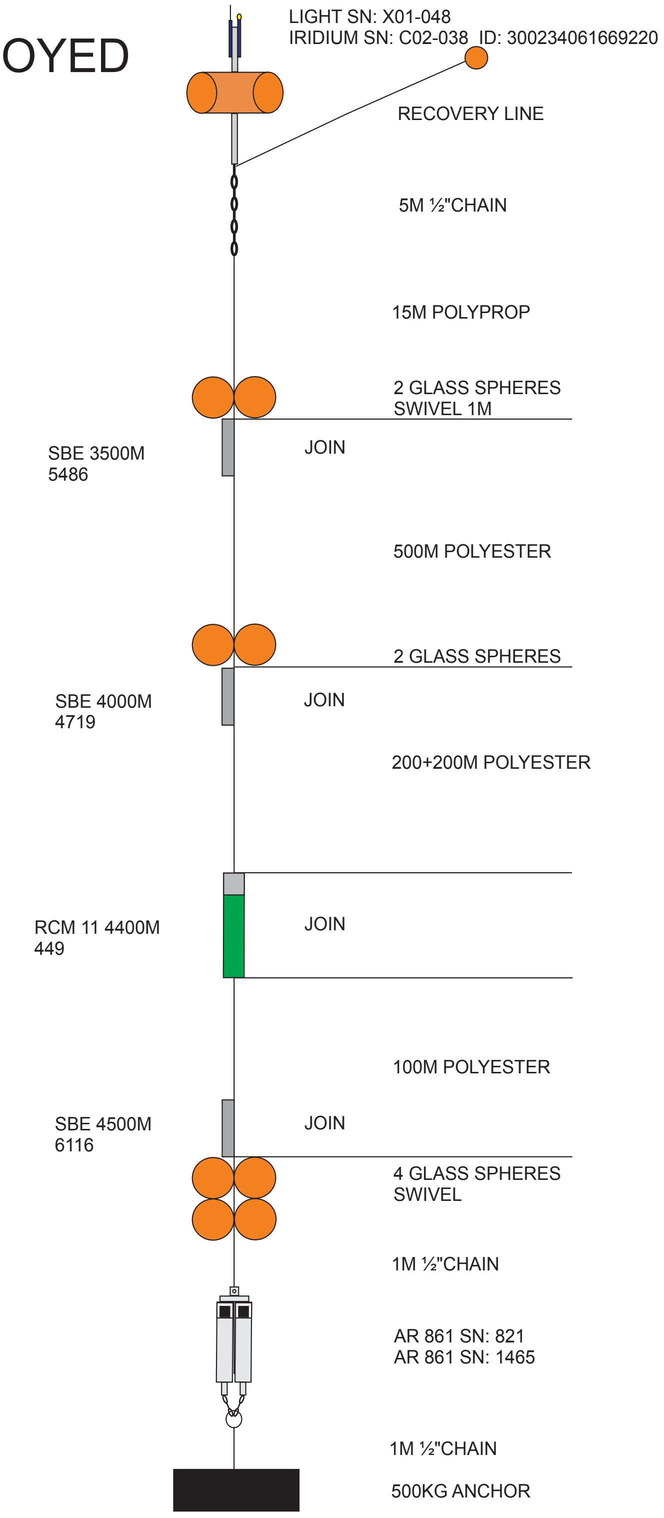
EBH4L5
AS DEPLOYED
2014



EBH4
AS DEPLOYED
2014



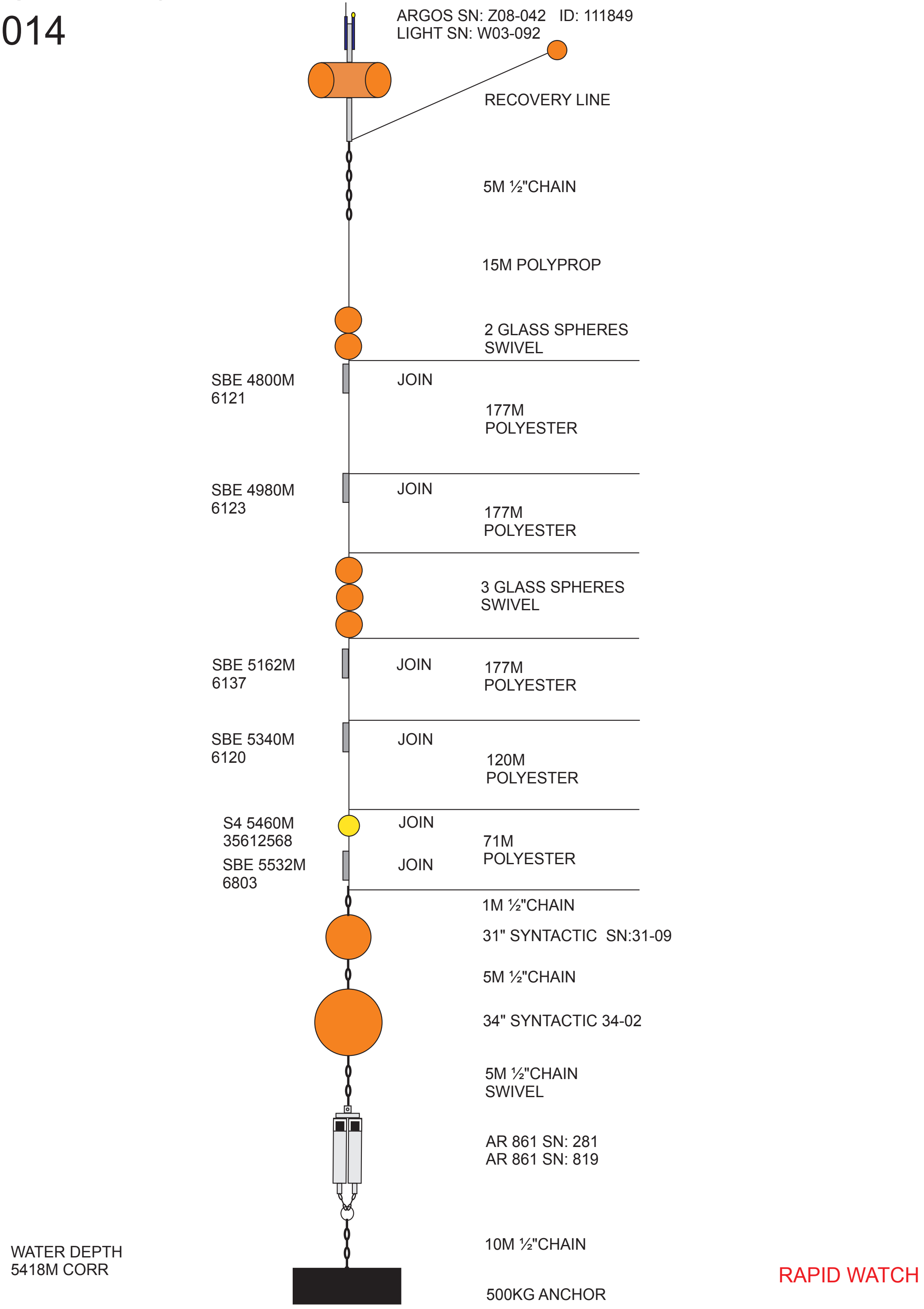
EBHi
AS DEPLOYED
2014



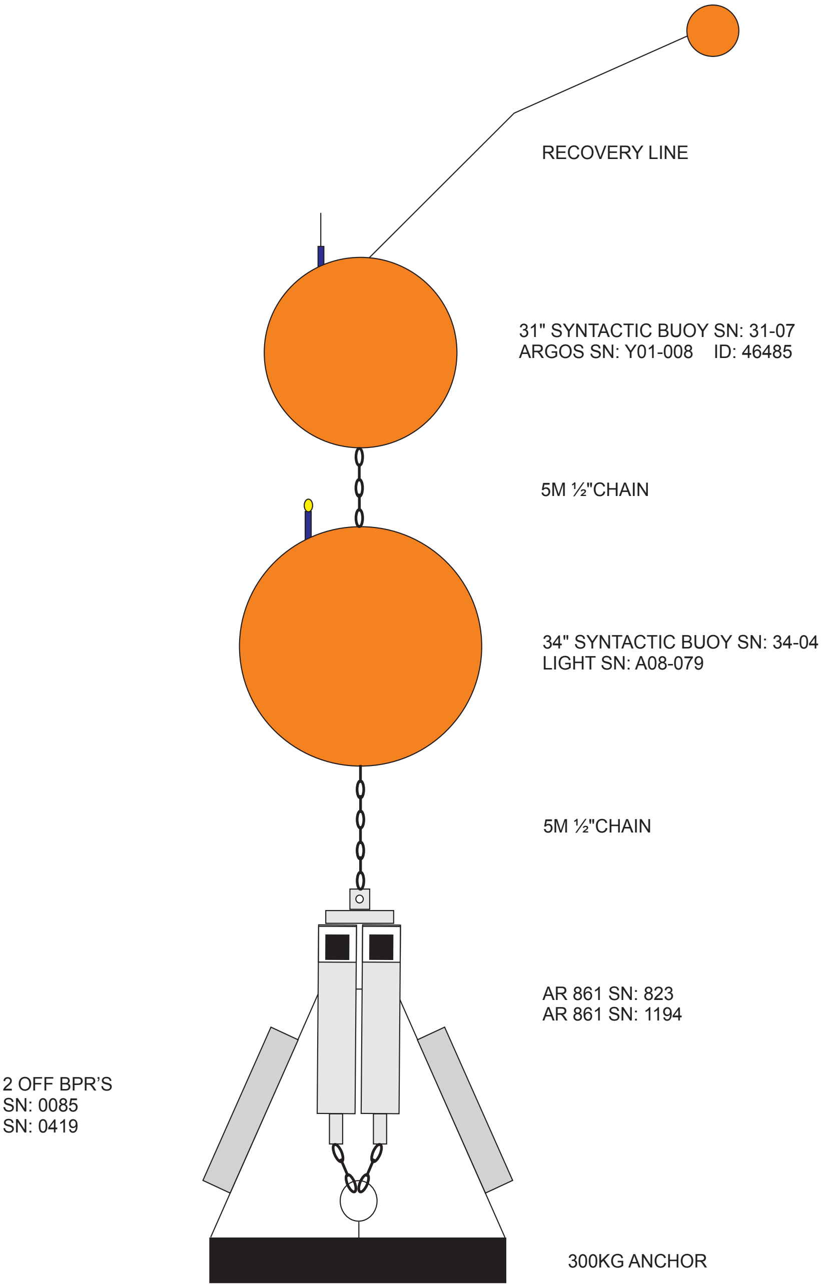
WATER DEPTH
4463M CORR

RAPID WATCH

MAR0
AS DEPLOYED
2014



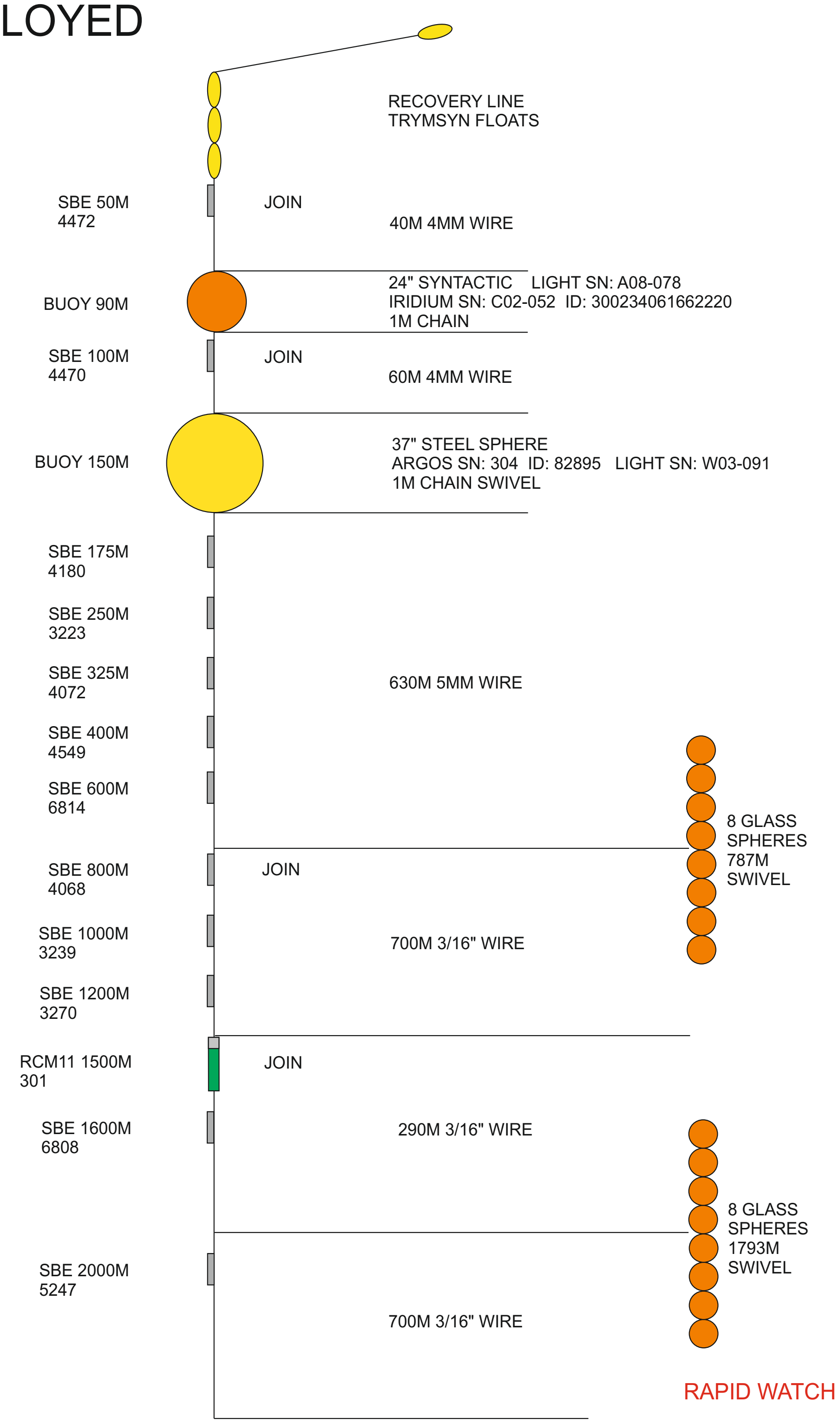
MAR1L9
AS DEPLOYED
2014



WATER DEPTH
5220M

RAPID WATCH

MAR 1
AS DEPLOYED
2014



MAR 1
AS DEPLOYED
2014

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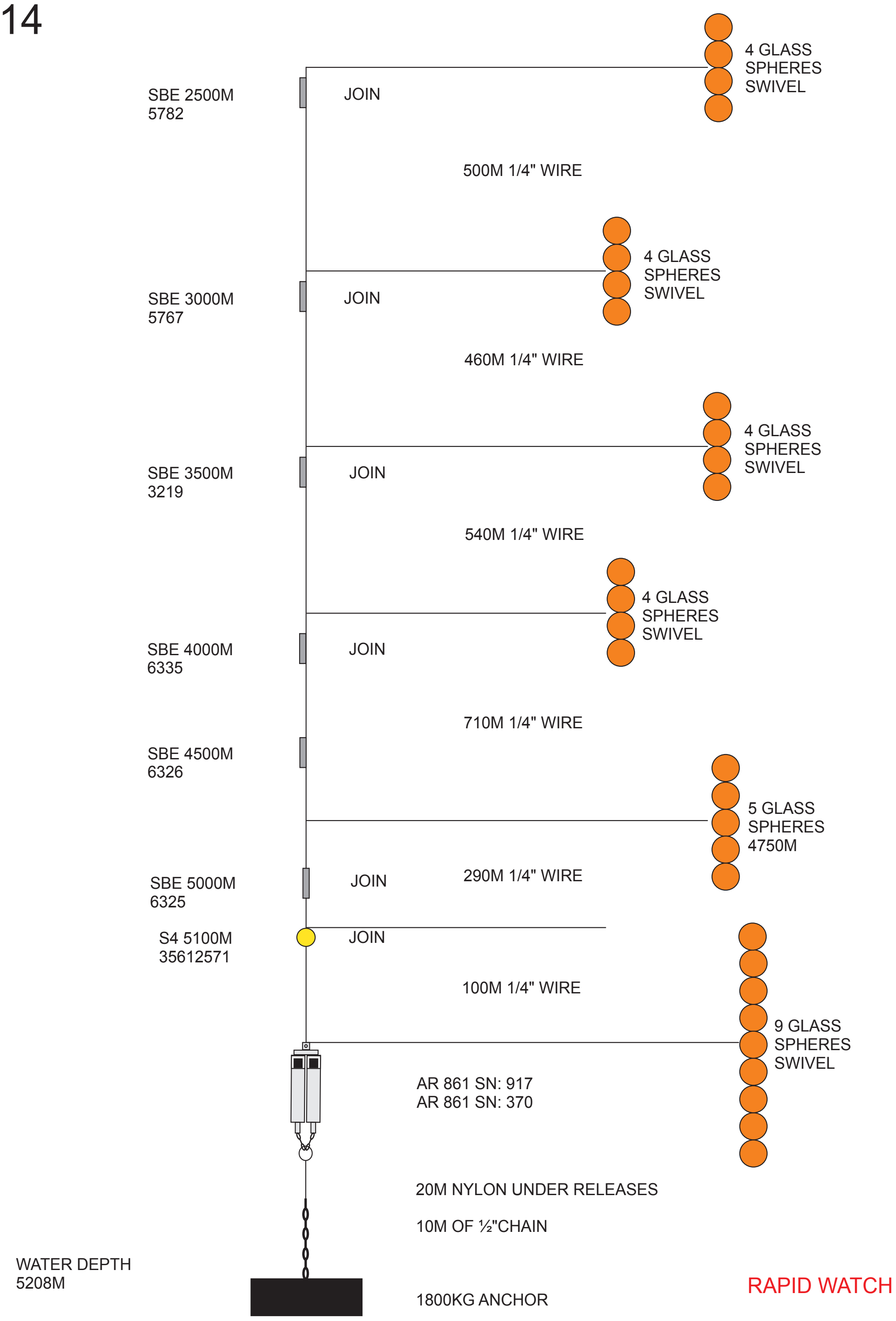
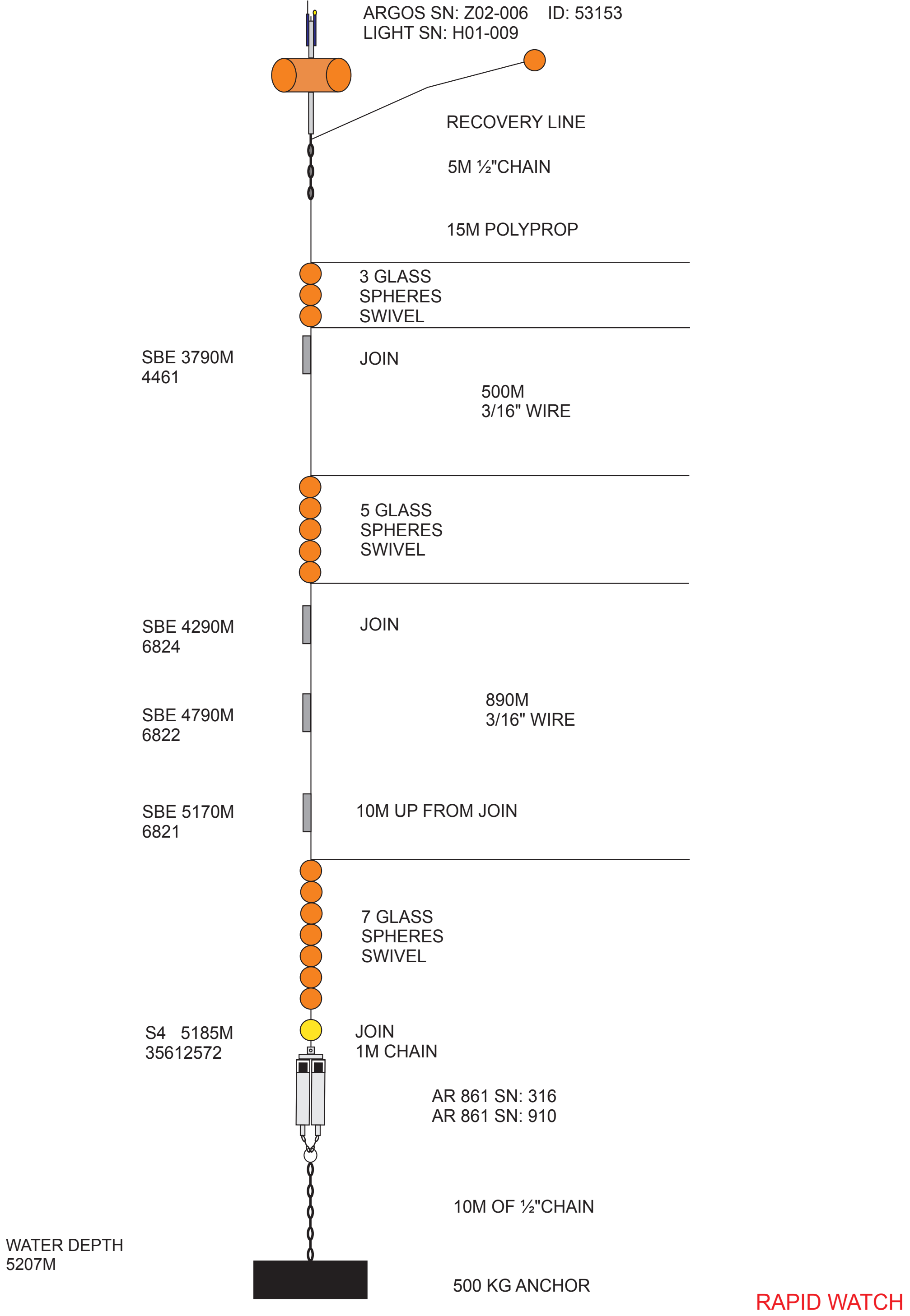
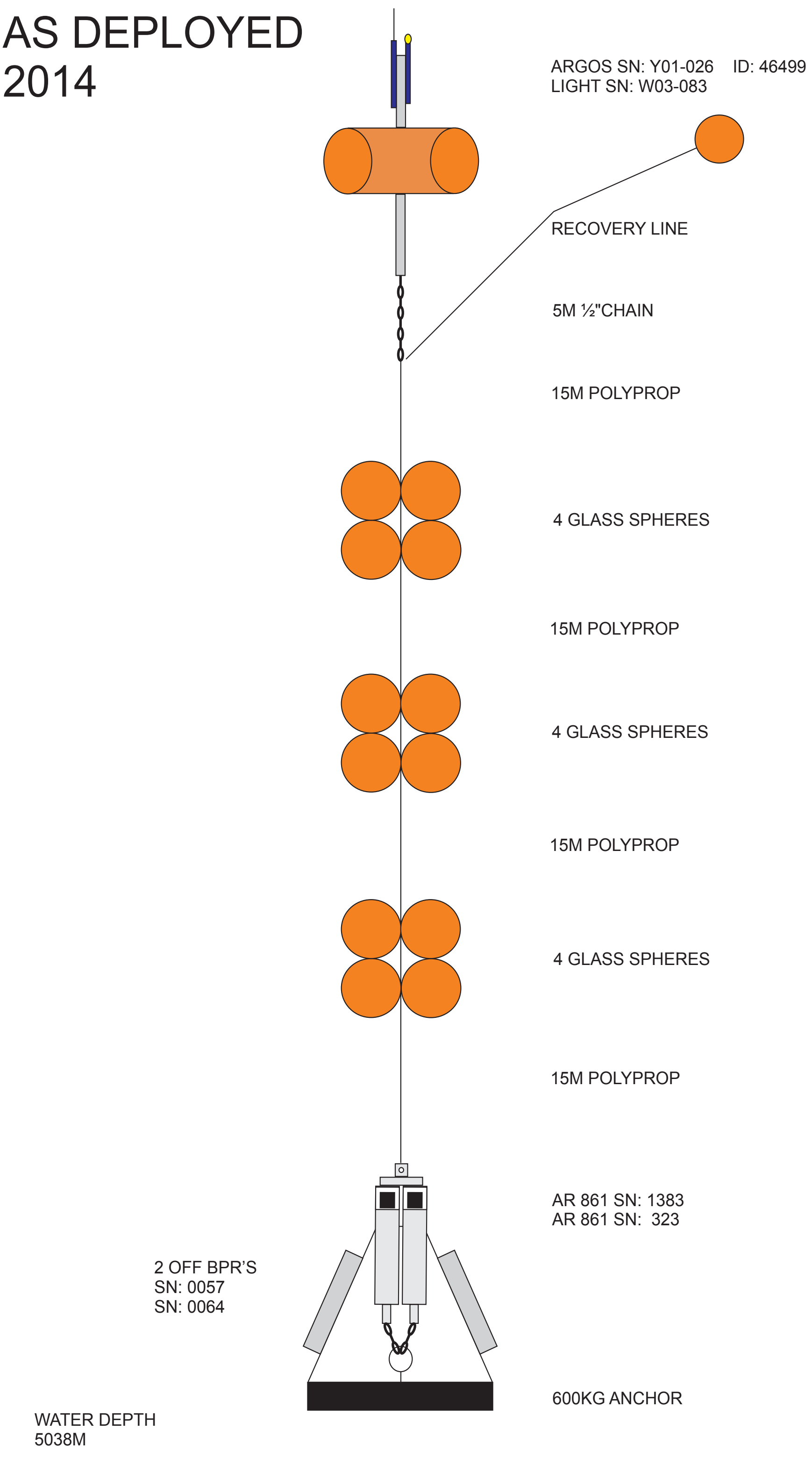


MAR 2
AS DEPLOYED
2014

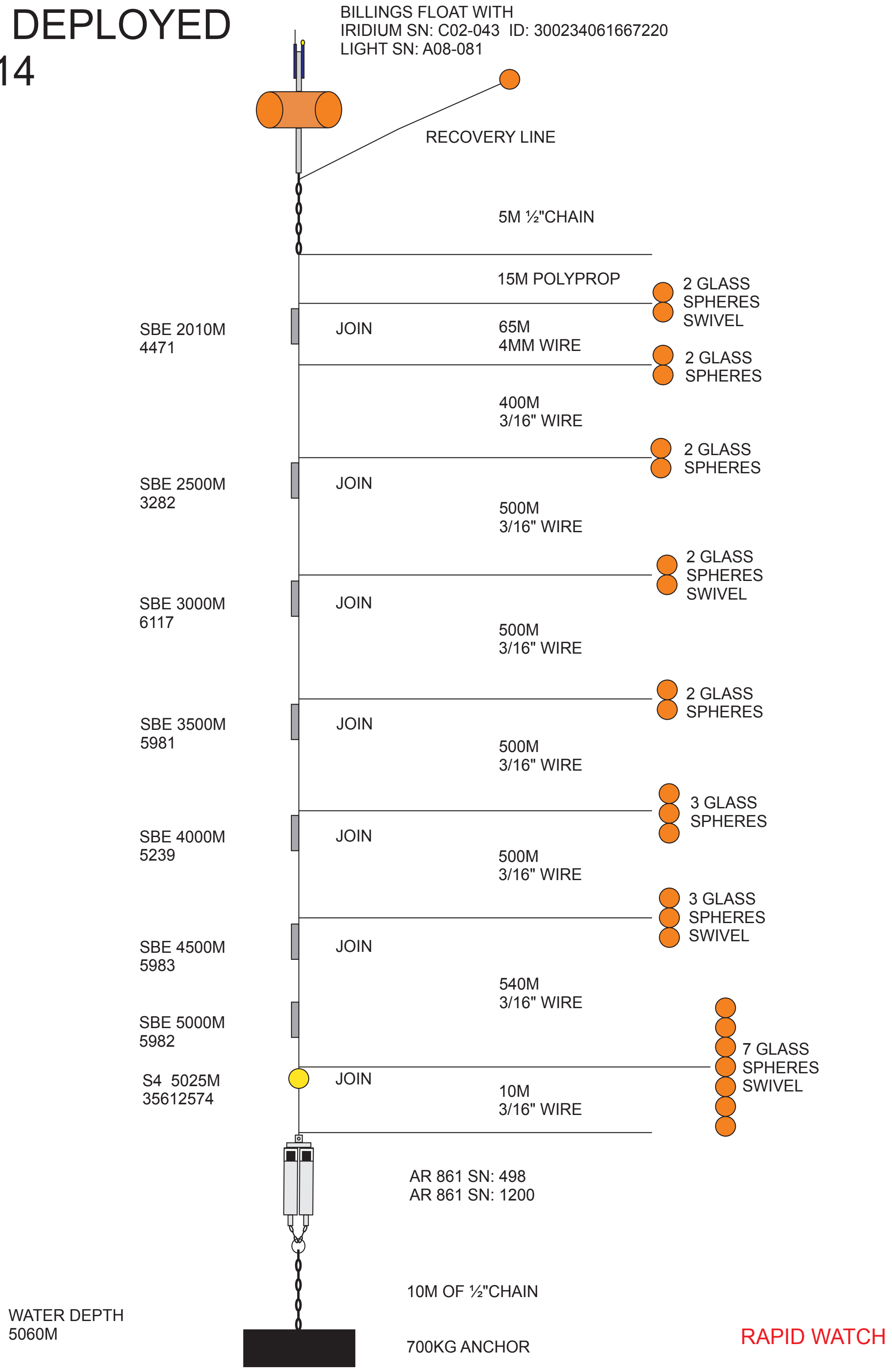


MAR3L9
AS DEPLOYED
2014

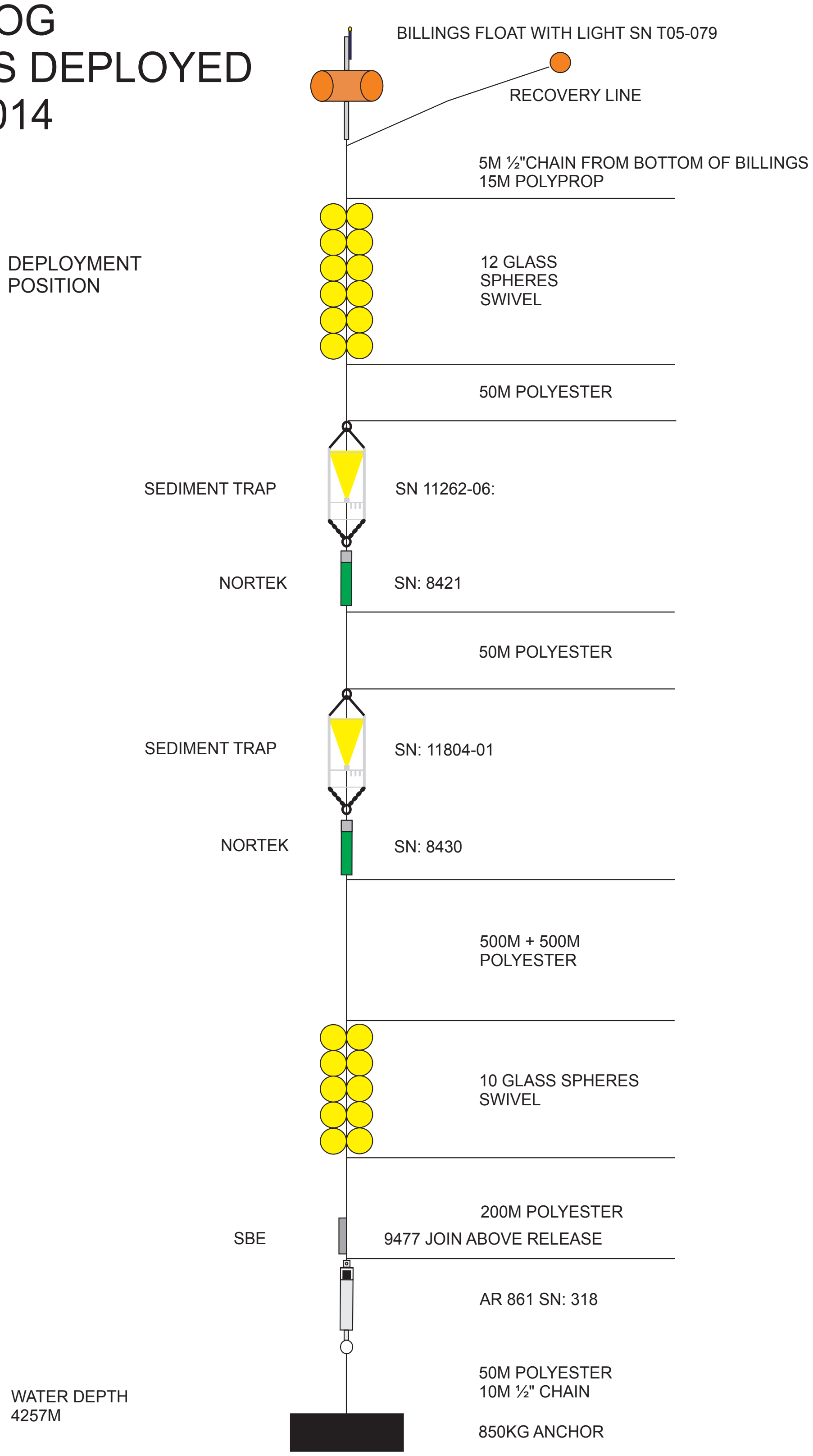


RAPID WATCH

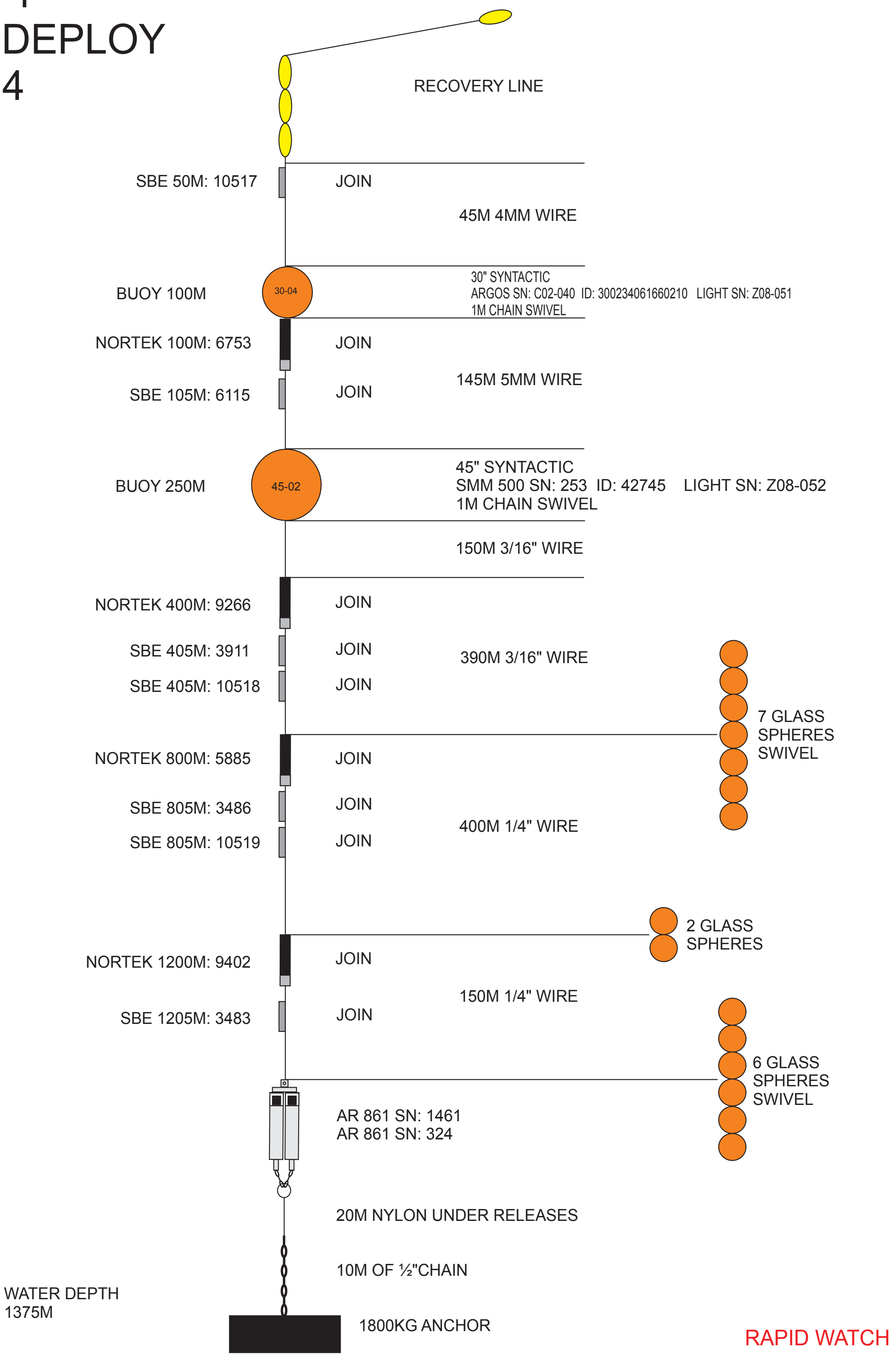
MAR 3
AS DEPLOYED
2014



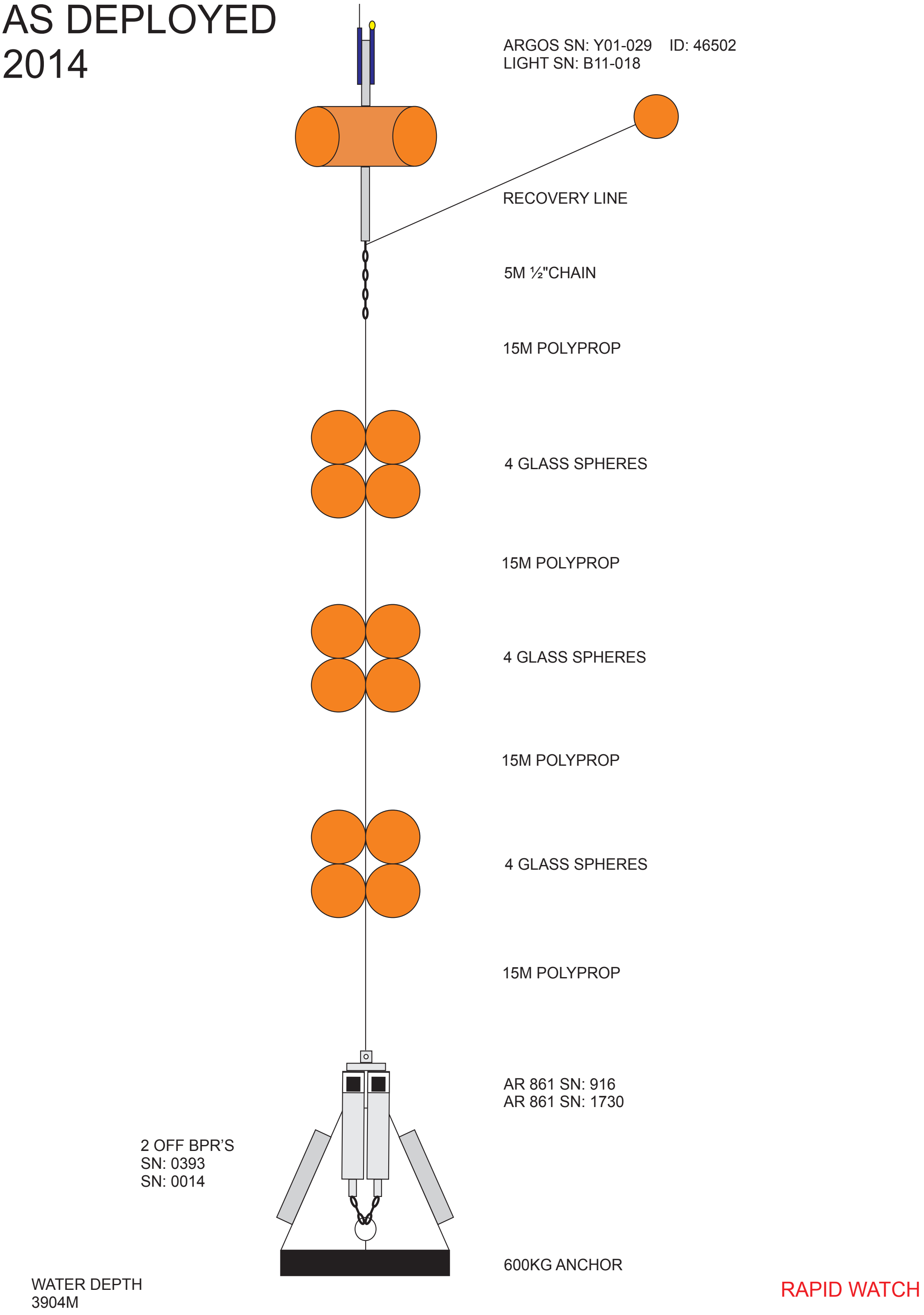
NOG
AS DEPLOYED
2014



WB 1
TO DEPLOY
2014

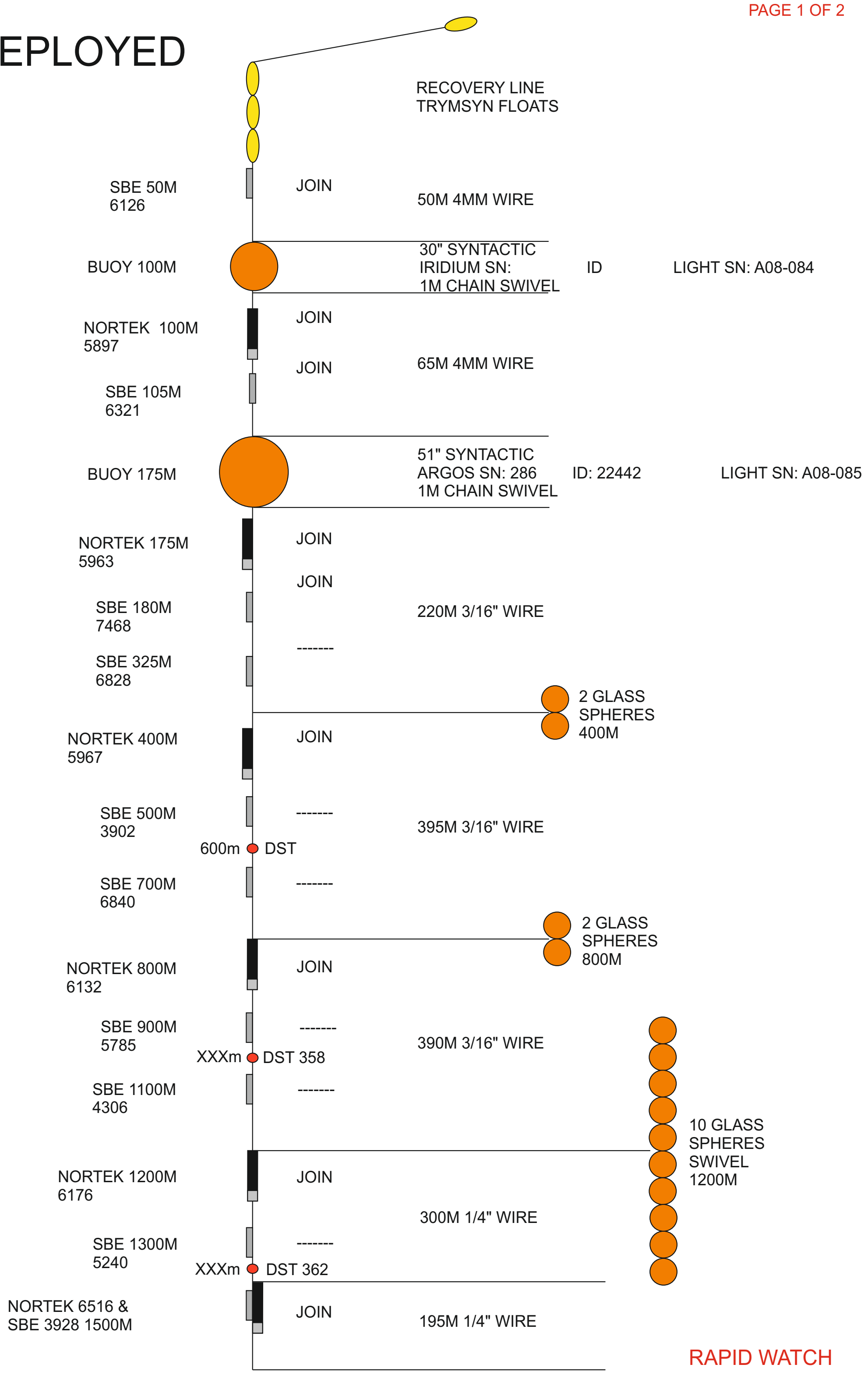


WB2L10
AS DEPLOYED
2014



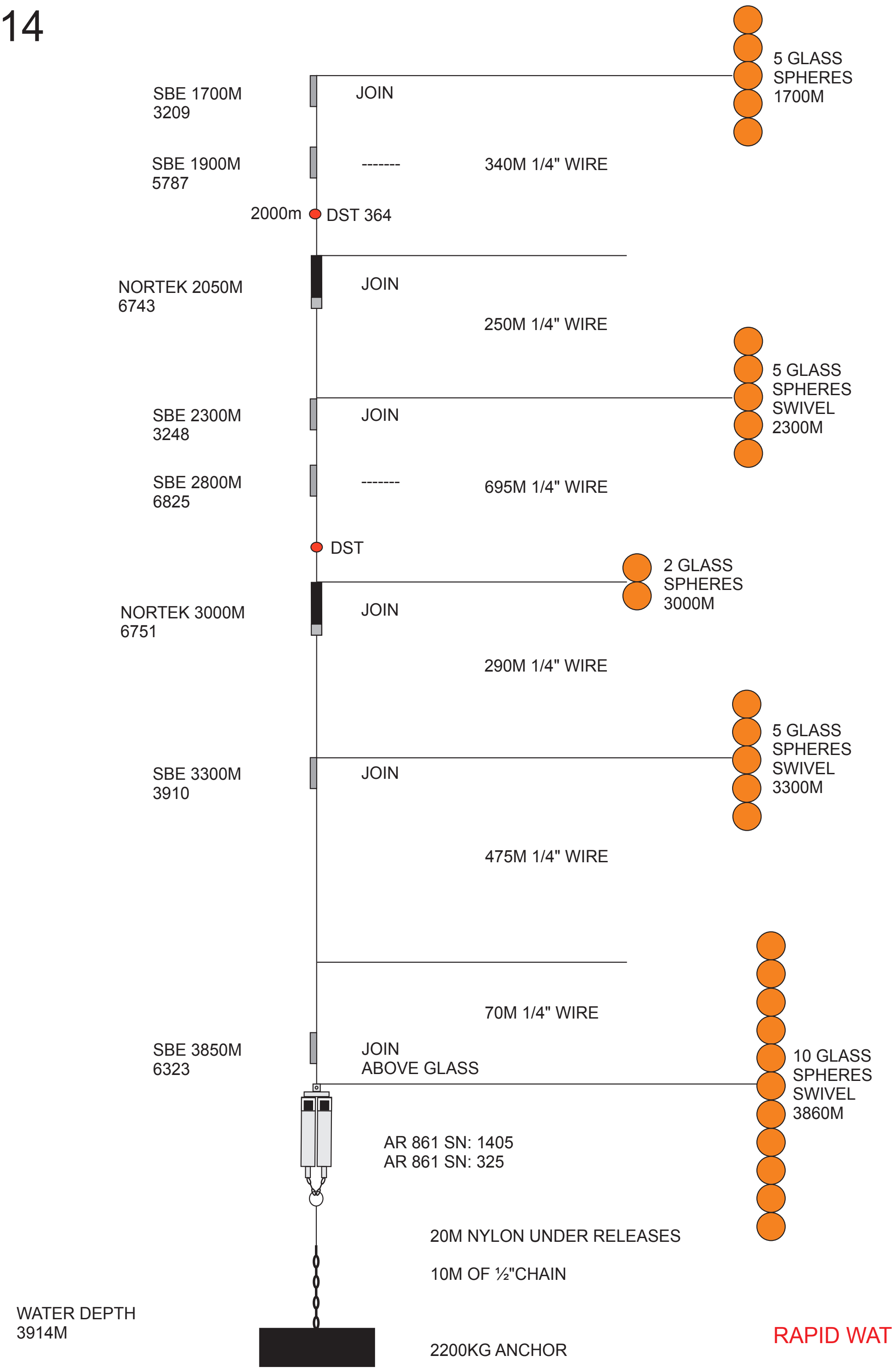
WB 2
AS DEPLOYED
2014

PAGE 1 OF 2



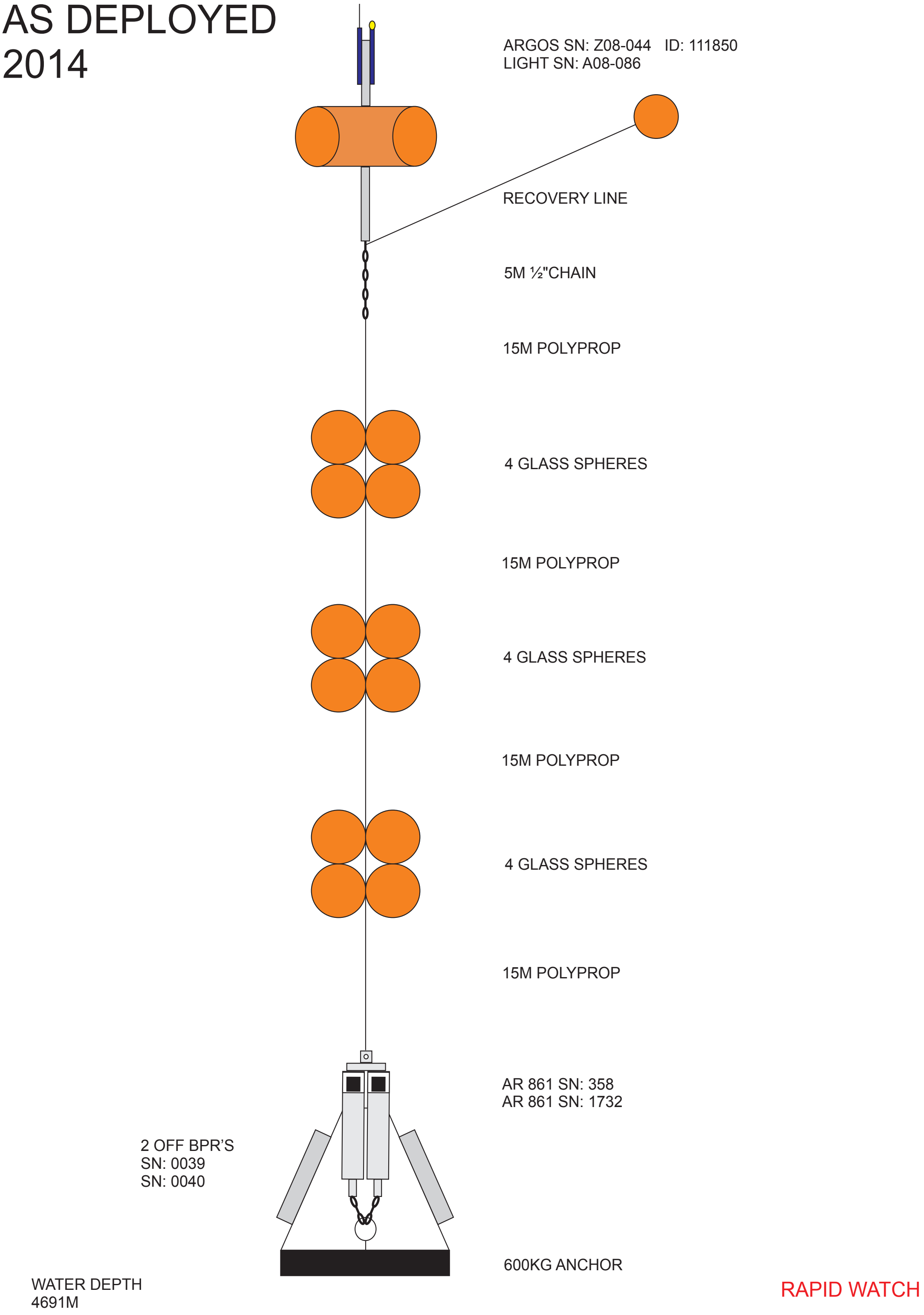
RAPID WATCH

WB 2
TO DEPLOY
2014



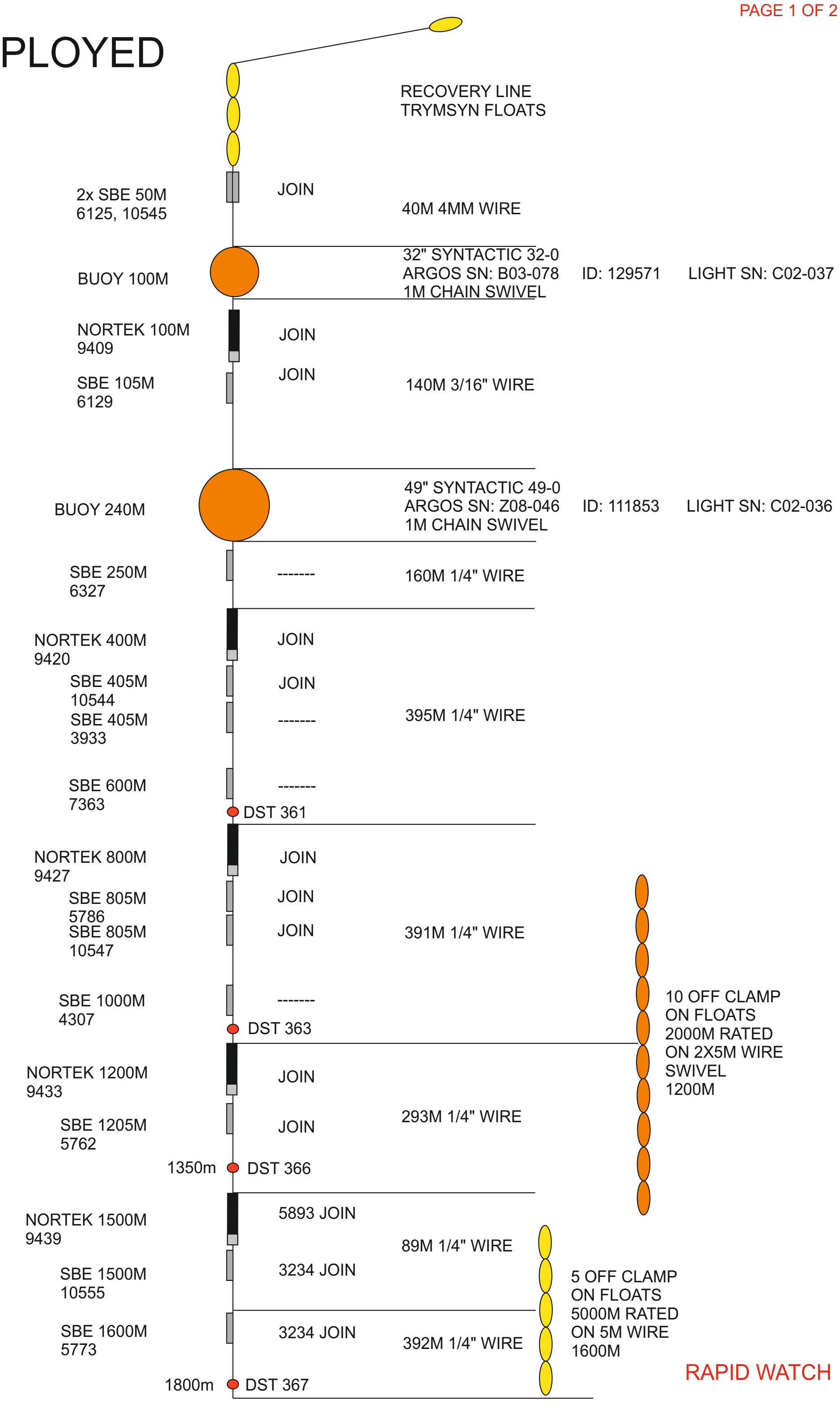
RAPID WATCH

WB4L10
AS DEPLOYED
2014



WB 4
AS DEPLOYED
2014

PAGE 1 OF 2



WB 4
AS DEPLOYED
2014

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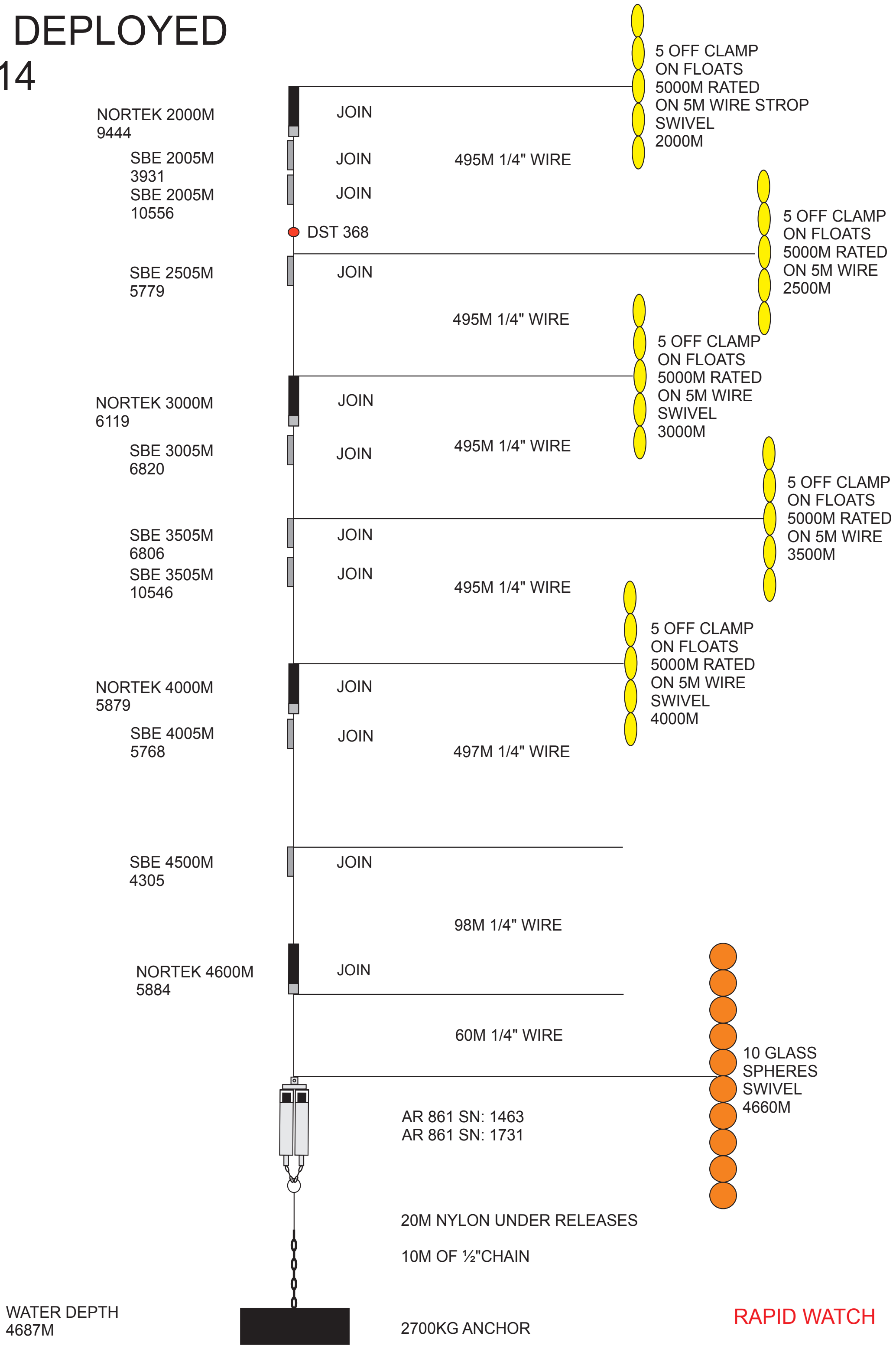
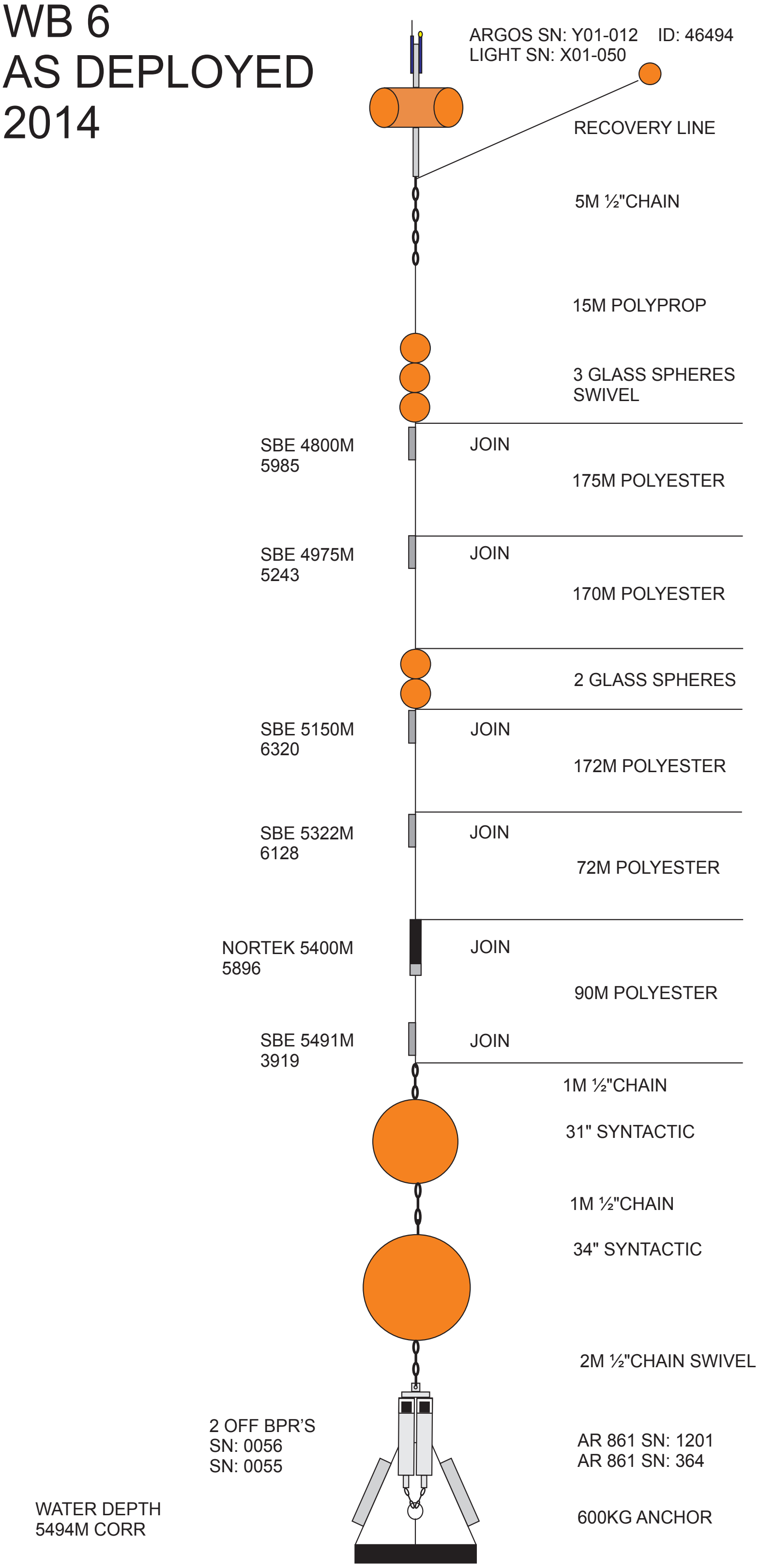


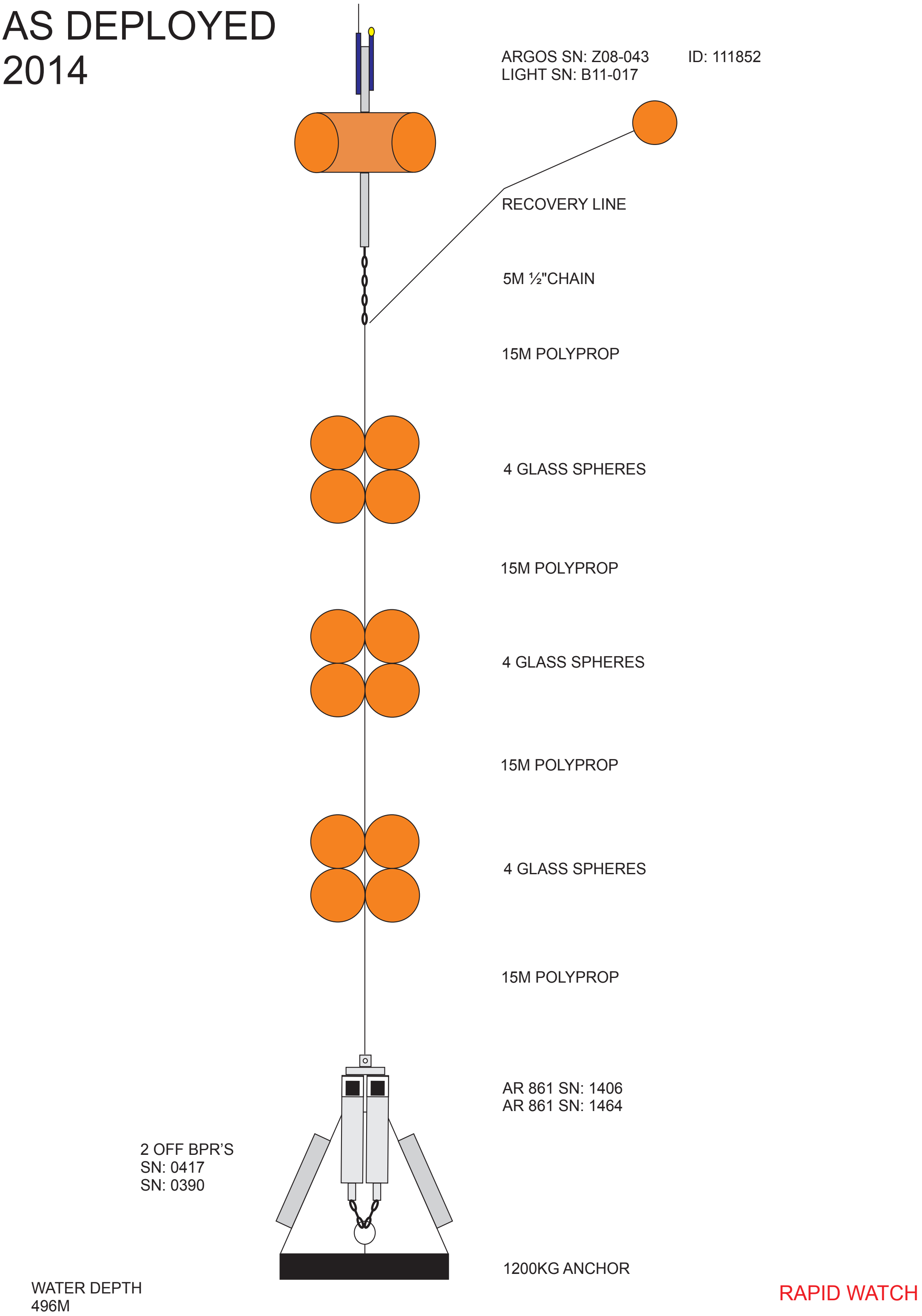
RAPID WATCH

WB 6
AS DEPLOYED
2014

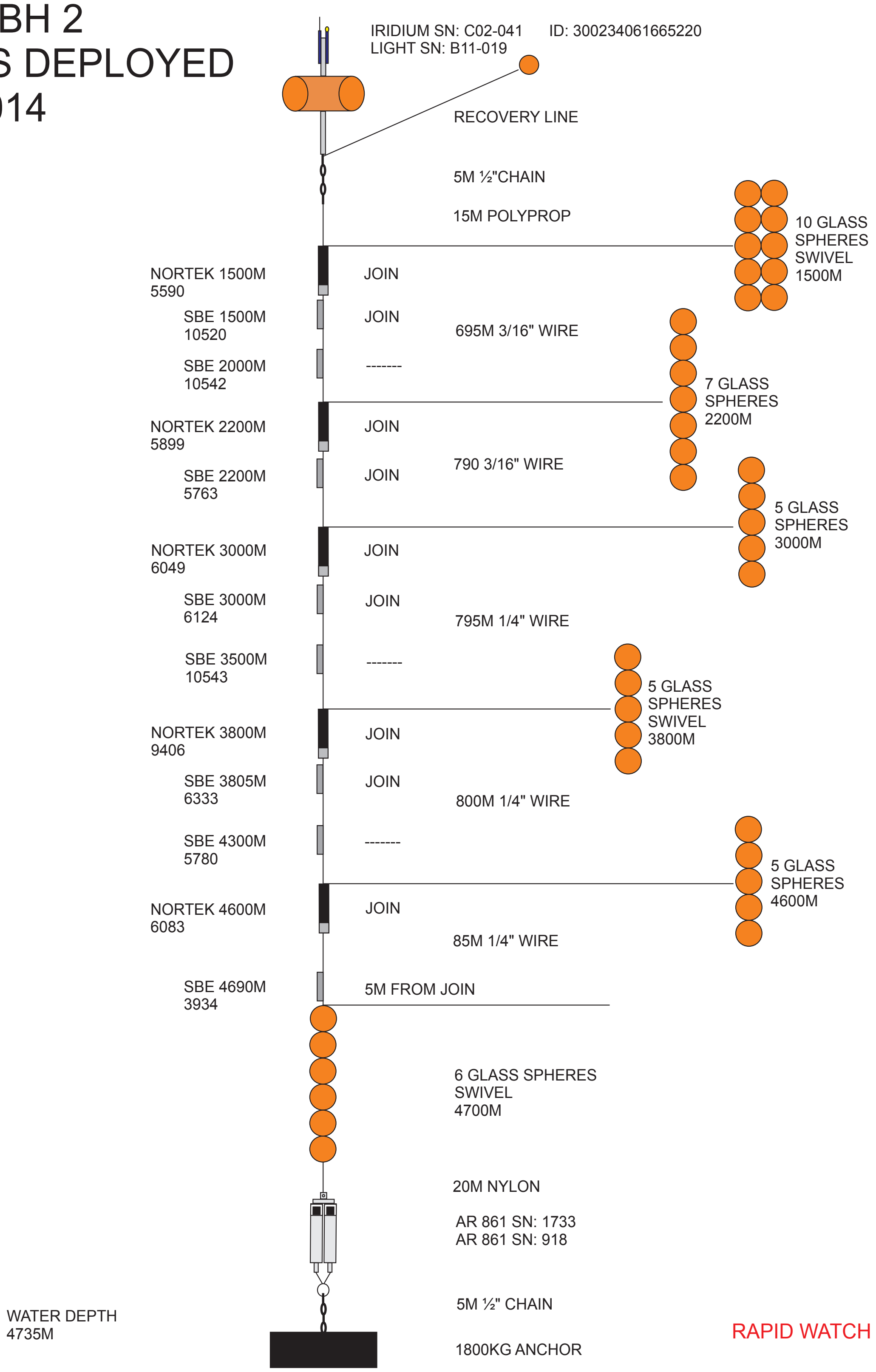


RAPID WATCH

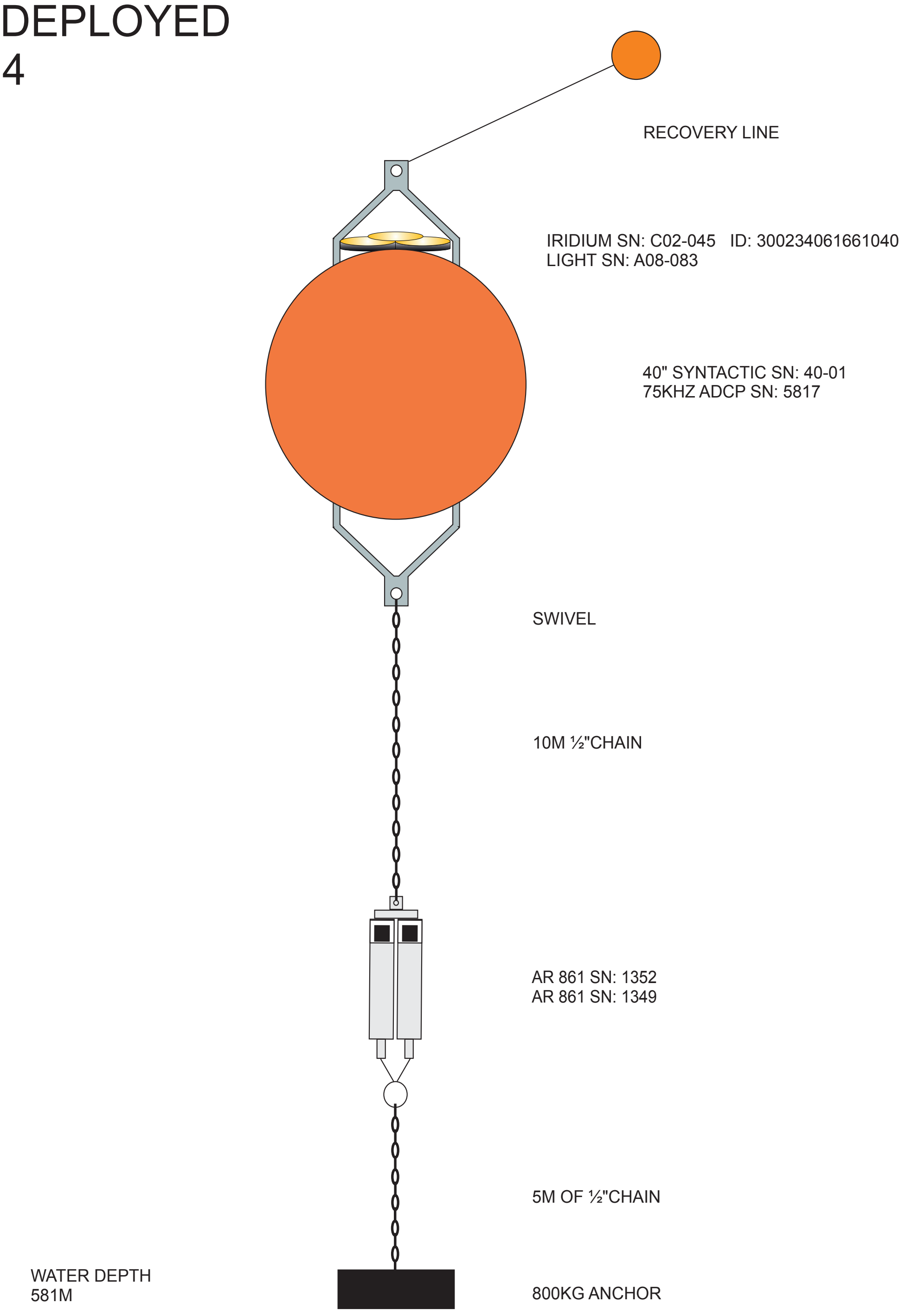
WBAL5
AS DEPLOYED
2014



WBH 2
AS DEPLOYED
2014



WB ADCP
AS DEPLOYED
2014



RAPID WATCH

16 Mooring Recovery Logsheets

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EB1L8** Cruise **JC103**

NB: all times recorded in GMT

Date 24 May 2014 **Site arrival time** Overnight

Time of first ranging 0757

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		10:28
Billings Float	n/a	3-PACK BILLINGS	10:3
with Light	U01-026	✓	
3 x 17" glass	n/a		10:34
3 x 17" glass	n/a	All 3 IMPLODED.	10:36
3 x 17" glass	n/a		10:38
BPR	0012 ✓		10:40
BPR	0058 ✓		
Acoustic Release #1	930 ✓	released	
Acoustic Release #2	253 ✓		

Ascent Rate 40 m/min

Ranging

Time	Range 1	Range 2	Command/comment
0757	5094		
0759	5095		ARM + Release OK
0800	5047	5041	
0801	5006	5000	
0805	4865		
0806	4825		
0820	4770		
0928	1773.4	1770.6	
0940	1390	1387	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EB1** Cruise **JC103**

NB: all times recorded in GMT

Date 23/May/2014 **Site arrival time** ________

Time of first ranging 15:29

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		16:10
3 x Mini-Trimsyns	n/a		16:13
MicroCAT	4066 ✓	Heavy fouling	16:13
24” syntactic float	n/a		16:18
with Light	Z08-049 ✓		
and Argos Beacon	W03-082 ✓	Aerial missing.	
Swivel	n/a		
MicroCAT	4713 ✓	Heavy fouling. Mollusc attached to guard.	16:20
37” steel sphere	n/a		16:24
with light	W03-097 ✓		1
and Argos Beacon	285 ✓		
Swivel	n/a		
MicroCAT	4720 ✓		16:26
MicroCAT	4718 ✓		16:29
MicroCAT	6817 ✓		16:30
MicroCAT	5765 ✓		16:32
4 x 17” glass	n/a		16:35
MicroCAT	4474 ✓	No guard.	16:39
4 x 17” glass	n/a	TANGLED	16:45
MicroCAT	4473 ✓	slight knock on deck during recovery.	16:45
MicroCAT	4466 ✓		16:54
4 x 17” glass	n/a	TANGLED.	16:58
Swivel	n/a		
MicroCAT	4462 ✓		17:02
RCM11	518 ✓		17:09
4 x 17” glass	n/a		17:12
MicroCAT	3259 ✓		17:15
MicroCAT	3257 ✓		17:25
4 x 17” glass	n/a		17:32
Swivel	n/a		
MicroCAT	3255 ✓		17:49
MicroCAT	3271 ✓		~~17:49~~
4 x 17” glass	n/a		18:10
Swivel	n/a		
MicroCAT	5238 ✓		18:16

4 x 17" glass	n/a	Tangled	18:2
MicroCAT	3916 ✓	1905	~~18:4~~
4 x 17" glass	n/a		18:5
Swivel	n/a		
MicroCAT	3256 ✓	1911 down to 1 lead over side	18.45
RCM11	507 ✓		1912
MicroCAT	6829 ✓		1912
8 x 17" glass	n/a	2x implosions, first set of 4, 2nd 4 ok	1916
Swivel	n/a		
Acoustic Release #1	1535		
Acoustic Release #2	1536		1918

Ascent Rate 65 m/min

Ranging

Time	Range 1	Range 2	Command/comment
15:29	–	5545	
1540	–	5052	
1542	4935	4922	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBH1L8** Cruise **JC103**

NB: all times recorded in GMT

Date 29 May 2014

Time of first ranging 0555

Site arrival time overnight

grappled: 6:58

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	Tangled	~~6:58~~
Billings Float	n/a		07:0
with Light	W03-096 ✓		
3 x 17" glass	n/a	Tangled.	07:04
3 x 17" glass	n/a	Tangled	07:0
3 x 17" glass	n/a		07:11
BPR	0396 ✓		
BPR	0397 ✓		07:14
Acoustic Release #1	282 ✓	released.	07:14
Acoustic Release #2	354 ✓		

Ascent Rate 77~~74~~ m/min

Ranging

Time	Range 1	Range 2	Command/comment
0555	3076	3078	ARM + ARM
0559	3104		Release OK
0600	–	–	
0601	2909		
060305	–	2779	
060605	–	–	
060705	2503	2495	294 m / 4 min

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBH1** **Cruise** **JC103**

NB: all times recorded in GMT

09:27:09 ~ GF

Date 29/May/2014. **Site arrival time** ________

Time of first ranging 08:20

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		09:27
Billings Float	n/a ✓	TANGLED	09:33
with Light	X01-051 ✓		09:33
and Argos Beacon	A08-071 ✓		09.33
2 x 17" glass	n/a ✓	TANGLED	09:34
Swivel	n/a		
MicroCAT	3251 ✓		09:34
2 x 17" glass	n/a ✓		09:43
RCM11	450 ✓		09:48
MicroCAT	5766 ✓		09:53
3 x 17" glass	n/a ✓		09:53
Swivel	n/a		
Acoustic Release #1	1351 ✓		09:54
Acoustic Release #2	251 ✓		09:54

Ascent Rate 60 m/min

Ranging

Time	Range 1	Range 2	Command/comment
08:20	—	-	ECHO SOUNDER ON (NO RANGE)
08.22	3147		
08:24	—	3150	RELEASE OK
08:25:38	3073	3067	
08:26:35	3011	3006	

092
14A

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBH2** Cruise **JC103**

NB: all times recorded in GMT

Date 30 May 2014 **Site arrival time** Overnight

Time of first ranging 0826

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	SURFACED 07:03. GRAPNELLED 07:30	07:30
Billings Float	n/a		07: 3
with Light	S01-181 ✓		
and Argos Beacon	A08-069 ✓		07:38
2 x 17" glass	n/a		07:38
Swivel	n/a		
MicroCAT	3207 ✓	07:38	~~07:38~~
2 x 17" glass	n/a	SURFACED 07:07	07:4
MicroCAT	3252 ✓		07:48
RCM11	516 ✓		07:51
MicroCAT	3220 ✓	Fouling.	07:55
3 x 17" glass	n/a		07:55
Swivel	n/a		
Acoustic Release #1	1346 ✓	released	
Acoustic Release #2	1534		

Ascent Rate ____________

Ranging

Time	Range 1	Range 2	Command/comment
0628	–	2129	UKM d AKM
0636			Releas On
0632	2050	2044	
3925	1962	1955	
064125			
064155	1811	1805	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBH3** Cruise **JC103**

NB: all times recorded in GMT

Date 30/May/2014 **Site arrival time** 13:30

Time of first ranging 12:57

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	grappled 13:30	13:33
Billings Float	n/a		13:34
with Light	X01-049	Light + Beacon lost on recovery	13:34
and Argos Beacon	A08-068	~~Beacon ID =~~	13:34
4 x 17" glass	n/a	Lots of Molluscs	13:34
Swivel	n/a		
MicroCAT	3212 ✓	FOULING	13:37
MicroCAT	3277 ✓	FOULING	13:39
MicroCAT	6823 ✓	FOULING + NO LOCKING SHIELD	13:42
MicroCAT	4712 ✓		13:44
3 x 17" glass	n/a	TANGLED ~~with rope~~ with ~~and~~ microcat 6816	13:46
MicroCAT	6816 ✓	NO LOCKING SHIELD	13:46
MicroCAT	5777 ✓		13:51
3 x 17" glass	n/a	TANGLED	13:54
Swivel	n/a		
RCM11	428 ✓		13:54
MicroCAT	4710 ✓		13:54
MicroCAT	3213 ✓		14:00
2 x 17" glass	n/a		14:02
MicroCAT	3912 ✓		14:02
RCM11	443 ✓		14:07
MicroCAT	3893 ✓		14:07
3 x 17" glass	n/a		14:11
MicroCAT	3249 ✓		14:13
RCM11	444		14:15
MicroCAT	5772 ✓		14:18
3 x 17" glass	n/a		14:21
MicroCAT	3214 ✓		14:21
RCM11	515		14:27
MicroCAT	3253 ✓	FOULING	14:31
4 x 17" glass	n/a		14:32
Swivel	n/a		
Acoustic Release #1	825 ✓	Record codes below	14:32
Acoustic Release #2	1345 ✓	Record codes below	
500kg Anchor	n/a		

Ascent Rate 50 m/min

Ranging

Time	Range 1	Range 2	Command/comment
12:57:50	—	1601	
12:59	1602	1602	
12:59:26	1601	1601	released ok
13:00:30	1549	—	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBH4L3** Cruise **JC103**

NB: all times recorded in GMT

Date 31/5/2014 **Site arrival time** Overnight

Time of first ranging 07:44

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		8:26
Billings Float	n/a		08:30
with Light	W03-089 ✓		
and Argos Beacon	Y01-013 ✓		
3 x 17" glass	n/a	Tangled	08:30
3 x 17" glass	n/a		08:31
3 x 17" glass	n/a		08:37
BPR	0003 ✓		
BPR	0013 ✓		08:4
Acoustic Release #1	922 ✓		
Acoustic Release #2	926 ✓		

Ascent Rate 64 m/min

Ranging

Time	**Range 1**	**Range 2**	**Command/comment**
0744	1427		ARM + ARM
4535	1424	1425	Release OK
4700	1356	1350	
4800	1305	1300	
4900	1254	1249	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBH4**

NB: all times recorded in GMT

Cruise **JC103**

Date 31/May/2014

Time of first ranging 09:50

Site arrival time 09:50

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		10:17
Billings Float	n/a	LOTS OF FOULING - MOLLUSCS.	10:23
with Light	Z08-50 ✓		
and Argos Beacon	A08-075 ✓	AERIAL INTACT	
4 x 17" glass	n/a		10:29
Swivel ✓	n/a		
MicroCAT	3230 ✓	HEAVY FOULING - HYDROIDS	10:30
MicroCAT	3215 ✓		10:32
3 x 17" glass	n/a	SLIGHT TANGLE	10:35
MicroCAT	6818 ✓		10:37
MicroCAT	3244 ✓		10:39
2 x 17" glass	n/a	SLIGHT TANGLE	10:41
MicroCAT	3224 ✓		10:43
MicroCAT	3265 ✓		10:46
2 x 17" glass	n/a	SLIGHT TANGLE	10:48
Swivel	n/a		~~10:53~~
MicroCAT	3264 ✓		10:53
MicroCAT	6831 ✓		10:55
2 x 17" glass	n/a		10:59
MicroCAT	3216 ✓		11:00
Sontek	D332 ✓		11:04
MicroCAT	3907 ✓		11:08
6 x 17" glass	n/a		11:10
Swivel	n/a		↓
Acoustic Release #1	1354		
Acoustic Release #2	246		

Ascent Rate 71 m/min

13° 32-42 W

Ranging

Time	Range 1	Range 2	Command/comment
09:30:35	—	1875	ARM + ARM SN 1354
09:31:15	1819	1804	"
09:50:31	—	1447	"
09:57:25	1436	1435	ARM + REL SN 1354 REL O/C
09:52 56	1294	1283	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBHi** Cruise **JC103**

NB: all times recorded in GMT

Date 26/5/14 **Site arrival time** Overnight

Time of first ranging 0750

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		09:32
Billings Float	n/a		09:38
with Light	Y01-021 ✓		↓
and Argos Beacon	Z02-008 ✓	AERIAL INTACT	
2 x 17” glass	n/a	SLIGHT TANGLE	
Swivel	n/a		
MicroCAT	3247 ✓		09:38
2 x 17” glass	n/a	) TANGLED	09:58
MicroCAT	3484 ✓		09:57
RCM11	451 ✓		10:10
MicroCAT	6819 ✓		10:14
4 x 17” glass	n/a		10:14
Swivel	n/a		↓
Acoustic Release #1	1348		10:15
Acoustic Release #2	1533		10:15

Ascent Rate 74 m/min

Ranging

Time	Range 1	Range 2	Command/comment
0750	4551	4551	
0758	4550	4550	
0759	4551	4552	ARM + Release ?
0800	4442	4	
0802	4365	4356	
0745	4210	4200	
? 0645	3987	3977	ETA 07:47 (SHIP'S TIME 08:47 GMT

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBP2** Cruise **JC103**

NB: all times recorded in GMT

Date 31/5/14 **Site arrival time** OVERNIGHT

Time of first ranging 5:45

ITEM	SER NO	COMMENT	TIME
PIES and pickup line	131 ☐		06:35
			06:37

Telemetry: 66
XPND : 70
Beacon : 74
Release : 3

SURFACED 06:22
SPOTTED 06:25

NO LIGHT FLASHING

12" GLASS PICKUP FLOAT ~~LINE~~ INSTEAD WITH ½" POLYPROP LIN OF PLASTIC BLOCK.
A LOT OF GROWTH ON THE LINK.

Ascent Rate ____________

Time at end of recovery ____________

Ranging

Time	Range 1	Range 2	Command/comment
5:45			RELEASE – 6 PING CONFIRMATION
			4-SEC PINGING HEARD

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR0** Cruise **JC103**

NB: all times recorded in GMT

Date 13/5/14

Time of first ranging 0830

Site arrival time 08=20

ITEM	**SER NO**		**COMMENT**	**TIME**
Recovery line	n/a			
Billings Float	n/a			
with Light		☐		
and Argos Beacon		☐		
3 x 17" glass	n/a			
Swivel	n/a			
MicroCAT	3284	☐	Failed to release.	
MicroCAT	6324	☐	See cruise report for	
3 x 17" glass	n/a		further details.	
Swivel	n/a			
MicroCAT	5788	☐		
S4	35612564	☐		
MicroCAT	6809	☐		
MicroCAT	3903	☐		
8 x 17" glass	n/a			
BPR	0062	☐		
BPR	0079	☐		
Acoustic Release #1	923	☐		
Acoustic Release #2	249	☐		

Ascent Rate n/a

Ranging

Time	Range 1	Range 2	Command/comment
0830	—	—	1837
0832	—	—	" "
0834	—	5542	14A6
0835	5543	5543	" "
0841	—	—	1837
0845	5542		14A6 Release oR
0846	5542	5543	"
0848	5543		"
0850			1837 Release – no rply
0852	—	—	14A6
0905	—	—	" "
0909			1837
0929	—	—	14A6
0930	—	—	1837
0935	5546	5547	1688 ** Old M
0937	—	—	14A6
0939			1837
0952	—	—	14A6
0954	—	=	1837)
0958	—	—	14A6
1000	—	—	1837
1004	5525	5524	1688 **
↓	—	—	} 1837
	—	—	} 14A6
10:14	5769	5773	1688 **
↓	—	—	} 1837
10:20	—	—	} 14A6
1021	5830	5828	1688 **
1021	—	—	14A6
1023	—	—	1837
1024	—	13342	1837
1025	—	—	14A6
1100	—	—	14A6
1101	—	—	14A6
1101	6098	—	14A6
1106	—	—	14A6
1107	—	—	14A6
1109	—	—	14A6
1300	—	—	1837
1301	—	—	14A6
1303	7906	7891	1688 xx Old M

NO RANGES WITH SUPERDUCER ON 14A6 OR 1837.

S'DUCER FINE TALKING TO RELEASES ON CTD, AS WAS HULL X'DUCER.

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR1L7** Cruise **JC103**

NB: all times recorded in GMT

Date 14/May/2014 **Site arrival time** ________

Time of first ranging 11:40

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		
Billings Float	n/a	Tangled	13:17
with Light			
and Argos Beacon			
3 x 17" glass	n/a	Tangled	13:17
3 x 17" glass	n/a	Tangled	13:19
3 x 17" glass	n/a		13:23
BPR	0033 ✓		13:26
BPR	0034 ✓	Mild corrosion on bpr frame clamps.	
Acoustic Release #1	921 ✓	Mild corrosion around release frame bolts.	13:26
Acoustic Release #2	1202 ✓		

Ascent Rate 91 m/min

Ranging

Time	Range 1	Range 2	Command/comment
~~113830~~	~~3051~~	~~3598~~	
114000	5946	5934	ARM + ARM 1835
114300	5745	5737	Release ok c 4-2 km of
11 4500	5563	—	
11 4700	5340	-	
11 5100	5191	-	
11 5200	4752	4738	
12 0300	3682	3674	1-9 km of
12 06	3522	3514	
12 30	1687	—	
12:40:50	1045·3	1039.1	
12:50			on surface
13:13			grappled.

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR1**
NB: all times recorded in GMT

Cruise ~~D382~~ JC103

Date 14/May/2014
Time of first ranging ___________

Site arrival time 14:38

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		14:38
3 x Mini-Trimsyn	n/a		14:41
MicroCAT	5242 ✓	Heavy fouling	14:41
24” syntactic float	n/a		14:47
with Light	202-23		
and Argos Beacon	A08-67		
MicroCAT	5244 ✓	Missing blanking screw cap. heavy fouling	14:50
37” Steel Sphere	n/a		14:53
with Light	W03-94		
and Argos Beacon	304		
Swivel	n/a		
MicroCAT	4060 ✓		~~15~~:14:5
MicroCAT	3281 ✓		14:59
MicroCAT	6834 ✓		15:01
MicroCAT	6839 ✓		15:04
MicroCAT	6838 ✓	Missing blanking screw cap.	15:09
8 x 17” glass	n/a	Tangled	15:14
Swivel	n/a		
MicroCAT	4062 ✓		15:14
MicroCAT	6833 ✓		15:22
MicroCAT	3901 ✓		15:27
RCM11	519 ✓		15:35
MicroCAT	3904 ✓		15:3
8 x 17” glass	n/a	Tangled	15:45
Swivel	n/a		
MicroCAT	7681 ✓		15:53
4 x 17” glass	n/a		16:05
Swivel	n/a	little bit of wear @ top of 1/4" wire	
MicroCAT	3229 ✓		16 08
4 x 17” glass	n/a		
Swivel	n/a		16 21
MicroCAT	6112 ✓		16 22
4 x 17” glass	n/a	tangle @ glass, change barrell 1636	16 30
Swivel	n/a		
MicroCAT	3254 ✓	resuming 1652	1707
4 x 17” glass	n/a		1705

slipped down to glass 500 m below

Swivel	n/a		
MicroCAT	3225 ✓		1707
MicroCAT	4468 ✓		17:26
5 x 17" glass	n/a ✓	tangled w/ [illegible]	17:34
Swivel	n/a		
S4	35612565 ✓		17:44
MicroCAT	6798 ✓		17:44
9 x 17" glass	n/a ✓		17.49
Swivel	n/a ✓		17:49
Acoustic Release #1	1200 ✓		17:49
Acoustic Release #2	319 ✓		17:49

Ascent Rate ____________

Ranging

Time	Range 1	Range 2	Command/comment

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR2** Cruise **JC103**

NB: all times recorded in GMT

Date 15 May '14

Time of first ranging 15:10

Site arrival time IMMEDIATELY AFTER MAR1 DEPLOYMENT

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	TANGLED WITH 3x GLASS + BILLINGS	16:45
Billings float	n/a	MAST ONLY JUST ABOVE SURFACE,	16:46
with Light		BUOYANCY AWASH	↓
and Argos Beacon		AERIAL INTACT	
3 x 17" glass	n/a		16:40
Swivel	n/a		✓
MicroCAT	6811 ✓		16:49
5 x 17" glass	n/a	WIRE TANGLED ABOVE	17:02
Swivel	n/a		
MicroCAT	~~4200~~ 3266		17:01
MicroCAT	3222 ✓		17:19
MicroCAT	3913 ✓		17:27
7 x 17" glass	n/a		17:30
S4	35612576		17:30
Acoustic Release #1	264		
Acoustic Release #2	1197		↓

Ascent Rate 83 m/MIN

2 PACKS GLASS SPOTTED ON SURFACE AT 16:07

3RD PACK SURFACED 16:13

HOOKED WITH HOOK ON POLE 16:35

HOOK FELL OFF 16:36

RE-HOOKED 16:36 INTO LINK OF CHAIN

Ranging

Time	Range 1	Range 2	Command/comment
15:10	5921	3728	ARM + ARM 14B5
15:11:00	5301	5299	
15:12:35	/	5288	ARM + DIAGNOSTIC 0880
			VERSION 12.7
15:13:20	5282	5281	ARM + REL 14B5 REL OK
15:14:20	5199	/	ARM + REL 14B5
15:15:20	5100	5088	
15:16:20	5017	5005	
15:17:20	4934	4924	
			ETA 39 MINS FROM 15:17 = 15:56

@ 83m/m

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR3L7** Cruise **JC103**

NB: all times recorded in GMT

Date 18/5/14 **Site arrival time** 12:00

Time of first ranging 12:02

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a	SURFACED 13:12 grappled 13:36	13:45
Billings Float	n/a		13:49
with Light			
~~and Argos Beacon~~			
3 x 17" glass	n/a	Tangled	13:49
3 x 17" glass	n/a	Tangled	13:53
3 x 17" glass	n/a		13:55
BPR	0035 ✓		13:59
BPR	0036 ✓		
Acoustic Release #1	1198 ✓	released	
Acoustic Release #2	262 ✓		

Ascent Rate 91 – 93 m/MIN

Ranging

Time	**Range 1**	**Range 2**	**Command/comment**
~~08:50~~	~~5074~~	~~5074~~	~~ARM + A~~
14 08:57:46	—	5220	0881 ARM + ARM AT MAR3 SITE
12:02:09	5465	5467	ARM + DIAG 0881
12:03:20	5484	5487	ARM + REL 0881 REL OK.
~~12:05:58~~			
12:04:58	5384	5371	REL OK
12:06:01	5292	5279	REL OK
12:07:01	5201	5188	
12:08:01	0 x	529 x	
12:08:25	5070	5057	
125300	1737	1728	
5500	1608	1602	

91 m/MIN

131m IN 1:24 ⇒ 93 m/MIN

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR3**
NB: all times recorded in GMT

Cruise **JC103**

Date 18/5/14
Time of first ranging 08:50

Site arrival time OVERNIGHT

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		10:13
Billings float	n/a	3-PACK BILLINGS	10:19
with Light	~~[illegible]~~		↓
and Argos Beacon	Y01-009	AERIAL INTACT	
2 x 17" glass	n/a		10:18
Swivel	n/a		
MicroCAT	6841 ✓		10:18
2 x 17" glass	n/a		10:26
2 x 17" glass	n/a		10:37
MicroCAT	6832 ✓		10:38
2 x 17" glass	n/a		10:50
Swivel	n/a		"
MicroCAT	5245 ✓		10:51
2 x 17" glass	n/a	] TANGLED	11:04
MicroCAT	5241 ✓		11:03
3 x 17" glass	n/a	] TANGLED	11:19
MicroCAT	3268 ✓		11:19
3 x 17" glass	n/a	] TANGLED	11:37
Swivel	n/a		11:37
MicroCAT	4178 ✓		11:36
MicroCAT	3900 ✓		11:52
7 x 17" glass	n/a		11:54
Swivel	n/a		
S4	35612577 ✓		11:54
Acoustic Release #1	824		11:58
Acoustic Release #2	925		11:58

Ascent Rate 93 m/min

Ranging

Time	Range 1	Range 2	Command/comment
08:50	5074	5074	ARM + ARM 824
08:50:30	—	5073	ARM + ARM 925
08:53:44	5075	5073	ARM + REL 824 REL OK
08:55:20	4949	4936	
08:57:02	4790	—	ARM + ARM 925
			ETA 09:17

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **NOG**

NB: all times recorded in GMT

Cruise **JC103**

Date 19/May/2014

Time of first ranging 08:40

Site arrival time Overnight

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	grappled 10:24	10:25
Billings Float	n/a	Tangled	10:35
with Light	T05-078 ✓		
12 x 17" glass	n/a	Tangled	10:35
Swivel	n/a		
Sediment Trap	12283-01 ✓		10:46
RCM11	644 ✓		10:47
Sediment Trap	12168-03 ✓		10:53
RCM11	646 ✓		10:53
10 x 17" glass	n/a	Tangled sb	11:22
Acoustic Release #1	1350		11:33

Ascent Rate 100 m/min

sbe 7300 11:33

Ranging

Time	Range 1	Range 2	Command/comment
~~0845~~			
0~~[illegible]~~			
0840	4184	4184	
0852	4~~134~~	4~~120~~	Release sent
0853	4134	4120	
0854	3990	3979	
0855	3893	3882	
0926	1380		

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB1**

Cruise **JC103**

NB: all times recorded in GMT

Date May 3rd 2014 123

Time of first ranging 16:35

Site arrival time ~~17:13~~ 16:35

ITEM	SER NO	COMMENT	TIME
1 x 12" glass pickup	✓		17:13
30" SYNTACTIC	✓	Heavily foufing	17:16
ARGOS	✓	" " and alge looked bad	
Light	✓		
swivel	✓	Heavily foulying	17:18
Nortek	6723 ☑	" " Animals too	17:18
SBE37 MicoCAT	5778 ☑	" " (Fishing line attached to wire)	17:22
45" syntactic	✓		17:31
ARGOS	✓		
LIGHT	✓		
swivel	✓		17:31
Nortek	6088 ☑	No more foulying	17:38
SBE37 MicoCAT	5783 ☑		17:38
10 x 17" glass spheres	✓		17:55
SWIVEL	✓		17:56
Nortek	6765 ☑		17:56
SBE37 MicoCAT	6835 ☑		17:58
2 x 17" glass		(All were tangled)	18:13
Nortek	6534 ☑		18:13
SBE37 MicoCAT	5776 ☑		18:13
10 x 17" glass			18:18
SWIVEL			18:18
Acoustic release #1	1201 ☑		18:19
Acoustic release #2	1194 ☑		

Ascent Rate 90 m/min

Time at end of recovery 18:19

Ranging

Time	Range 1	Range 2	Command/comment
16:35:40	2316	8368	SW 1201 ARM + ARM E/S ON.
16:36	1532	—	
	—	1531	
16:37:45	1531	1530	
16-39:30	1528	1527	ARM + REL - RELEASE OK.
16:40:10	1468	1457	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB2L8** Cruise **JC103**

NB: all times recorded in GMT

Date 2/5/14

Time of first ranging 11:15

Site arrival time ________

ITEM	SER NO	COMMENT	TIME
1 x Trymsyn pickup float		Badly tangled.	12:16
Billings float			12:37
ARGOS			
LIGHT			
4 x 17" glass			12:37
4 x 17" glass			12:27
4 x 17" glass			12:27
BPR #1 in tripod	0414 ☑		12:39
BPR #2 in tripod	0030 ☑		12:39
Release #1 in tripod	498 ✓		12:39
Release #2 in tripod	370 ✓		12:39.

Ascent Rate 88 m/min

Time at end of recovery 12:39

Ranging

Time	Range 1	Range 2	Command/comment
111531	3930		Release ok
112531	3049		
113631	2085		

tted 11:57

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB2**

Cruise **JC103**

NB: all times recorded in GMT

Date 27May2014.

Site arrival time 12:53

Time of first ranging 13:01

ITEM	SER NO	COMMENT	TIME
1 x Trymsyn pickup float			14:18
3 x Trymsyn floats			14:24
SBE 37 MicroCAT	6119 ☑	Very heavy fouling	14:24
30" SYNTACTIC			
ARGOS		Y01-026	
Light		X01-052	
swivel			
RCM11	306 ☑	Heavy Fouling	14:33
SBE 37 MicroCAT	3932 ☑		14:35
51" syntactic			14:38
ARGOS		- 286	
Light		- X01-050	
swivel			
RCM11	395 ☑	Heavy Fouling	14:38
SBE 37 MicroCAT	7723 ☑	Heavy Fouling.	14:43
SBE 37 MicroCAT	6830 ☑	No Locking sheild	14:46
2 x 17" glass			14:48
Nortek	6747 ☑		14:48
SBE37 MicroCAT	4717 ☑	Missing guard : Damaged	14:52
SBE 37 MicroCAT	4721 ☑	~~scratched~~ torn labels on,	14:58
2 x 17" glass			15:01
Nortek	5889 ☑		15:01
SBE 37 MicroCAT	6836 ☑	missing guide clamp	~~15:07~~ 15:
SBE 37 MicroCAT	5774 ☑	guide clamp above float.	15:11
10 x 17" glass		Tangled!	15:15
Swivel			
Nortek	6805 ☑		15:15.
SBE 37 MicroCAT	3228 ☑		15:20.
Nortek	8052 ☑		15:26
MicroCAT	3206 ☑	missing Locking sheild.	15:26.
5 x 17" glass			15:33
SBE 37 MicroCAT	3221 ☑	1m below glass (should be 5m)	15:33
SBE 37 MicroCAT	3269 ☑		1540
Nortek	8120 ☑		1544

surface@13:06.

Changed drum @ 1550
restarting @ 1556

5 x 17" glass			1603
Swivel			
SBE 37 MicroCAT	6113 ✓	& wobbly Scrape nr. end cap	1604
SBE 37 MicroCAT	6813 ✓		1617
2 x 17" glass spheres			1623
Nortek	9204 ✓		"
5 x 17" glass spheres			
swivel			1634
SBE 37 MicroCAT	6805 ✓	tangle	1632
SBE 37 MicroCAT	6815 ✓		1649
10 x 17" glass spheres			1652
Swivel			
Release #1	323 ✓		
Release #2	917 ✓		1652

Ascent Rate 100 m/min
Time at end of recovery 1652

Ranging

Time	Range 1	Range 2	Command/comment
			~~release code sent~~
~~13:01~~	~~3002~~	~~3984~~	
13:01	3983·6	3478·6	
13:02:55	3985		release ok.
13:03:	3887·6		
13:04	~~1749.5~~	3780·8	100 m/min.

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

* Delayed, no back tensio
on winch

Mooring **WB4** Cruise **JC103**

* Winch on ag
at: 17:

NB: all times recorded in GMT

Date 30/4/14 **Site arrival time** 17:05

Time of first ranging 16:45 WHILST APPROACHING

First catched time: 17:44:02

ITEM	SER NO	COMMENT	TIME
1 x Trimsyn pickup float	✓		17:44
3 TRYMSYN floats	✓	Heavily fouled	17:58
MicroCAT	5247 ☑	Heavily fouled	17:59
32" syntactic	✓	" "	18:11
with Argos beacon	T05-076		
and light	Z02-003		
Swivel	✓		
RCM11	399 ☑	Heavily fouled	18:11
MicroCAT	5484 ☑	" "	18:15
49" syntactic	✓	No fouling	18:21
with Argos beacon		208-046	
and light		W03-092	
swivel	✓		
MicroCAT	3219 ☑		18:25
Nortek	5590 ☑		18:30
MicroCAT	6810 ☑		18:30
MicroCAT	3891 ☑		18:38
Nortek	5611 ☑		18:43
MicroCAT	3233 ☑		18:43
MicroCAT	5789 ☑		18:51
10 x Orange CF-16s	✓	wire tangle on the big ring	18:57
Nortek	5831 ☑		18:58
MicroCAT	6807 ☑		18:58
Nortek	5893 ☑		19:19
5 x yellow CF-16s	✓		19:24
MicroCAT	3234 ☑		19:30
5 x yellow CF-16s	✓	Green rope around	19:41
Swivel	✓		
Nortek	5896 ☑	~~Green rope~~ * Green rope too	19:42
MicroCAT	3232 ☑	Green rope around too	19:44
5 x yellow CF-16s	✓	Green rope attached (a lot)	19:59
MicroCAT	6114 ☑	Red stuff on conector (sticky)	20:16
5 x yellow CF-16s	✓		20:29

Swivel	✓		20:39
Nortek	5899 ☑		20:31
MicroCAT	6804 ☑		20:31
5 x yellow CF-16s	✓		20:45
MicroCAT	5486 ☑		20:47
5 x yellow CF-16s	✓		21:00
Swivel	✓		
Nortek	5955 ☑		21:01
MicroCAT	6801 ☑		21:01
MicroCAT	6802 ☑		21:17
Nortek	6049 ☑		21:20
10x glass spheres			21:23
Swivel			21'
Acoustic release #1	910 ☑		21:23
Acoustic release #2	316 ☑	Released	21:23

Ascent Rate 4704/(4h30)

Time at end of recovery 21:23

Ranging

Time	Range 1	Range 2	Command/comment
16:45:30	—	4991.9	ARM + ARM SN 910
16:46:10	4954.8	4943.5	
16:47:00	—	4872.3	ARM + ARM SN 316
16:47:35	4853.6	4845.5	
17:00:00	4517.4	4434	

RAPID-WATCH MOORING LOGSHEET RECOVERY

Mooring **WB6** Cruise **JC103**

NB: all times recorded in GMT

Date 8/May/2014. **Site arrival time** ________

Time of first ranging 13:05

ITEM	**SER NO**	**COMMENT**	**TIME**
1 x Trymsyn pickup float			16:38.
Billings float			16:38
Argos	A08 -073		
Light	N 08-027		
3 x 17” glass		imploded.	16:37
Swivel			
SBE MicroCAT	4708 ☑		16:36
SBE MicroCAT	5978 ☑		16:33
3 x 17” glass		TANGLED.	16:29
SBE MicroCAT	4797 ☑		16:29
SBE MicroCAT	4800 ☑		16:25
Nortek	6050 ☑		16:25
SBE MicroCAT	6812 ☑		16:11
4 x 17” glass			16:10
4 x 17” glass and Swivel			10:17
BPR #1 on tripod	0394 ☑		
BPR #2 on tripod	0081 ☑		16:17.
Release #1 in tripod	819 ☑	released.	
Release #2 in tripod	281 ☑		16:17

Ascent Rate 48 m/min

Time at end of recovery 16:17

16:06: hooked into a pack of 4x glass

Ranging

Time	Range 1	Range 2	Command/comment
	5027 ×	/	SN ~~[illegible]~~ 819
13:05	6178	6178	ARM + ARM DURING CTD &
13:08	/	6178	ARM + ARM SN 281
14:11:30	5910		released
14:12:30	5862		Release ok
14:14	5641		
142045	4955	—	Ship in position c 6 cable
~~14:72~~			
142715	4537	4529	
144815	3278	3272	
145015	3157	3151	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBADCP** Cruise **JC103**

NB: all times recorded in GMT

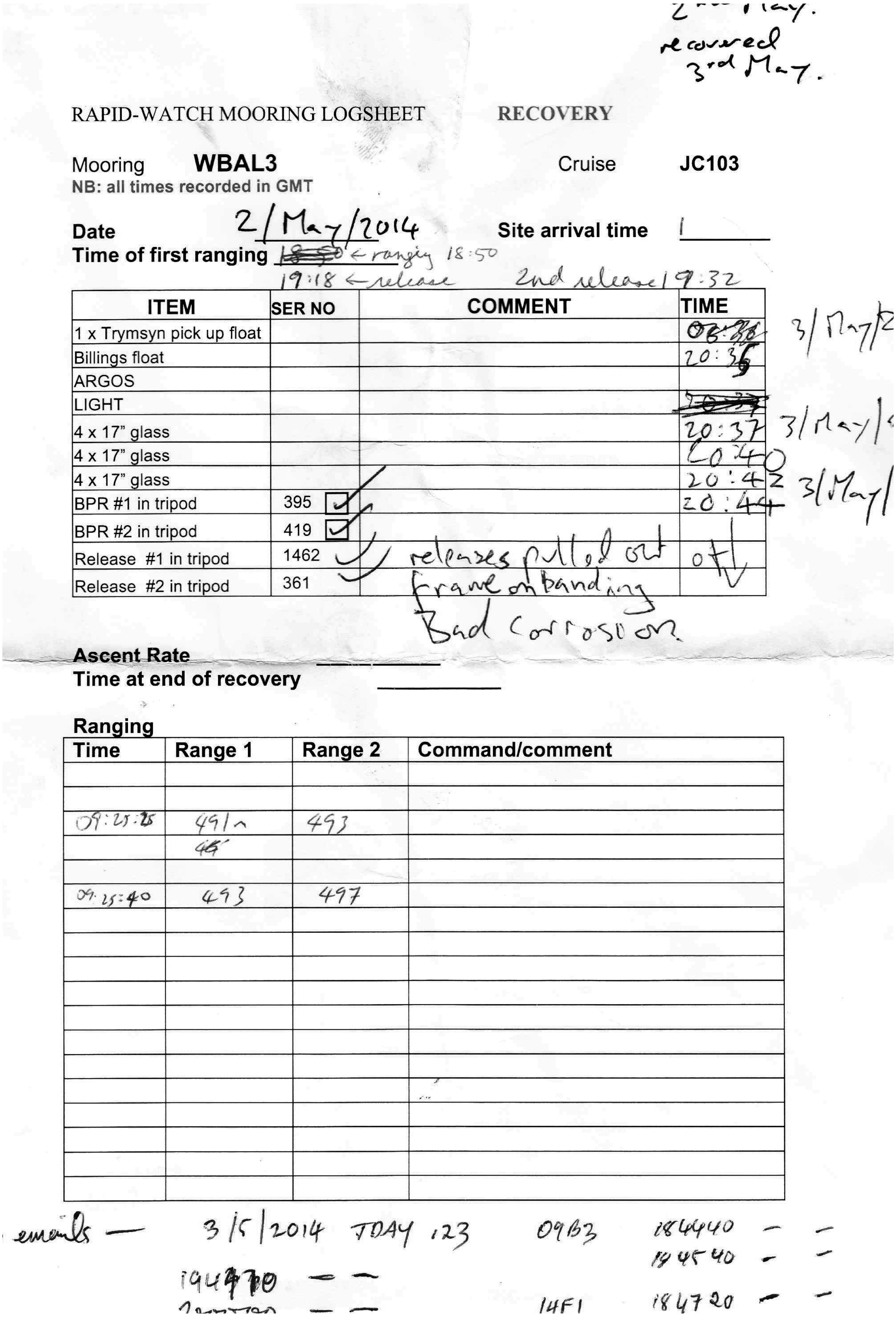
Date 3/5/14 **Site arrival time** 21:57 ISH
Time of first ranging 21:57 ISH

ITEM	SER NO	COMMENT	TIME
1 x 12" glass pickup float		SURFACED 22:05	
ADCP in 40 " syntactic	10311 ☐		2026
with Argos beacon			
and light			
swivel			
Acoustic Release #1			2026
Acoustic Release #2			2026

Ascent Rate 80 m/min
Time at end of recovery 20:26

Ranging

Time	Range 1	Range 2	Command/comment
21:59	829	830	RELEASE OK
~~215~~			
22:00:00	714	704	
22:01:10	633		



2nd May.
recovered
3rd May.

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBAL3** Cruise **JC103**

NB: all times recorded in GMT

Date 2/May/2014 **Site arrival time** |

Time of first ranging ~~18:50~~ ← ranging 18:50

19:18 ← release 2nd release 19:32

ITEM	SER NO	COMMENT	TIME
1 x Trymsyn pick up float			~~08:38~~
Billings float			20:36
ARGOS			
LIGHT			~~20:37~~
4 x 17" glass			20:37
4 x 17" glass			20:40
4 x 17" glass			20:42
BPR #1 in tripod	395 ☑ ✓		20:44
BPR #2 in tripod	419 ☑		
Release #1 in tripod	1462 ✓	releases pulled out	off
Release #2 in tripod	361 ✓	frame on banding	

3/May/2
3/May/
3/May/

Bad corrosion

Ascent Rate ____________

Time at end of recovery ____________

Ranging

Time	Range 1	Range 2	Command/comment
09:25:25	491^	493	
	~~45~~		
09:25:40	493	497	

emails — 3/5/2014 JDAY 123 09B3 184440 — —
184540 — —
194470 — —
14F1 184720 — —

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBAL4** Cruise **JC103**

NB: all times recorded in GMT

Date 4/5/14 **Site arrival time** 11:55

Time of first ranging 11:55

ITEM	SER NO	COMMENT	TIME
1 x Trymsyn pick up float		SURFACED ~ 12:10.	12:32
Billings float		PICK UP LINE TANGLED	12:37
ARGOS		HOOKED 12:28 + 12:32 FOR PICKUP LINE	
LIGHT		ARGOS AERIAL INTACT	
4 x 17" glass		LIGHT CAUGHT ON ROPE	12:37
4 x 17" glass			
4 x 17" glass			
BPR #1 in tripod	395 ☐		12:43
BPR #2 in tripod	399 ☐		12:43
Release #1 in tripod	1195	LINK STILL IN JAWS OF FIRST	↓
Release #2 in tripod	320	~~RELEASES~~ RELEASE.	↓

RELEASES TILTED IN BRACKETS

RELEASE HAD FIRED BUT LINK JAMMED. PULLING IT CAUSED THE LINK TO PULL OUT.

Ascent Rate __________

Time at end of recovery __________

Ranging

Time	Range 1	Range 2	Command/comment
11:55	664	664	ARM + DIAG ON 1ST RELEASE NO DIAGS.
11:56:20	672	673	ARM + RELEASE RELEASE OK.
11:56:58	677	676	— " — "
11:57:50	681	681	
11:59:10	✓	✓	
11:59:51	✓	✓	
12:00:50	✓	702	ARM + ARM 2ND RELEASE
12:01:20	704	703	
12:02:20	709	710	
12:04:55	711	711	ARM + REL 2ND RELEASE. REL OK.
12:05:35	676	1117 X	
12:05:58	654	7966 X	
12:06:30	~~8~~ ✓	608	
12:07:05	592	~~5~~ 7903 X	
12:08:~~5~~	545	128	
12:08:40	513	508	
12:09:00	157 X	492	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBH2** Cruise **JC103**

NB: all times recorded in GMT

Date 124 4 May 2014 **Site arrival time** 21: 24

Time of first ranging 18: 37

ITEM	**SER NO**	**COMMENT**	**TIME**	
1 x Trymsyn pickup float	n/a	~~sto~~ spotted 20:38	21:37	
Billings float	n/a		21:32	
ARGOS				
Light				
12x 17" glass	n/a		2137	
Swivel	n/a			
Nortek	9210 ☑		2137	
7 x 17" glass	n/a	~~FISHING GEAR~~ TANGLED.	2158	
Nortek	9213 ☑		2158	
Nortek	9435 ☑		~~10:24~~	22:
3 x 17" glass	n/a	TANGLED.	~~10:42~~	22:
Swivel	n/a			
Nortek	5490 ☑		10:42	bent
MicroCAT	3905 ☑	HIT THE DECK ON RECOVERY. lost blanking plug.	10:42	
MicroCAT	6799 ☑		~~11:09~~	23
3 x 17" glass	n/a	Tangled	~~11:17~~	23
RCM11	426 ☑		~~11:17~~	23
MicroCAT	6800 ☑		~~11:23~~	23
5 x 17" glass	n/a		~~11:23~~	23
Swivel	n/a			
Release #1	687 ☑		23:24	
Release #2	827 ☑			

Ascent Rate 85 m/min

Time at end of recovery 23:24

18:37			range
18:38			
18:39			
18:44			release
18:48			change clock unit
18:50			
19:00			superducer. no answer.
19:39		5696	superducer
20:17	4800		
20:23	4898		ok
20:25	–	4300	
20:26	–	4475	
20:27	–	4390	ok
20:29			
20:32		4202	
20:33		4185	
20:34		4160	
20:35		~~4107~~4130	
20:36		4107	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBP1** Cruise **JC103**

NB: all times recorded in GMT

Date 30/4/14 **Site arrival time** OVERNIGHT

Time of first ranging 08:33

ITEM	SER NO	COMMENT	TIME
PIES and pickup line	136 ☑		10:17

RELEASE COMMAND ACKNOWLEDGED 08:33

SURFACED 09:57

LIFTED BY STARBOARD DECK CRANE

Ascent Rate __________

Time at end of recovery __________

Ranging

Time	Range 1	Range 2	Command/comment

17 Mooring Deployment Logsheets

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EB1L10**
Cruise **JC103**
NB: all times recorded in GMT
Date 24/05/2014
Site arrival time 16:58
Setup distance 0
Start time 17:08
End time 17:14
Start Position
Latitude 23.7914 **Longitude** -24.1086

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		17:08
31" Syntactic	n/a 31-10	Has the ARGO	17:12
with Light	Y01-019		
and Argos Beacon	A08-073	Beacon ID = 121984	
34" Syntactic	n/a 34-03	HAS THE LIGHT	17:14
BPR	391		"
BPR	038		
Acoustic Release #1	264	Record codes below	17:14
Acoustic Release #2	921	Record codes below	"
300kg Anchor	n/a		"

Release #1 arm code [redacted] SN264
Release #1 release cod
Release #2 arm code
Release #2 release cod
Argos beacon #1 ID 121984

Anchor Drop Position
Latitude 23.7918 **Longitude** -24.1080

Uncorrected water depth 5044.29 (at anchor launch)
Corrected water depth 5086.6 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EB1**
Cruise **JC103**
NB: all times recorded in GMT
Date 24/May/2014
Site arrival time 12:00
Setup distance 4.5 nm
Start time 1208
End time 16:33
Start Position
Latitude 23.7125 **Longitude** -24.2244

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		1208
3 x Mini-Trimsyns	n/a		
MicroCAT	4723		〃
24" syntactic float	n/a		12:14
with Light		Z02-023	
Z and Iridium Beacon	~~E02-042~~	Beacon ID = 300234061664230	
Swivel	n/a		
MicroCAT	4724		12:14
37" steel sphere	n/a		12:21
with light		Y01-018	
and Argos Beacon	094	Beacon ID = 74027	
Swivel	n/a		
MicroCAT	4722		12:21
MicroCAT	6826		12:2
MicroCAT	3231		12:2
MicroCAT	4071		12:2
4 x 17" glass	n/a		12:35
MicroCAT	4070		12:39
4 x 17" glass	n/a		12:46
MicroCAT	6331		12:48
MicroCAT	5485		12:54
4 x 17" glass	n/a		13:01
Swivel			
MicroCAT	5770		13:04
RCM11	302		13:14
4 x 17" glass	n/a		13:17
MicroCAT	6322		13:20
MicroCAT	5784		13:29
4 x 17" glass	n/a		13:38
Swivel			
MicroCAT	6127		13:43
MicroCAT	6804		13:55
4 x 17" glass	n/a		14:04
Swivel			
MicroCAT	4464		14:10

4 x 17" glass	n/a		14:21
MicroCAT	6801		14:25
4 x 17" glass	n/a		14:38
Swivel			
MicroCAT	4184		14:38
RCM11	395		14:54
MicroCAT	5246	directly beneath RCM - 1.5m	14:54
8 x 17" glass	n/a		15:02
Swivel	n/a		
Acoustic Release #1	1197	Record codes below	15:09
(*) Acoustic Release #2	319	Record codes below	
1450kg Anchor	n/a		16:33

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]
Argos beacon #1 ID ____________

Anchor Drop Position
Latitude 23.7583 **Longitude** -24.1560
Uncorrected water depth 5044.22 (at anchor launch)
Corrected water depth 5[illegible]86.6 (at anchor launch)

(*) Hydiolics broke between 15:35 to 16:19 (approx.)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH1L10** Cruise **JC103**
NB: all times recorded in GMT

Date 29/May/2014 **Site arrival time** 11:15
Time of first ranging ___________
Setup distance 0.1 Nmiles

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		11:55
Billings Float	n/a		11:55
with Light	A1556		
and Argos Beacon	202-008	ID = 53157	
4 x 17" glass	n/a		11:56
4 x 17" glass	n/a		11:56
4 x 17" glass	n/a		11:57
BPR	414		
BPR	0030		
Acoustic Release #1	925		12:07:0
Acoustic Release #2	262		12:01:0

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]
Argos beacon #1 ID 53157

Anchor Drop Position
Latitude 27.20404 N **Longitude** 15.41688 W
Uncorrected water depth 3028.9 (at anchor launch)
Corrected water depth 3032.2 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH1** Cruise **JC103**

NB: all times recorded in GMT

Date 29/May/2014

Site arrival time 10:35

Setup distance 0.4 Nmiles

Start time 10:46

End time 11:05:50

Start Position

Latitude 27.2207 N **Longitude** 15.4277 W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		10:46
Billings Float	n/a		10:46
with Light	T05-078		10:46
and Iridium Beacon	C02-049	Beacon ID = 300234061661230	10.46
2 x 17" glass	n/a		10:47
Swivel	n/a		
MicroCAT	4475		10:47
2 x 17" glass	n/a		10:53
RCM11	448		10:56
MicroCAT	3229		10:58
3 x 17" glass	n/a		10:58
Swivel	n/a		
Acoustic Release #1	1202	Record codes below	11:05:5
Acoustic Release #2	827	Record codes below	11:05:5
500kg Anchor	n/a		11:05:5

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

Argos beacon #1 ID 300234061661230

Anchor Drop Position

Latitude 27.2227 N **Longitude** [illegible]5.4219 W

Uncorrected water depth 2993.6599 (at anchor launch)

Corrected water depth 2996.6 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH2**
Cruise **JC103**
NB: all times recorded in GMT
Date 30/May/2014.
Site arrival time 8:00
Setup distance 0.3 Nmiles
Start time 9:00
End time 9:11
Start Position
Latitude 27.6107 N **Longitude** -14.2144 W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		9:00
Billings Float	n/a		9:00
with Light	N08-027		
and Iridium Beacon	C02-047	Beacon ID = 300234061668230	
2 x 17" glass	n/a		9:01
Swivel	n/a ✓		
MicroCAT	4795		9:01
2 x 17" glass	n/a		9:04
MicroCAT	3234		9:04
RCM11	445		9:06
MicroCAT	4714		9:07
3 x 17" glass	n/a		9:07
Swivel	n/a ✓		
Acoustic Release #1	1198	Record codes below	9:11
Acoustic Release #2	1350	Record codes below	9:11
500kg Anchor	n/a		9:11

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code [redacted]
Argos beacon #1 ID 300234061668230

Anchor Drop Position
Latitude 27.6143 **Longitude** -14.2113

Uncorrected water depth 2007.74 (at anchor launch)
Corrected water depth 2004.7 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH3**
Cruise **JC103**
NB: all times recorded in GMT
Date 30/May/2014
Site arrival time 15:25
Setup distance 0·35 Nmiles
Start time 15:27
End time 16:48
Start Position
Latitude 27.7839 N **Longitude** -13.75700 W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		15:27
Billings Float	n/a		15:28
with Light	208-049		
and Iridium Beacon	JO3SE1	Beacon ID = 300234061662230	
4 x 17” glass	n/a		15:28
Swivel	n/a ✓		
MicroCAT	5778		15:28
MicroCAT	4725		15:32
MicroCAT	3932		15:35
MicroCAT	7723		15:37
3 x 17” glass	n/a		15:41
MicroCAT	6830		15:42
MicroCAT	4717		15:45
5 x 17” glass	n/a		15:49
Swivel	n/a ✓		
RCM11	303		15:49
MicroCAT	4721		15:51
MicroCAT	5774		15:54
4 x 17” glass	n/a		15:58
MicroCAT	3228		15:59
RCM11	305		16:04
MicroCAT	3269		16:04
3 x 17” glass	n/a		16:08
MicroCAT	3233		16:10
RCM11	383		16:13
MicroCAT	5789		16:17
3 x 17” glass	n/a		16:21
MicroCAT	3221		16:22
Sontek	322		16:26
MicroCAT	3206		16:30
4 x 17” glass	n/a		16:34
Swivel	n/a ✓		
Acoustic Release #1	1535	Record codes below	16:42
Acoustic Release #2	930	Record codes below	16:42
500kg Anchor	n/a		16:48

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]
Argos beacon #1 ID 300234061662230

Anchor Drop Position
Latitude 27.8076 N **Longitude** 13.7170 W

Uncorrected water depth 1412.2 (at anchor launch)
Corrected water depth 1414.2 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH4L5** Cruise **JC103**

NB: all times recorded in GMT

Date 31/May/2014 **Site arrival time** overnight

Setup distance 0

Start time 09:11 **End time** 09:15:30

Start Position

Latitude 27.86184N **Longitude** 13.51385 W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		09:11
Billings Float	n/a		09:12
with Light	W03-097		
and Argos Beacon	A08-069	ID= 121990	
4 x 17" glass	n/a		09:12
4 x 17" glass	n/a		09:13
4 x 17" glass	n/a		09:13
BPR	395		09:15
BPR	033		
Acoustic Release #1	1533		
Acoustic Release #2	1348		

Release #1 arm code [redacted]

Release #1 release code

Release #2 arm code

Release #2 release code

Argos beacon #1 ID 121990

Anchor Drop Position

Latitude 27.86788 N **Longitude** 13.51283 W

Uncorrected water depth 988.9 (at anchor launch)

Corrected water depth 1016.6 (at anchor launch)

note: drop position 0.15 Nmiles away from mooring site to account for current.

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH4** Cruise **JC103**

NB: all times recorded in GMT

Date 31/May/2014 **Site arrival time** ________

Setup distance 1 Nmile

Start time 1222 **End time** 13:26

Start Position

Latitude ~~27.383~~ 27.8384N **Longitude** – 13.5539 W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		12:22
Billings Float	n/a		12:2
with Light	V01-026		
and Iridium Beacon	J03157	Beacon ID = 300234061660230	
4 x 17" glass	n/a		12:24
Swivel	n/a		
MicroCAT	3904		
MicroCAT	3905		12:26
3 x 17" glass	n/a		12:29
MicroCAT	6802		12:31
MicroCAT	3232		12:34
2 x 17" glass	n/a		12:38
MicroCAT	6810		12:39
MicroCAT	3891		12:43
2 x 17" glass	n/a		12:47
Swivel	n/a ✓		
MicroCAT	68.38		12:49
MicroCAT	3901		12 53
2 x 17" glass	n/a		12 56
MicroCAT	5783		12 58
Sontek	D298		13:06
MicroCAT	6807		13:08
6 x 17" glass	n/a		13:15
Swivel	n/a ✓		
Acoustic Release #1	253	Record codes below	13:18
Acoustic Release #2	1536	Record codes below	13:18
700kg Anchor	n/a		13:26

Release #1 arm code [redacted]

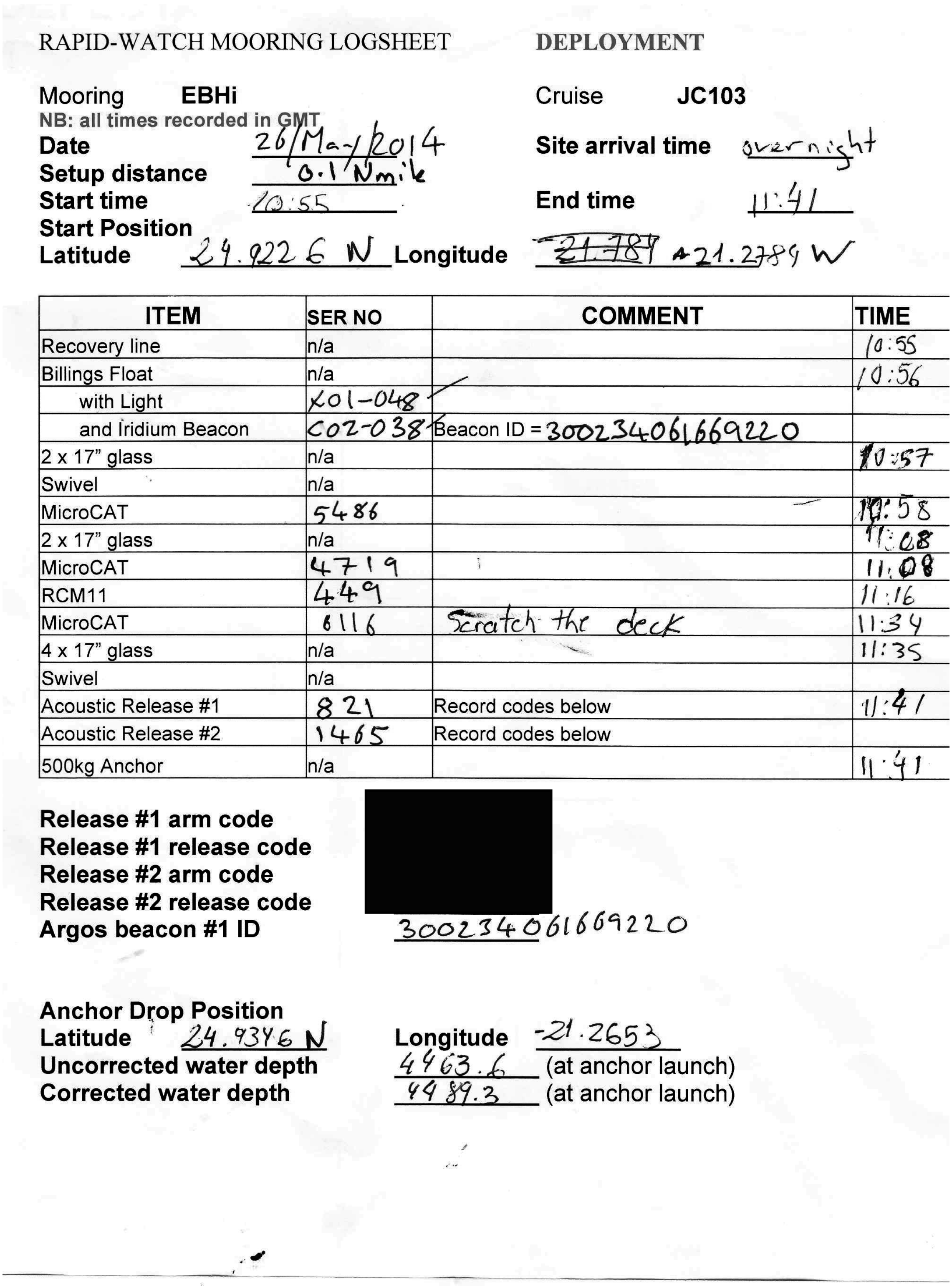
Release #1 release code

Release #2 arm code

Release #2 release code

Argos beacon #1 ID 300234061660230

Anchor Drop Position



RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBHi**
Cruise **JC103**
NB: all times recorded in GMT
Date 26/May/2014
Site arrival time overnight
Setup distance 0.1 Nmile
Start time 10:55
End time 11:41
Start Position
Latitude 24.9226 N **Longitude** ~~21.787~~ -21.2789 W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		10:55
Billings Float	n/a		10:56
with Light	X01-048		
and Iridium Beacon	C02-038	Beacon ID = 300234061669220	
2 x 17” glass	n/a		10:57
Swivel	n/a		
MicroCAT	5486		10:58
2 x 17” glass	n/a		11:08
MicroCAT	4719		11:08
RCM11	449		11:16
MicroCAT	6116	Scratch the deck	11:34
4 x 17” glass	n/a		11:35
Swivel	n/a		
Acoustic Release #1	821	Record codes below	11:41
Acoustic Release #2	1465	Record codes below	
500kg Anchor	n/a		11:41

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code [redacted]
Argos beacon #1 ID 300234061669220

Anchor Drop Position
Latitude 24.9346 N **Longitude** -21.2653
Uncorrected water depth 4463.6 (at anchor launch)
Corrected water depth 4489.3 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR0**
Cruise **JC103**

NB: all times recorded in GMT

Date 13/May/2014
Setup distance 0.4 Nmiles
Start time 18:59
Site arrival time ________
End time 19:24:08
Start Position
Latitude 25.1390 N **Longitude** 52.02884 W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		18:59
Billings Float	n/a		19:00
with Light	W03-092		
and Argos Beacon	Z08-042	Beacon ID = 111849	
2 x 17” glass	n/a		19:01
Swivel			
MicroCAT	6121		19:01
MicroCAT	6123		19:05
~~2~~3x 17” glass	n/a		19:09
MicroCAT	6137		19:09
S4	35612568		19:16
MicroCAT	6120		19:14
MicroCAT	6803		19:19
8 x 17” glass	~~n/a~~	31" Syndectic	19:19
SBE26 BPR		34" Syntactic	19:21
SBE53 BPR			
Acoustic Release #1	281	Record codes below	19:21
Acoustic Release #2	819	Record codes below	
600kg Anchor	n/a		19:24:08

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code [redacted]
Argos beacon #1 ID 111849

Anchor Drop Position
Latitude 25.14064 N **Longitude** 52.02223 W

Uncorrected water depth 5403.6 (at anchor launch)
Corrected water depth 5461.7 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR1L9** Cruise **JC103**
NB: all times recorded in GMT
Date 14/May/2014.
Setup distance 0.1 Nmile
Start time 18:34
Site arrival time
End time 18:40
Start Position
Latitude 24.2000 N **Longitude** 49.7333 W

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		18:34
~~Billings Float~~	n/a		
~~with Light~~			
~~and Argos Beacon~~		~~Beacon ID =~~	
1 x 31" syntactic	n/a	ARGOS Y01-008 ID= 46485	18:36
1 x 34" syntactic	n/a	Light A08-079.	18:39
BPR	419		
BPR	085		
Acoustic Release #1	1194	Record codes below	
Acoustic Release #2	823	Record codes below	
300kg Anchor	n/a		18:40:2

Release #1 arm code [redacted]
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID 46485

Anchor Drop Position
Latitude 24.19843 N **Longitude** 49.73328 W

Uncorrected water depth 5176.3 (at anchor launch)
Corrected water depth 5226.6 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR1** Cruise **JC103**

NB: all times recorded in GMT

Date 15/May/2014 **Site arrival time** ________

Setup distance 4.2 N miles

Start time 10:04 **End time** 15:04

Start Position

Latitude 24.10170 N **Longitude** 49.73391

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		10:04
3 x Mini-Trimsyn	n/a		10:04
MicroCAT	4472		10:04.
24" syntactic float	n/a		10:11
with Light	A08-078		
and ~~Argos~~ Beacon	C02-052	Beacon ID = 300234061662220	
Swivel	n/a		
MicroCAT	4470		10:11
37" Steel Sphere			10:17
with Light	W03-091		
and Argos Beacon	304	Beacon ID = 82895	
Swivel	n/a		
MicroCAT	4180		10:20
MicroCAT	3223		10:23
MicroCAT	4072		10:27
MicroCAT	4549	repositioned ship. commenced deployment @ 11:50	11:52
MicroCAT	6814		11:57
8 x 17" glass	n/a		12:07
Swivel	n/a		
MicroCAT	4068		12:07
MicroCAT	3239		12:12
MicroCAT	3270		12:18
RCM11	301		12:27
MicroCAT	6808		12:30
8 x 17" glass	n/a		12:37
Swivel	n/a		
MicroCAT	5247		12:46
4 x 17" glass	n/a		13:50
Swivel	n/a		
MicroCAT	5782		13:00
4 x 17" glass	n/a		13:15
Swivel	n/a		
MicroCAT	5767		13:15
4 x 17" glass	n/a	13:28	~~13:33~~
Swivel	n/a	13:28	~~13:33~~

			ANCHOR TARGET
MicroCAT	3219		13:29
4 x 17" glass	n/a		13:43
Swivel	n/a		
MicroCAT	6335		13:44
MicroCAT	6326		13:56
5 x 17" glass	n/a		14:02
Swivel	n/a		
S4	35612571		14:14
MicroCAT	6325		14:14
9 x 17" glass	n/a		14:22
Swivel	n/a		
Acoustic Release #1	917	Record codes below	14:25
Acoustic Release #2	370	Record codes below	
1800kg Anchor	n/a	~~heaving~~ Towing line still attached to chain above anchor.	15:04

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]
Argos beacon #1 ID 300234061662220
Argos beacon #2 ID 82895

Anchor Drop Position
Latitude 24.17117 N **Longitude** 49.75125 W

Uncorrected water depth 5164 (at anchor launch)
Corrected water depth 52139 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR2**

Cruise **JC103**

NB: all times recorded in GMT

Date 15/May/2014

Site arrival time ________

Setup distance 1.5 Nmiles

Start time 18:08

End time 19:31

Start Position

Latitude 24.16949N **Longitude** 49.73588W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		18:08
Billings float	n/a		18:09
with Light	H01-009		
and Argos Beacon	Z02-006	Beacon ID = 53153	
3 x 17" glass	n/a		18:10
Swivel	n/a ✓		
MicroCAT	4461 ✓		18:10
5 x 17" glass	n/a		18:27
Swivel	n/a ✓		
MicroCAT	6824 ✓		18:28
MicroCAT	6822 ✓		18:40
MicroCAT	6821 ✓		18:50
7 x 17" glass	n/a		18:52
Swivel	n/a ✓		18:53
S4			18:59
Acoustic Release #1	910	Record codes below	18:59
Acoustic Release #2	316	Record codes below	18:59
500kg Anchor	n/a		19:31

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

Argos beacon #1 ID 53153

Anchor Drop Position

Latitude 24.18378N **Longitude** 49.76244 W

Uncorrected water depth 5167.1 (at anchor launch)

Corrected water depth 5217.1 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR3L9** Cruise **JC103**

NB: all times recorded in GMT

Date 18/May/2014 **Site arrival time** ________

Setup distance 0.1 N miles

Start time 18:01 **End time** 18:06

Start Position

Latitude 2 3.86279N **Longitude** 41.10017W

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		18:01
Billings Float	n/a		18:02
with Light	W03-083		
and Argos Beacon	Y01-026	Beacon ID = 46499	
4 x 17” glass	n/a		18:02
4 x 17” glass	n/a		18:03
4 x 17” glass	n/a		18:04
BPR	~~885~~ 0064		18:06
BPR	0057		18:06
Acoustic Release #1	1383	Record codes below	18:06
Acoustic Release #2	323	Record codes below	18:06
Anchor	n/a		18:06

Release #1 arm code [redacted]
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID S/N: Y01-026 ID: 46499

Anchor Drop Position

Latitude 23.86258N **Longitude** 41.09895W

Uncorrected water depth ___________ (at anchor launch) ca600 turned o

Corrected water depth ___________ (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR3**
Cruise **JC103**
NB: all times recorded in GMT
Date 18/May/2014
Site arrival time ________
Setup distance 2.5 Nmiles
Start time 15:12
End time 17:37
Start Position
Latitude 23.88852N **Longitude** 41.13264 W ✓

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		15:12
Billings float	n/a		15:12
with Light	A08-081		
and ~~Argos~~ Beacon IRIDIUM	C02-043	Beacon ID = 300234001667220	
2 x 17" glass	n/a		15:13
Swivel ✓	n/a		
MicroCAT	4471 ✓		15:13
2 x 17" glass	n/a		15:19
2 x 17" glass	n/a		15:31
MicroCAT	3282 ✓		~~15~~ 15:31
2 x 17" glass	n/a	15:45	~~15:32~~
Swivel	n/a ✓		
MicroCAT	6117 ✓		15:46
2 x 17" glass	n/a		15:59
MicroCAT	5981 ✓		16:01
3 x 17" glass	n/a		16:14
MicroCAT	5239 ✓		16:15
3 x 17" glassl			16:28
Swivel	n/a ✓		16:30
~~S4~~	No		
MicroCAT	59853 ✓		16:30
MicroCAT	5982 ✓		16:42
7 x 17" glass	n/a		16:47
Swivel ✓	n/a		(16:50)
S4	3561274 ✓	Over the 7glasses (tech said easier to recover)	16
Acoustic Release #1	12006	Record codes below	16:55
Acoustic Release #2	498	Record codes below	16:55
700kg Anchor	n/a		17:37

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]
Argos beacon #1 ID 300234001667220

Anchor Drop Position

Latitude 23.86802 N **Longitude** 41.08989W

Uncorrected water depth ____________ (at anchor launch) ea600 turned of

Corrected water depth ____________ (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **NOG**
Cruise **JC103**

NB: all times recorded in GMT

Date 19/05/2014
Setup distance 1.25 Nmiles
Start time 12:47
Site arrival time 12:43
End time 13:55

Start Position
Latitude 23.76725 N **Longitude** 41.12238 W

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		12:47
Billings Float	n/a		12:48
with Light	R05-079		~~12:49~~
12 x 17" glass	n/a		12:49
Swivel	n/a ✓		12:52
Sediment Trap	11262-06		12:57
Nortek	8421		12:57
Sediment Trap	11804-01		13:02
Nortek	8430		13:02
10 x 17" glass	n/a		13:30
MicroCAT	9477		13:36
Acoustic Release #1	~~[illegible]~~ 318		13:38
Anchor	n/a		13:55

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

Anchor Drop Position
Latitude 23.7714 N **Longitude** 41.0970 W

Uncorrected water depth 4236.3 (at anchor launch)
Corrected water depth 4257.4 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB1**
NB: all times recorded in GMT
Date 4/May/2014.
Setup distance 2.1 Nmiles
Start time 1605
Start Position
Latitude 26.4825 N **Longitude** 76.78995 W

Cruise **JC103**
Site arrival time 15:00
End time 17:29

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		16:05
3 x Mini-Trimsyn	n/a		16:06
MicroCAT-ODO	10517 ✓		16:06
30" syntactic float	n/a		16:12
with light	Z08-051		
and Argos Beacon	C02-040	Beacon ID = 300234061660210	
Swivel	n/a ✓		
Nortek	6753 ✓		16:13
MicroCAT	6115 ✓		16:13
45" syntactic float	n/a		16:21
with light	Z08-055		
and Argos Beacon	·253	Beacon ID = ~~SMM 500~~ 42745	
Swivel	n/a	I haven't seen it	
Nortek	9266 ✓		16:29
MicroCAT	3911 ✓		16.29
MicroCAT-ODO	10518 ✓		16:30
7 x 17" glass	n/a		16:41
Swivel	n/a ✓		16:43
Nortek	5885 ✓		16:43
MicroCAT	3486 ✓		16:46
MicroCAT-ODO	10519 ✓		16.46
2 x 17" glass	n/a		16:57
Nortek	9402 ✓		16:57
MicroCAT	3483 ✓		16:58
6 x 17" glass	n/a		17:04
Swivel	n/a ✓		17:08
Acoustic Release #1	1461 ✓	Record codes below	17:08
Acoustic Release #2	324 ✓	Record codes below	17:08
1800kg Anchor	n/a		17:29

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]
Argos beacon #1 ID 300234061660210
Argos beacon #2 ID 42745

S/n 1461 ✓
09B2
0955

S/n 324 ✓

Anchor Drop Position
Latitude 26.50795 N **Longitude** 76.81612 W

Uncorrected water depth 1355.7 (at anchor launch)
Corrected water depth 1364.1 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB2L10**
Cruise **JC103**

NB: all times recorded in GMT

Date 2/May/2014.
Site arrival time 17:25
Setup distance 0
Start time 17:25
End time 17:28
Start Position
Latitude 26.5109 W **Longitude** 76.74665 W

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		
Billings Float	n/a		17:25
with Light	B11-018		
and Argos Beacon	Y01-029	Beacon ID = 46502/3FA8E6A	
4 x 17" glass	n/a		17:26.
4 x 17" glass	n/a		17:26.
4 x 17" glass	n/a		17:27
BPR	393		
BPR	14		
Acoustic Release #1	1730	Record codes below	
Acoustic Release #2	916	Record codes below	
600kg Anchor	n/a		17:28:37

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]
Argos beacon #1 ID 46502

Anchor Drop Position
Latitude 26°30.62' N **Longitude** 76°44.79' W

Uncorrected water depth 3869 (at anchor launch)
Corrected water depth 3888 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB2**

NB: all times recorded in GMT

Date 3/May/2014.

Setup distance 3.5 Nmiles

Start time 12:14

Start Position

Latitude 26.57153 N **Longitude** 76.73727 W

Cruise **JC103**

Site arrival time ______

End time 15:43

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		
3 x Mini-Trimsyn			12:14
MicroCAT	6126 ✓		12:14
30" syntactic float	n/a		
with light		A08-084.	12:23
and Argos Beacon	C02-044	~~Beacon ID~~ = IMEI 300234061666230	
Swivel	n/a		
~~RCM11~~ NORTEK	5897 ✓		12:23
MicroCAT	6321 ✓		
51" syntactic float	n/a		
with light		A08-085	12:33
and Argos Beacon	286	Beacon ID = 22447	
Swivel	n/a		
~~RCM11~~ NORTEK	~~5963~~	5890 ✓	12:33
MicroCAT	7468 ✓		
MicroCAT	6828 ✓		12:40
2 x 17" glass	n/a		
Nortek	5967 ✓		12:45
MicroCAT	3902 ✓		12:47
DST Tilt	352		12:52
MicroCAT	6840 ✓		12:55
2 x 17" glass	n/a		
Nortek	6132 ✓		12:59
MicroCAT	5785 ✓		~~[illegible]~~ 13:
DST Tilt	358		13:07
MicroCAT	4306 ✓		13:10
10 x 17" glass	n/a		
Swivel	n/a		
Nortek	6176 ✓		13:19
MicroCAT	5240 ✓		~~[illegible]~~ 13
DST Tilt	362 ✓		13:24
Nortek	6516 ✓		13:31
MicroCAT	3928 ✓		13:31
5 x 17" glass	n/a		
MicroCAT	3209 ✓		~~[illegible]~~ 13:

MicroCAT	5787 ✓		13:45
DST Tilt	364		13:49
Nortek	6743 ✓		13:52
5 x 17" glass	n/a		13:59
Swivel	n/a		
MicroCAT	3248 ✓		14:00
MicroCAT	6825 ✓		14:14
DST Tilt	370		14:14
2 x 17" glass	n/a		
Nortek	6751 ✓		14:20
5 x 17" glass	n/a		
MicroCAT	3910 ✓		14:30
MicroCAT	6323 ✓		14:44
10 x 17" glass	n/a		
Swivel	n/a		
Acoustic Release #1	325	Record codes below	14:52
Acoustic Release #2	1405	Record codes below	
2200kg Anchor	n/a		15.43

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code [redacted]
Argos beacon #1 ID 300234061666230
Argos beacon #2 ID 22442

Anchor Drop Position
Latitude 26°30.78 N **Longitude** 76°44.33 W

Uncorrected water depth 3854 (at anchor launch)
Corrected water depth 3873 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB4L10**
Cruise **JC103**

NB: all times recorded in GMT

Date 1/5/2014
Site arrival time 18:50
Setup distance ~~1 cable~~ 4 cables
Start time 18:50:31
End time 18:56
Start Position
Latitude 26.48563 N **Longitude** 75.70684 W

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		
Billings Float	n/a		18:51
with Light	a08-086		
and Argos Beacon	Z08-44	Beacon ID = 111850	
4 x 17" glass	n/a		
4 x 17" glass	n/a		18:52
4 x 17" glass	n/a		18:54
BPR	0400		
BPR	0039		
Acoustic Release #1	358	Record codes below	
Acoustic Release #2	1732	Record codes below	
600kg Anchor	n/a		18:56:20

Release #1 arm code [redacted]
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID 111850

Anchor Drop Position
Latitude 26.4848 **Longitude** -75.7061

Uncorrected water depth 4653 (at anchor launch)
Corrected water depth 4689 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB4**

NB: all times recorded in GMT

Date 1 May 2014

Setup distance 4·5 Nmiles

Start time ~~[illegible]~~ 12:49

Start Position

Latitude 26·52517 N

Longitude 75·77182 W

Cruise **JC103**

Site arrival time ________

End time 18:24

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		
3 x Mini-Trimsyn			
MicroCAT	6125	10545	12:50
32" syntactic float	n/a		
with light	C02-037		
and Argos Beacon	B03-078	Beacon ID = 129571	
Swivel	n/a		
~~RCM11~~ nortek	9409		
MicroCAT	~~[illegible]~~	6129	13:00
49" syntactic float	n/a		13:13
with light	C02-036		
and Argos Beacon	Z08-046	Beacon ID = 111853	
Swivel	n/a		
MicroCAT	~~[illegible]~~	6327	13:13
Nortek	4420.		~~[illegible]~~
MicroCAT	~~10544~~	3933	13:23
MicroCAT-ODO	~~3933~~	10544	
MicroCAT	7363		13:31
DST Tilt	361		
Nortek	~~9427~~	~~9433~~ 9427 ✓	
MicroCAT	5786 ✓		13:41
MicroCAT-ODO	10547 ✓		
MicroCAT	4307		13:4
DST Tilt	363		
10 x Orange CF-16s	n/a		
Swivel	n/a		14:04
Nortek	~~5762~~	9433	
MicroCAT	5762		
DST Tilt	366		~~14:09~~
Nortek	n/a 9439		~~[illegible]~~
MicroCAT-ODO	10555	14:17	
5 x Yellow CF-16s			
MicroCAT	5773		14:21
DST Tilt	~~367~~	357	
5 x Yellow CF-16s	n/a		

Swivel	n/a		
Nortek	9444		
MicroCAT	3931		14:43
MicroCAT-ODO	10556		
DST Tilt	368		14:50
5 x Yellow CF-16s	n/a		14:59
MicroCAT	5779		15:01
5 x Yellow CF-16s	n/a		15:17
Swivel	n/a		~~15~~
Nortek	6119		15:18
MicroCAT	6820		15:19
5 x Yellow CF-16s	n/a		
Swivel	n/a		
MicroCAT	6806		15:36
MicroCAT-ODO	10546		"
5 x Yellow CF-16s	n/a		1551
Nortek	5879		1554
MicroCAT	5768		"
MicroCAT	4305		1612
Nortek	5884		1616
10 x 17" glass	n/a	Orange	16:28
Swivel	n/a ✓		
Acoustic Release #1	1731	Record codes below	16:35
Acoustic Release #2	1463	Record codes below	
2700kg Anchor	n/a		18:24:21

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]
Argos beacon #1 ID ______
Argos beacon #2 ID ______

Anchor Drop Position
Latitude 26.47612 **Longitude** -75.69975

Uncorrected water depth 4650.62 (at anchor launch)
Corrected water depth 4686.14 (at anchor launch)

slow steam due to
ng for hydraulic
for the little beefy winch.
17:01 - 1 kt
ing into a current
7:45 & still 45 min to go
:49 hydralics back on - 10 min
7:58 winch operational

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB6**

Cruise **JC103**

NB: all times recorded in GMT

Date 8/May/2014

Site arrival time Overnight

Setup distance ~~17:55~~ 4cable

Start time 17:55

End time 18:20

Start Position

Latitude 26.49108 **Longitude** -70.63089

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		17:55
Billings Float	n/a		17:55
with Light		X01-050	
and Argos Beacon		Beacon ID = ~~X01-050~~ Y01-012	
3 x 17" glass with swivel ✓	n/a		17:56
MicroCAT	5985 ✓		17:56
MicroCAT	5243 ✓		17:59
2 x 17" glass	n/a		18:02
MicroCAT	6320 ✓		18:02
MicroCAT	6128 ✓		18:06
Nortek	5896 ✓		18:07
MicroCAT	3919 ✓		18:08
31" syntactic	n/a	Change chain lengths to	
34" syntactic	n/a	24 (see back)	
SBE53 BPR	0056		
SBE53 BPR	0055		18:20
Acoustic Release #1	1201	Record codes below	18:20
Acoustic Release #2	364	Record codes below	18:20
600kg Anchor	n/a		18:20

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

[redacted]

Argos beacon #1 ID 46492

Anchor Drop Position

Latitude 26.4948 **Longitude** -70.62362

Uncorrected water depth 5435 (at anchor launch)
Corrected water depth 5494 (at anchor launch)

184050 2125 2134 } 100 m/min
144120 2116 2186 }

going down and both

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WBADCP**
Cruise **JC103**

NB: all times recorded in GMT

Date 03/May/2014
Site arrival time 22:58
Setup distance 0
Start time 22:58
End time 23:04

Start Position
Latitude 26.53028 N **Longitude** 76.86656 W

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		22:58
ADCP in float			23:01
with Light	a08-083		
and Argos Beacon	c02-045	Beacon ID = 300234061661040	
Swivel	n/a		
Acoustic Release #1	1352	Record codes below	
Acoustic Release #2	1349	Record codes below	
800kg Anchor	n/a		23:04

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code [redacted]
Argos beacon #1 ID 300234061661040

Anchor Drop Position
Latitude 26° 31.8N **Longitude** 76° 52.02W

Uncorrected water depth 572 (at anchor launch)
Corrected water depth 581 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

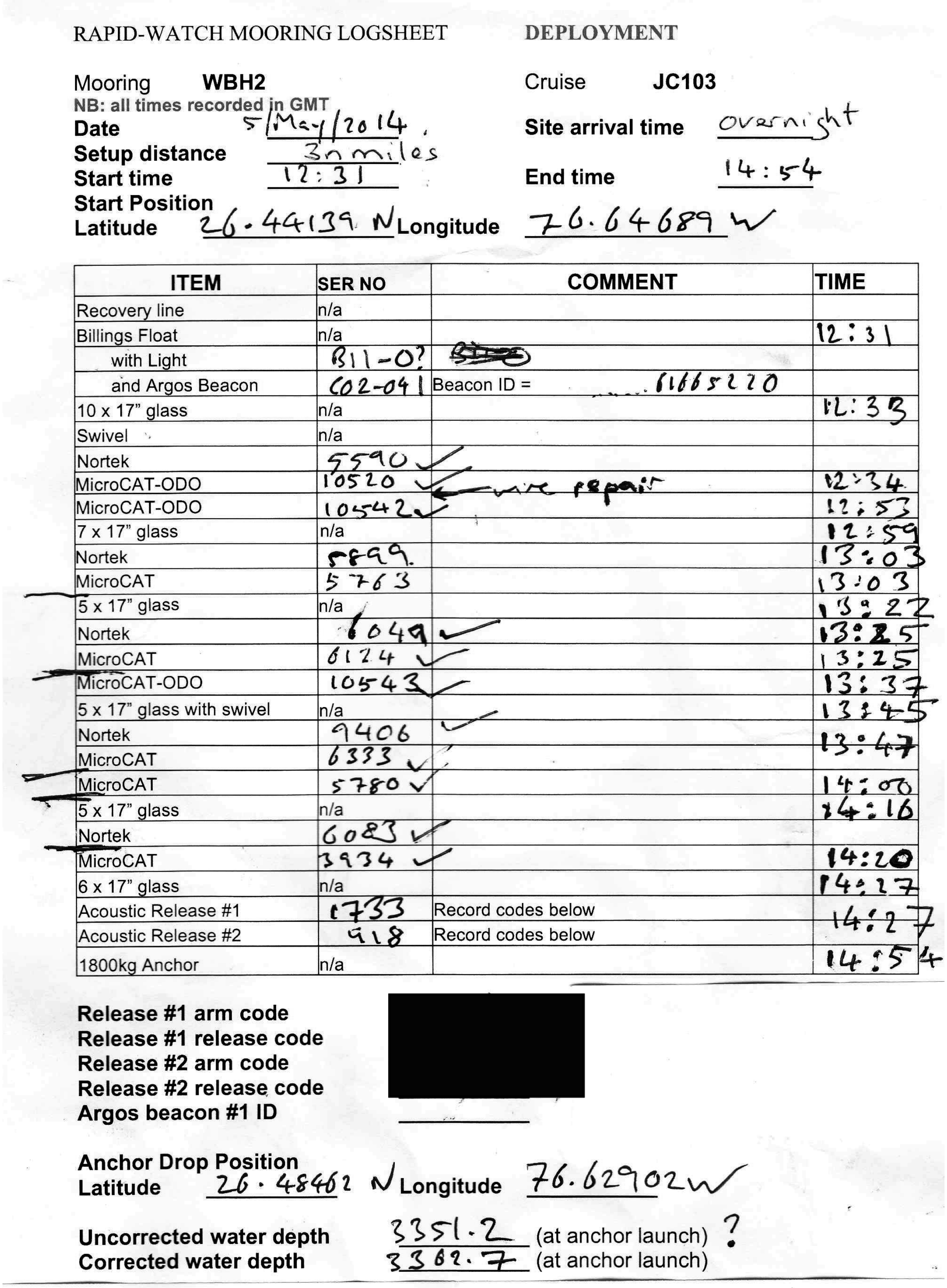
Mooring **WBAL5**
Cruise **JC103**
NB: all times recorded in GMT
Date 4/May/2014.
Site arrival time ________
Setup distance 0·1 N mile
Start time ~~13:50~~ 13:52
End time 13:56
Start Position
Latitude 26·5352 N **Longitude** 76·87433 W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		~~13:50~~ 13:
Billings Float	n/a		13:53
with Light		B11-017	
and Argos Beacon	208-043	Beacon ID = 111852	
4 x 17" glass	n/a		13:54
4 x 17" glass	n/a		13:54
4 x 17" glass	n/a		13:55
BPR	0390		↓
BPR	0417		
Acoustic Release #1	1406	Record codes below	13:56
Acoustic Release #2	1464	Record codes below	
1200kg Anchor	n/a		↑

Release #1 arm code [redacted]
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID 11852

Anchor Drop Position
Latitude 26° 32·186 'N **Longitude** 76° 52·397 W

Uncorrected water depth 488 (at anchor launch)
Corrected water depth 496 (at anchor launch)



RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WBH2**
Cruise **JC103**
NB: all times recorded in GMT
Date 5/May/2014.
Site arrival time overnight
Setup distance 3n miles
Start time 12:31
End time 14:54
Start Position
Latitude 26.44139 N **Longitude** 76.64689 W

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line	n/a		
Billings Float	n/a		12:31
with Light	B11-0?		
and Argos Beacon	C02-041	Beacon ID = 61665220	
10 x 17" glass	n/a		12:33
Swivel	n/a		
Nortek	5590 ✓		
MicroCAT-ODO	10520 ✓	← wire repair	12:34
MicroCAT-ODO	10542 ✓		12:53
7 x 17" glass	n/a		12:59
Nortek	5899.		13:03
MicroCAT	5763		13:03
5 x 17" glass	n/a		13:22
Nortek	6049 ✓		13:25
MicroCAT	6124 ✓		13:25
MicroCAT-ODO	10543 ✓		13:37
5 x 17" glass with swivel	n/a		13:45
Nortek	9406 ✓		13:47
MicroCAT	6333 ✓		
MicroCAT	5780 ✓		14:00
5 x 17" glass	n/a		14:16
Nortek	6083 ✓		
MicroCAT	3934 ✓		14:20
6 x 17" glass	n/a		14:27
Acoustic Release #1	1733	Record codes below	14:27
Acoustic Release #2	918	Record codes below	
1800kg Anchor	n/a		14:54

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]
Argos beacon #1 ID ________

Anchor Drop Position
Latitude 26.48462 N **Longitude** 76.62902W

Uncorrected water depth 3351.2 (at anchor launch) ?
Corrected water depth 3362.7 (at anchor launch)

Appendices

A RAPID mooring and hydrographic cruises

Cruise	Vessel	Date	Objectives	Cruise Report
D277	RRS Discovery	Feb - Mar 2004	Initial Deployment of Eastern Boundary and Mid-Atlantic Ridge moorings	RRS Discovery Cruise D277 and D278. Southampton Oceanography Centre Cruise Report, No 53, 2005
D278	RRS Discovery	Mar-04	Initial Deployment of UK and US Western Boundary Moorings	RRS Discovery Cruise D277 and D278. Southampton Oceanography Centre Cruise Report, No 53, 2005
P319	RV Poseidon	Dec-04	Emergency deployment of replacement EB2 following loss	Appendix in RRS Charles Darwin Cruise CD170 and RV Knorr Cruise KN182-2. National Oceanography Centre Southampton Cruise Report, No. 2, 2006
CD170	RRS Charles Darwin	Apr-05	Service and redeployment of Eastern Boundary and Mid-Atlantic Ridge moorings	RRS Charles Darwin Cruise CD170 and RV Knorr Cruise KN182-2. National Oceanography Centre Southampton Cruise Report, No. 2, 2006
KN182-2	RV Knorr	May-05	Service and redeployment of UK and US Western Boundary Moorings and Western Boundary Time Series (WBTS) hydrography section	RRS Charles Darwin Cruise CD170 and RV Knorr Cruise KN182-2. National Oceanography Centre Southampton Cruise Report, No. 2, 2006
CD177	RRS Charles Darwin	Nov-05	Service and redeployment of key Eastern Boundary moorings	RRS Charles Darwin Cruise CD177. National Oceanography Centre Southampton Cruise Report, No. 5, 2006
WS05018	RV F.G. Walton Smith	Nov 05	Emergency recovery of drifting WB1 mooring	No report published

RB0602	RV Ronald H. Brown	Mar-06	Service and redeployment of UK Western Boundary moorings and WBTS hydrography section	RV Ronald H. Brown Cruise RB0602 and RRS Discovery Cruise D304. 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	RV Ronald H. Brown Cruise RB0602 and RRS Discovery Cruise D304. National Oceanography Centre Southampton Cruise Report, No. 16, 2007
P343	RV Poseidon	Oct 06	Service and redeployment of key Eastern Boundary moorings	RS Poseidon Cruises P343 and P345. National Oceanography Centre Southampton Cruise Report No. 28, 2008.
P345	RV Poseidon	Dec 06	Emergency redeployment of EB1 and EB2 following problems on P343	RS Poseidon Cruises P343 and P345. National Oceanography Centre Southampton Cruise Report No. 28, 2008.
SJ06	RV Seward Johnson	Sep - Oct 2006	Recovery and redeployment of WB2 and US Western Boundary moorings, and WBTS hydrography section	Appendix G in RV Ronald H. Brown Cruise RB0701. 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	RV Ronald H. Brown Cruise RB0701. 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	RRS Discovery Cruise D324, National Oceanography Centre,Southampton Cruise Report, No 34
SJ0803	RV Seward Johnson	Apr-08	Service and redeployment of the Western Boundary moorings	RV Seward Johnson Cruise SJ0803, 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	RRS Discovery D344, National Oceanography Centre, Southampton, Cruise Report No. 38, 2009

RB0901	RV Ronald H. Brown	April - May 2009	Service and redeployment of the UK and US Western Boundary moorings and WBTS hydrography section	RV Ronald H. Brown Cruise RB0901, National Oceanography Centre, Southampton Cruise Report, No 39, 2009
D344	RRS Discovery	Oct - Nov 2009	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings	RRS Discovery Cruise, D334, 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	No cruise report to be published
OC459-1	RV Oceanus	Apr-10	Service and redeployment of the Western Boundary moorings	RV Oceanus Cruise OC459-1, National Oceanography Centre, Cruise Report, No. 1, 2011
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, 2012
KN200-4	RV Knorr	April 2011 - May 2011	Recovery and redeployment of US Western Boundary moorings, and WBTS hydrography section	National Oceanography Centre, Cruise Report No. 07, 2012
JC064	RRS James Cook	September 2011 - October 2011	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings	National Oceanography Centre, Cruise Report No. 14, 2012
RB1201	RV Ronald H Brown	February 2012	Recovery and redeployment of UK Western Boundary moorings, and WBTS hydrography section	National Oceanography Centre, Cruise Report No. 19, 2012
EN517	RV Endeavor	September 2012 - October 2012	Recovery and redeployment of US Western Boundary moorings and WBTS hydrography section	R/V Endeavor Cruise EN-517 Cruise Report

Di382	RRS Discovery	October - November 2012	Recovery and redeployment of full UK RAPID array	National Oceanography Centre, Cruise Report No. 21, 2012
AE1404	RV Atlantic Explorer	Marchr 2014	Recovery and redeployment of US Western Boundary moorings and WBTS hydrography section	R/V Endeavor Cruise EN-517 Cruise Report
JC103	RRS James Cook	April - June 2014	Recovery and redeployment of full UK RAPID array	This Report

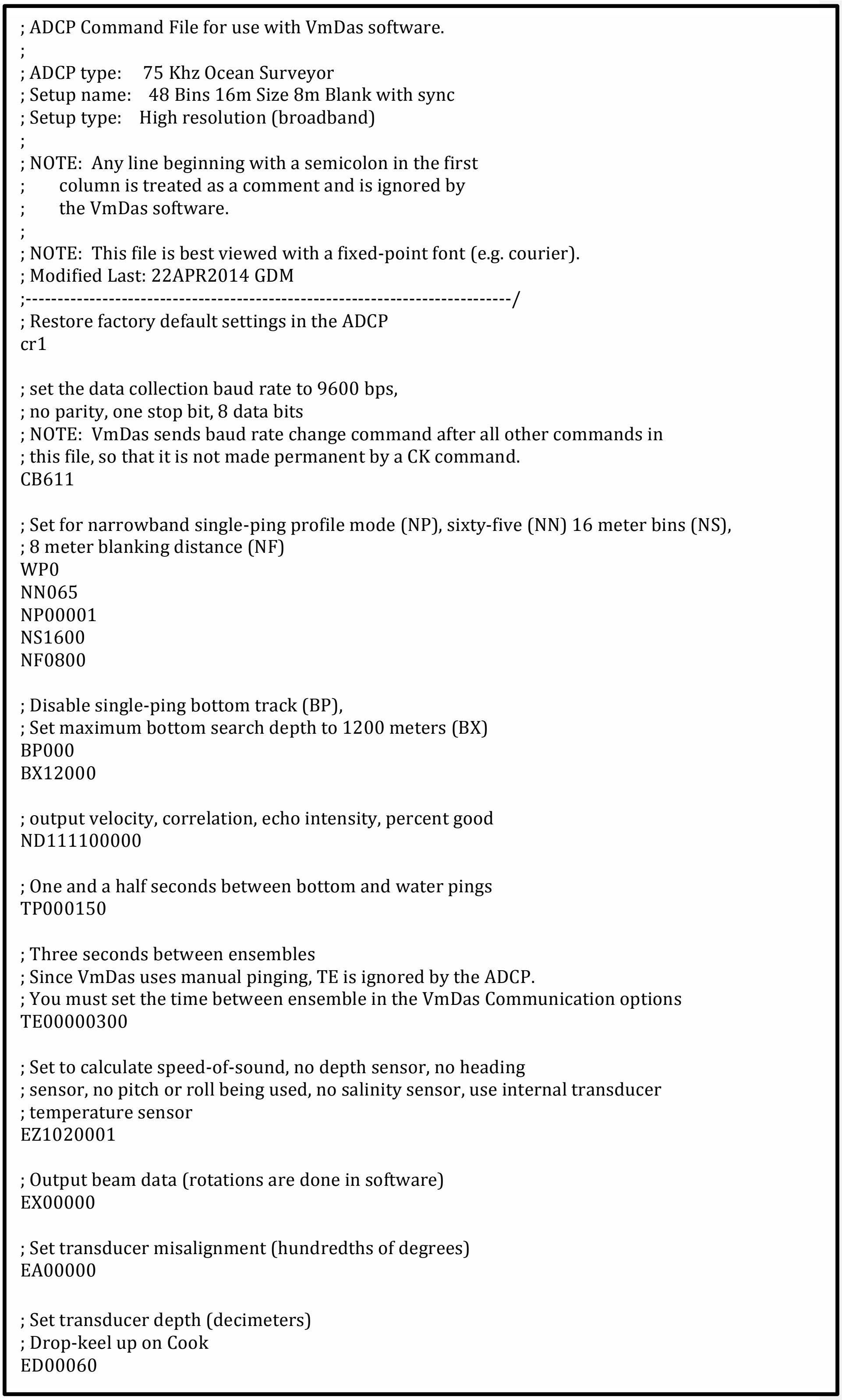
B Mstar CTD proessing steps

step	script	example infile(s)	example otfiles	comments
1	msam_01	none	sam_jc103_NNN.nc	create empty sam file (eg list of vars is in sam_di82_varlist.csv) variable list file is kept in directory M_TEMPLATES
2	mctd_01	ctd_jc103_NNN_ctm.cnv	ctd_jc103_NNN_raw.nc	read in ctd data
3	mctd_02	ctd_jc103_NNN_24hz.nc	ctd_jc103_NNN_24hz.nc	rename SBE variable names. Broken into mctd_02a and mctd_02b when a custom oxygen hysteresis is applied
4	mctd_03	ctd_jc103_NNN_24hz.nc	ctd_jc103_NNN_1hz.nc ctd_jc103_NNN_psal.nc	average to 1 hz and calculate psal, potemp
5	mdcs_01	None	dcs_jc103_NNN.nc	create empty dcs file; this is used to store information about start, bottom and end of good data in CTD file
6	mdcs_02	dcs_jc103_NNN.nc	dcs_jc103_NNN.nc	populate dcs file with data to identify bottom of cast
7	mdcs_03g	dcs_jc103_NNN.nc	dcs_jc103_NNN.nc ctd_jc103_NNN_surf.nc	populate dcs file with data to identify start and end of cast. Uses graphical selection
8	mctd_04	ctd_jc103_NNN_psal.nc	ctd_jc103_NNN_2db.nc	extract downcast data from psal file using index information in dcs file; sort, interpolate gaps and average to 2db.
9	mfir_01	ctd_jc103_NNN.bl	fir_jc103_NNN_bl.nc	read in .bl file and create fir file
10	mfir_02	fir_jc103_NNN_bl.nc ctd_jc103_NNN_1hz.nc	fir_jc103_NNN_time.nc	merge time from ctd onto fir file using scan number
11	mfir_03	fir_jc103_NNN_time.nc ctd_jc103_NNN_psal.nc	fir_jc103_NNN_ctd.nc	merge ctd upcast data onto fir file
12	mfir_04	fir_jc103_NNN_ctd.nc	sam_jc103_NNN.nc	paste ctd fir data into sam file
13	mwin_01	techsas_files	win_jc103_NNN.nc	times extracted from start and end of ctd 1hz file, plus 10 minutes at either end

14	mwin_03	fir_jc103_NNN_time win_jc103_NNN.nc	fir_jc103_NNN_winch.nc	merge winch wireout onto fir file (only relevant if winch data available)
15	mwin_04	fir_jc103_NNN_winch.nc	sam_jc103_NNN.nc	paste win fir data into sam file
16	mctd_checkplots			Creates useful plots for checking of CTD data quality
17	mctd_rawshow			Shows the raw data to visually check
18	mctd_rawedit			allows manual editing of raw data. Steps XXX need to be rerun following this
19	mdcs_04	dcs_jc103_NNN.nc pos_jc103_01.nc	dcs_jc103_NNN_pos.nc	merge positions onto ctd start bottom end times (requires nav file)
20	mdcs_05	dcs_jc103_NNN_pos.nc	dcs_jc103_NNN_pos.nc ctd_jc103_NNN_raw,nc ctd_jc103_NNN_24hz.nc ctd_jc103_NNN_1hz.nc ctd_jc103_NNN_psal.nc ctd_jc103_NNN_surf.nc ctd_jc103_NNN_2db.nc fir_jc103_NNN_bl.nc fir_jc103_NNN_time.nc fir_jc103_NNN_winch.nc fir_jc103_NNN_ctd.nc sal_jc103_NNN.nc sam_jc103_NNN.nc sam_jc103_NNN_resid.nc dcs_jc103_NNN.nc	apply positions to set of files. Any of this list have positions set if the file exists The list should be extended to include any other chemistry files, and the winch file if it exists It can be used at any time, once step 8 is complete
21	msal_01	none	sal_jc103_NNN.nc	read in the bottle salinities
22	msal_02	sal_jc103_NNN.nc	sam_jc103_NNN.nc	paste sal data into sam file

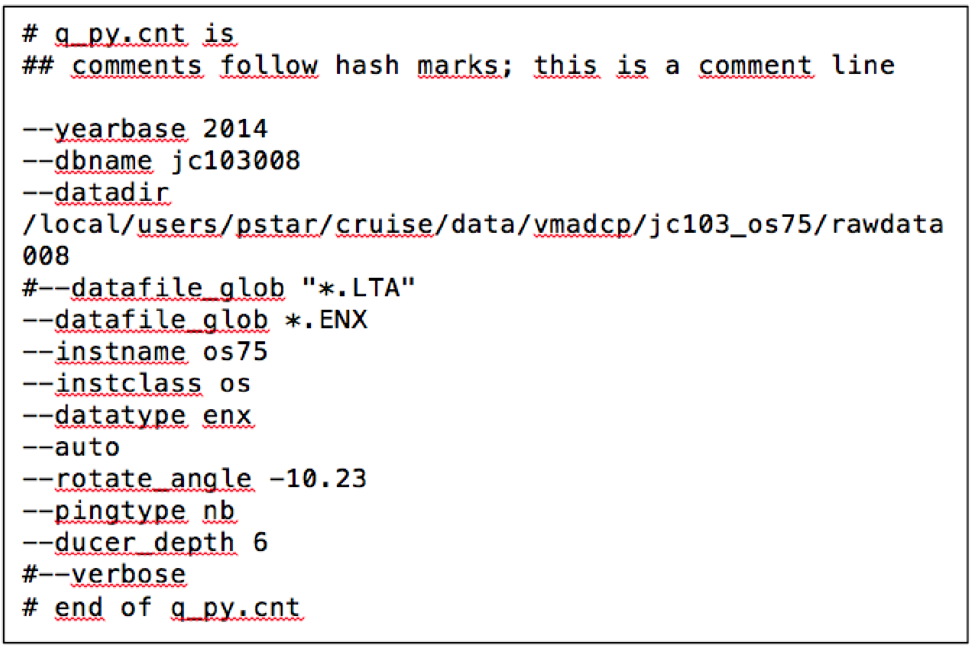
23	moxy_01	none	sal_jc103_NNN.nc	read in the bottle oxygen
24	moxy_02	sal_jc103_NNN.nc	sam_jc103_NNN.nc	paste oxygen data into sam file
25	msam_oxykg	sam_jc103_NNN.nc	sam_jc103_NNN.nc	converts umol/l to umol/kg
26	mapend	sam_jc103_NNN.nc	sam_jc103_all.nc	append all samfiles together
27	msam_updateall	sam_jc103_NNN.nc	sam_jc103_all.nc	update the values in appended samfile

C VMADCP control files



```
; ADCP Command File for use with VmDas software.
;
; ADCP type:     75 Khz Ocean Surveyor
; Setup name:    48 Bins 16m Size 8m Blank with sync
; Setup type:    High resolution (broadband)
;
; NOTE:  Any line beginning with a semicolon in the first
;        column is treated as a comment and is ignored by
;        the VmDas software.
;
; NOTE:  This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 22APR2014 GDM
;--------------------------------------------------------------------------/
; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 9600 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
CB611

; Set for narrowband single-ping profile mode (NP), sixty-five (NN) 16 meter bins (NS),
; 8 meter blanking distance (NF)
WP0
NN065
NP00001
NS1600
NF0800

; Disable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX)
BP000
BX12000

; output velocity, correlation, echo intensity, percent good
ND111100000

; One and a half seconds between bottom and water pings
TP000150

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000300

; Set to calculate speed-of-sound, no depth sensor, no heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA00000

; Set transducer depth (decimeters)
; Drop-keel up on Cook
ED00060
```

Figure 24: VMADCP Control File



```
# q_py.cnt is
## comments follow hash marks; this is a comment line

--yearbase 2014
--dbname jc103008
--datadir
/local/users/pstar/cruise/data/vmadcp/jc103_os75/rawdata
008
#--datafile_glob "*.LTA"
--datafile_glob *.ENX
--instname os75
--instclass os
--datatype enx
--auto
--rotate_angle -10.23
--pingtype nb
--ducer_depth 6
#--verbose
# end of q_py.cnt
```

Figure 25: An example of the q_py.cnt file

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