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RRS James Cook Cruise JC064

10 SEP - 09 OCT 2011

RAPID moorings cruise report

Principal Scientist
S A Cunningham

Editors
G McCarthy & J Collins

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National Oceanography Centre, Southampton
University of Southampton Waterfront Campus
European Way
Southampton
Hants SO14 3ZH
UK

Tel: +44 (0)23 8059 6175
Email: gerard.mccarthy@noc.ac.uk

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ABSTRACT <p>This cruise report covers scientific operations conducted during RRS <i>James Cook</i> Cruise JC064. Cruise JC064, departed from Falmouth on Thursday 1st September 2011 arriving Santa Cruz de Tenerife Saturday 10th September to pick up extra members of the scientific party and arriving again in Santa Cruz on the 9th October. The purpose of the cruise was the refurbishment of an array of moorings on the mid-Atlantic Ridge and off the Moroccan Coast at a nominal latitude of 26.5°N. The moorings are part of a purposeful Atlantic wide mooring array for monitoring the Atlantic Meridional Overturning Circulation and Heat Flux. The array is a joint UK/US programme and is known as the RAPID-WATCH/MOCHA array. Information and data from the project can be found on the web site hosted by the National Oceanography Centre Southampton http://www.noc.soton.ac.uk/rapidmoc and also from the British Oceanographic Data Centre http://www.bodc.ac.uk.</p> <p>The array as deployed in 2011-2012 consists of a total of 17 moorings, 16 landers and a single inverted echo sounder. The moorings are primarily instrumented with self logging instruments measuring conductivity, temperature and pressure. Direct measurements of currents are made in the shallow and deep western boundary currents. The bottom landers are instrumented with bottom pressure recorders (also known as tide gauges), measuring the weight of water above the instrument.</p> <p>The RAPID naming convention for moorings is Western Boundary (WB), Eastern Boundary (EB) and Mid-Atlantic Ridge (MAR) indicating the general sub-regions of the array. Numbering increments from west to east. An L in the name indicates a bottom lander, M indicates a mini-mooring with only one instrument, H indicates a mooring on the continental slope. During JC064 we recovered: MAR0, MAR1L4, MAR1, MAR2, MAR3, MAR3L4, EB1, EB1L7, EBHi, EBH1, EBH1L7, EBH2, EBH3, EBH4, EBP2, EBH5, EBM5. We did not recover EBM1, EBM4, EBM6, EBH1 and MAR3. We deployed: MAR0, MAR1L7, MAR1, MAR2, MAR3, MAR3L6, EB1, EB1L7, EBHi, EBH1, EBH1L8, EBH2, EBH3, EBH4, EBP2, EBH5. A sediment trap mooring NOGST was also recovered and redeployed for the Ocean Biogeochemistry and Ecosystems Group at the NOCS.</p> <p>CTD stations were conducted at convenient times throughout the cruise for purposes of providing pre and post deployment calibrations for mooring instrumentation and for testing mooring releases prior to deployment.</p> <p>Shipboard underway measurements were systematically logged, processed and calibrated, including: waves (spectra of energy and significant wave height), surface meteorology (air pressure, temperature, wind speed and direction and radiation (total incident and photosynthetically active), 6m-depth sea temperatures and salinities, water depth, navigation (differential GPS measurements feeding two independent and different receivers, heading, pitch and roll, gyro heading and ships speed relative to the water using an electromagnetic log). Water velocity profiles from 15m to approximately 800m/300m depth were obtained using a ship mounted 75/150 kHz acoustic Doppler current profiler. Seawater samples from CTD stations and of the sea-surface were obtained for calibration and analysed on a salinometer referencing these samples against standard sea water. For velocity data (wind and currents) measured relative to the ship considerable effort was made to obtain the best possible earth referenced velocities.</p> <p>Seven APEX argo floats supplied by the Met Office were deployed at preassigned locations, filling gaps in the network.</p>	
KEYWORDS	
ISSUING ORGANISATION National Oceanography Centre University of Southampton Waterfront Campus European Way Southampton SO14 3ZH UK Tel: +44(0)23 80596116 Email: nol@noc.soton.ac.uk <i>A pdf of this report is available for download at: http://eprints.soton.ac.uk</i>	

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1 Ship's and Scientific Personnel

Stuart Cunningham	Principal Scientist RAPID, NOC
Gerard McCarthy	RAPID Research Scientist, NOC
Cristian López	Visiting Scientist, Universidad de Las Palmas
Eleni Tzortzi	Ph.D. Student, NOC
Patrick Farrell	Visiting Scientist, Imperial College, London
Rob McLachlan	NMFSS, Head of Moorings
Chris Crowe	NMFSS, Instrument Technician
Dave Childs	NMFSS, Instrument Technician
Rhys Roberts	NMFSS, Engineering
Jon Seddon	NMFSS, Engineering
Jason Scott	NMFSS, Engineering
Jeff Benson	NMFSS, CTD

Table 1: Scientific Personnel

John Leask	Master
Philip Gauld	1st Officer
Malcolm Graves	2nd Officer
Vanessa Laidlow	3rd Officer
George Parkinson	Chief Engineer
John Thomson	2nd Engineer
Geraldine OSullivan	3rd Engineer
Philip Appleton	Senior ETO
Vivian Wythe	Deck Engineer
Duncan Lawes	EPRO
Paul Lucas	Purser
Kevin Luckhurst	CPO Deck
Philip Allison	PO Deck
Steve Smith	CPO Scientific
Gary Crabb	AB
John Hodgson	AB
John Dale	AB
Steve Day	AB
Darren Caines	Head Chef
Amy Whalen	Chef
Peter Robinson	Steward
Roger Herbertson	A/Steward

Table 2: Ship's Personnel

2 Itinerary

Cruise JC064, departed from Falmouth on Thursday 1st September 2011 (this leg was also referred to as JC063) arriving Santa Cruz de Tenerife Saturday 10th September to pick up extra members of the scientific party. The ship departed Santa Cruz on the same day and arrived again in Santa Cruz on the 9th October.

3 Introduction

Stuart Cunningham

The Atlantic Meridional Overturning Circulation (AMOC) at 26.5°N carries a northward heat flux of 1.3 PW. 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 UK 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. Two papers (Cunningham et al., 2007; Kanzow & Coauthors, 2007) demonstrated that not only does the system of observations achieve a mass balance for the AMOC, it reveals dramatic and unexpected richness of variability. In the first year the AMOC mean strength and variability is 18.7 ± 5.6 Sv. From estimates of the degrees-of-freedom the year-long mean AMOC is defined with a resolution of around 1.5 Sv so abrupt changes would be readily identified and long-term changes will be measured relative to the 2004-2005 average.

The NERC contribution to the first four years of continuous AMOC observations was funded under the directed programme RAPID Climate Change. Following an international review NERC will continue funding to 2014 under the programme RAPID-WATCH. The NSF and NOAA have also continued funding and commitments so that the system can continue operating at the same level of activity to 2014.

The objectives of RAPID-WATCH are: To deliver a decade-long time series of calibrated and quality-controlled measurements of the Atlantic MOC from the RAPID-WATCH array and; To exploit the data from the RAPID-WATCH array and elsewhere to determine and interpret recent changes in the Atlantic MOC, assess the risk of rapid climate change, and investigate the potential for predictions of the MOC and its impacts on climate.

3.1 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 (80km), shallow (800m) 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 1). Variability in Gulf Stream flow is derived from cable voltage measurements across the Florida Straits, and variability in wind-driven surface-layer Ekman transport across 26.5°N is derived from satellite-based observations. To monitor the mid-ocean flow we deployed an array of

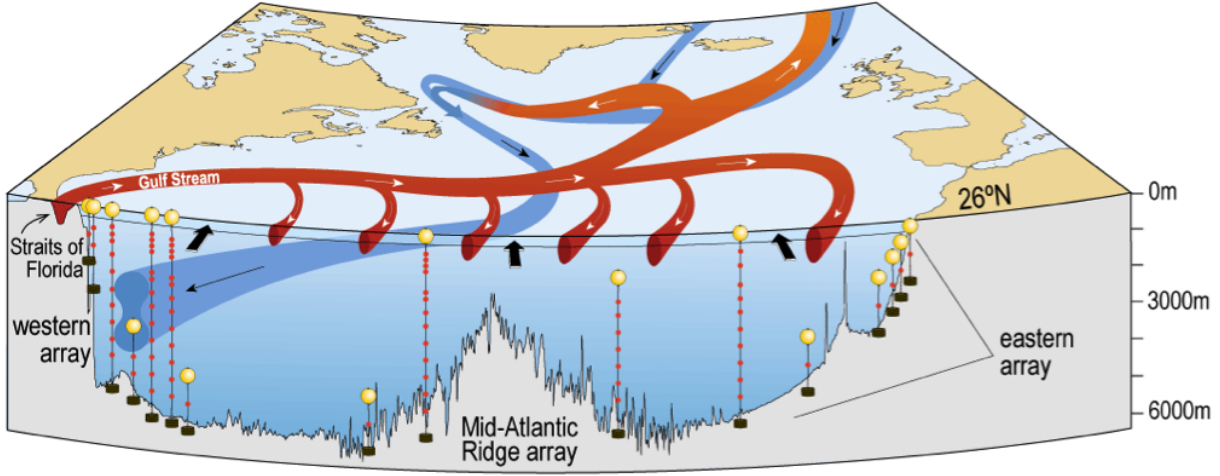


Figure 1: Schematic of the principal currents of the Atlantic meridional overturning circulation. The vertical lines across the Atlantic at 26.5°N indicate moorings instrumented to measure the vertical density profiles. The Gulf Stream (red) transport is measured by a submarine cable in the Straits of 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.

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, the transports of the Antilles current and deep western boundary current are monitored by direct velocity measurements.

3.2 Array Specification

The array as deployed in 2011-2012 consists of a total of 17 moorings, 16 landers and a single inverted echo sounder. Figure 2 and Figure 3 show the eastern boundary and mid-Atlantic moorings as deployed on cruise JC064. The western boundary moorings (Figure 4) were serviced in the Spring of 2010 during cruise OC459-1 and will be serviced again in Spring 2012 from the RV Ronald H. Brown. 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.

3.2.1 Eastern Boundary Sub-array

The Eastern Boundary sub-array currently consists of one tall mooring EB1, consisting of eighteen CTDs and two current meters, and a series of shorter CTD moorings EBH1, EBH2, EBH3, EBH4, and EBH5 that step up the slope reducing the influence of

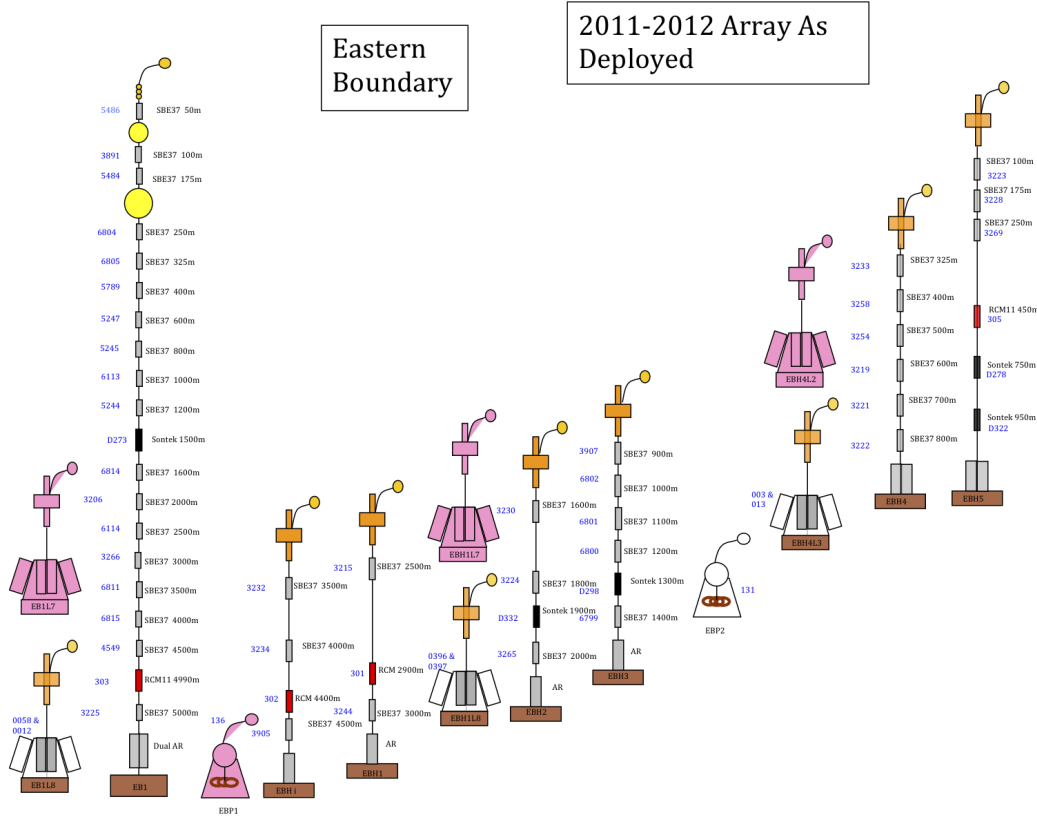


Figure 2: Eastern boundary sub-array as deployed after January 2011. The pink landers were serviced on this cruise

bottom triangles when combined with the more offshore EB1 mooring. EBH4 and EBH5 are co-located and together they construct a single full depth density profile. Finally the Eastern sub-array includes six bottom pressure landers; two at the site of EB1, comprising two bottom pressure recorders (BPRS) each, two at the site of EBH1, comprising one bottom pressure recorder each and two at the site of EBH4/EBH5. EBH4L was deployed close to the site of EBH4/EBH5 as a replacement for the Inverted Echo Sounder with a pressure sensor (PIES) instrument that could not be redeployed during this cruise. The landers are serviced in alternate years so that each recovery provides a two-year record with a year overlap with the previous lander to remove instrument drift. There is currently one PIES deployed in the eastern boundary sub-array, EBP2, which was serviced on D359. Data from the PIES are downloaded annually through acoustic telemetry. EBP1 was recovered on this cruise and not redeployed.

3.2.2 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 four landers (two at the site of MAR1, and two at the site of MAR3). MAR0 is a recent addition to the array and consists of five CTDs, one current meter and a BPR 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 CTDs, with MAR2 acting as a backup to 1000m

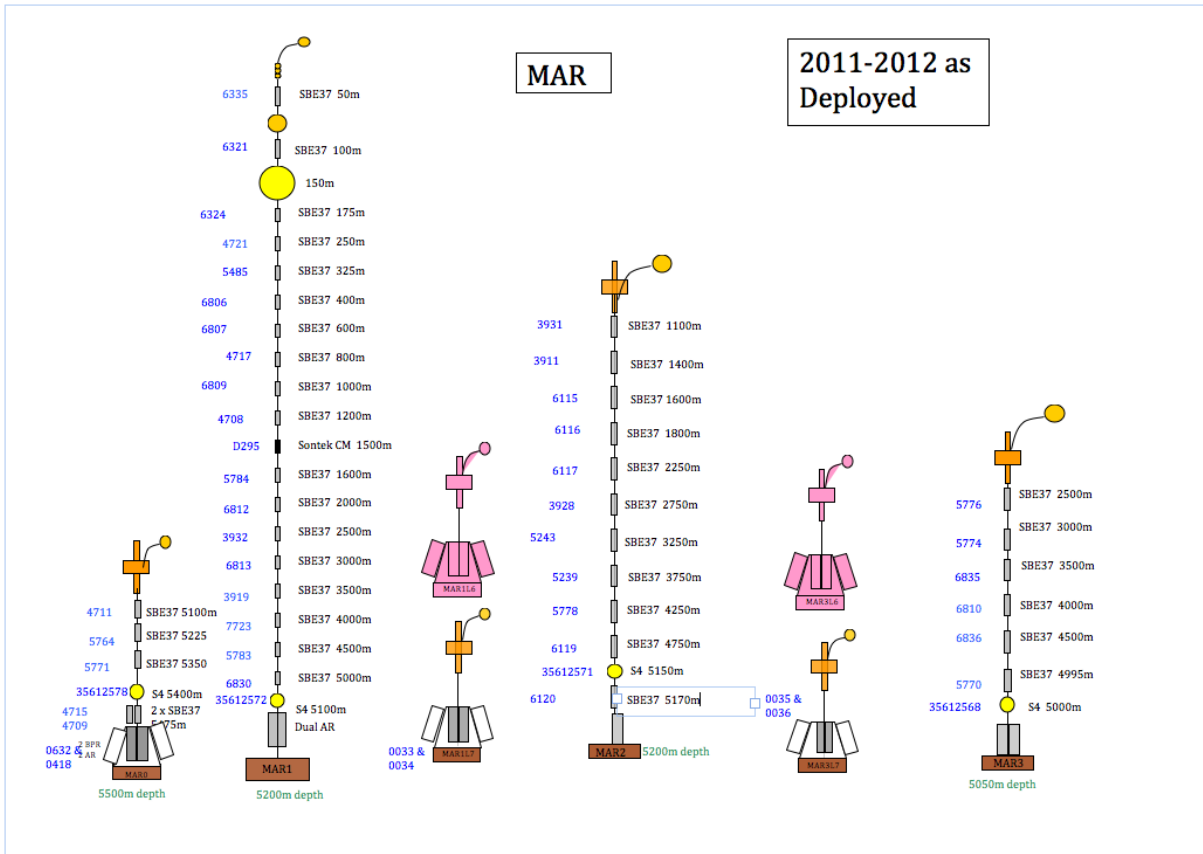


Figure 3: The Mid-Atlantic Ridge sub-array after January 2011. The pink landers were refurbished on this cruise.

on the west of the ridge. MAR3 is sited to the east of the ridge and allows separation of the eastern and western basin MOC contributions. The landers are deployed as per those for the Eastern Boundary, with two at the site of MAR1, and two at the site of MAR3.

3.2.3 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. The resolution of the profile can be improved by merging data from the nearby WB1. As of May 2011, WB2 comprises sixteen CTDs and eight current meters, whereas WB1 comprises fifteen CTDs 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 CTDs and five current meters. At the normal offshore extent of the Deep Western Boundary Current (DWBC) is WB4, which comprises fifteen CTDs and nine current meters. Further offshore is WB6 comprising five CTDs 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 again four landers in this sub-array; two at the site of WB2 (two BPRs each); and two at the site of WB4 (one BPR each).

In addition to the moorings listed above, the western boundary sub-array also contains three full depth moorings and four landers from the University of Miami, that were

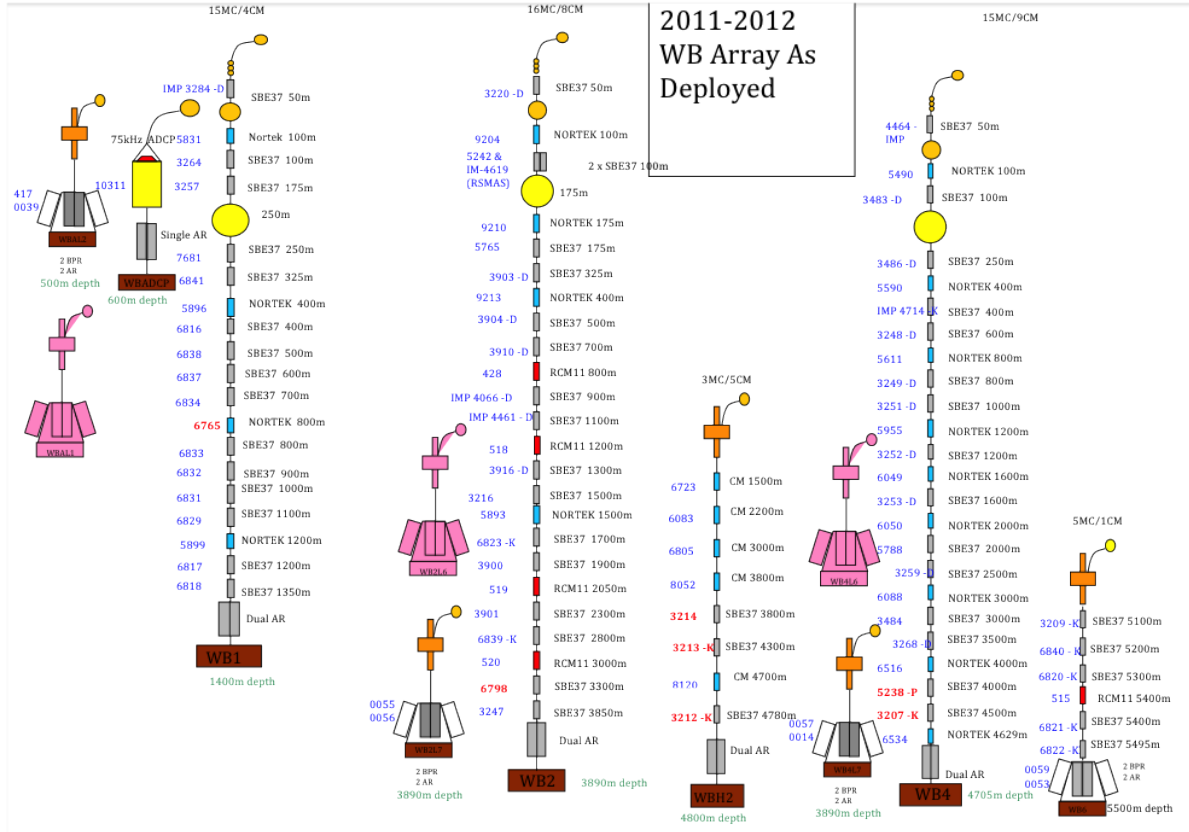


Figure 4: The Western Boundary sub-array after March 2011

served on KN200-4. WB0 comprises four CTDs and current meters and an upward looking ADCP. WB3 is 22 km east of WB2 and so acts as a critical backup in case of loss of WB2. WB3 consists of seven CTDs and current meters. Combined with the other inshore moorings it provides the thermal-wind shear and measured velocities from the core of the DWBC. WB5 is located 500 km offshore and is instrumented with seventeen CTDs and provides the thermal-wind shear across the full width of the boundary currents including any recirculation.

3.3 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.noc.soton.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

Jon Seddon

4.1 Level C and TECHSAS

The Ifremer TECHSAS system is described at www.noc.soton.ac.uk/nmf/wiki/TECHSAS. 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. The TECHSAS NetCDF files were the primary files used during this cruise; the logging system performed well during the cruise with the following exceptions:

1. The EM log was not logged on this cruise
2. From the start of the cruise on 10th September until it was restarted at 11:44 on the 12th September, the Techsas data logger did not write any data to the Surfmet, DPS116 or Seapath files. The instruments were showing as green on the Techsas screen, but the data size was not incrementing. A close watch was kept on the data size for the rest of the cruise. Data were still written to the Level-C system and so a Matlab script was written to generate NetCDF files from the Level-C data. The regenerated files were given the standard NetCDF filenames but with the suffix *.regen*.
3. A bug was identified by the scientific party in the Techsas CNAV module. In the CNAV NetCDF files the latitude and longitude were not written in decimal degree format and instead in the format [D]DD.MMmmmmmm, where the numbers before the decimal place DD or DDD are the degrees, the most significant two decimal places MM are the minutes and the remaining decimal places are the decimal minutes. Therefore a latitude or longitude in the NetCDF file of 12.34567890 actually represents 12° 34.567890'. The Level-C files and UDP broadcasts of the CNAV data were not affected and were generated correctly in decimal degree format. The NetCDF documentation was amended to reflect this bug and British Oceanographic Data Centre (BODC) informed that it had been present since CNAV data was first recorded on cruise JC052 in September 2010. The CNAV module is being fixed at National Oceanography Centre Southampton (NOCS).
4. A fault that prevented the Vigor routers firewall from blocking out going traffic was identified. This fault was reproduced on the Test Ship network at NOCS and the manufacturers are helping to fix the problem. Inbound traffic is still protected by the Sonicwall firewall in Aberdeen and the Network Address Translation (NAT) feature on the Vigor router.

5 Underway Data Processing and Calibration

Cristian López, Eleni Tzortzi, Jon Seddon

5.1 ADCP

Cristian López

During the cruise, horizontal velocities were calculated using the two vessel-mounted Acoustic Doppler Current Profilers (ADCPs) onboard RRS James Cook. These instruments, installed on the port drop keel, are 75kHz and 150kHz Ocean Surveyor (OS) instruments supplied by Teledyne RD Instruments.

For good data, referencing with an accurate source of heading and position is needed. In this cruise, Posmv was determined as the source for both ship's position and attitude. The newer CNAV GPS should prove more accurate in the future once the bugs associated with CNAV are sorted out (Section 4.1).

The instruments can be operated with the keel either retracted or lowered. The keel up position allows greater ship speed, but also exposes the instrument to more bubbles, which significantly reduces its profiling range. The keels were retracted throughout the cruise to optimise ship's speed.

Each instrument works with a different frequency. While the 75 kHz has the advantage of a deeper scope, it lacks a finer resolution. The 150 kHz instrument reaches a shallower depth but it is characterised by an improved vertical resolution. With the keel up, the regular depth penetration for the 75 kHz adcp was 800 m, while the 150 kHz reached to 400m.

5.1.1 Data Acquisition

The data from the two instruments were acquired using the RD Instruments VmDas software package version 1.42. This software is installed on two PCs in the main laboratory. The software allows data acquisition in a number of configurable formats and performs preliminary screening and transformation of the data from beam to Earth coordinates.

To start acquiring data with VmDas, several things have to be set and checked. First, the VmDas program needs to be opened from the Start Menu. Then, under the file menu, collect data should be clicked. Subsequently it is set up with the edit data options under options menu.

The actual recording starts by clicking the blue record button in the top left of the screen. The data collection stops when clicking the blue stop button next to the record one. Stopping and restarting the logging with these two buttons should start a new sequence dataset. During the cruise, it was restarted once every 1-2 days in order to spare the data size in different ensembles to make post processing faster. Leaving it on the same file for more than 3 days makes the file become large and the processing slower.

Every time the set up needs to be changed (e.g. dropping keels, or activating bottom track), the recording has to be stopped and restarted. Once the recording has started, some things need to be checked in order to assure good measurements. The log-files document any problems such as buffer overload, timeouts or resetting of the ADCP. If the size increases suddenly over 10KB, some error might be occurring and needs to be

checked. An increase in data files size should be noted as an indication of data being logged. It is most important to make sure the sequence increases with every dataset every time it is restarted and that no data are being overwritten.

A logsheet was made to keep track of every time a dataset was stopped and restarted, including notes such as whether bottom track was activated, some interesting features and logging errors and gaps.

5.1.2 VmDas configuration

The configuration was set using one of the four .txt files made for this cruise (one file for every type of measurement: 75 or 150 kHz, bottom track on or off. All narrow band and keel up). In case keel down or broadband were used, a different setup file should be made. The used configuration was:

- Communications ADCP Input: COM1, 9600, N, 8, 1. COM7, 19200, N, 8, 1. COM8, 4800, N, 8, 1. Communication Parameters: Enable serial. Comport: COM1. Baud rate: 9600. No parity. Data bits: 8. Stop bits: 1.

- ADCP Setup

Here the setup was configured from file, with the path:

\Program files\RD instrument\VmDas\JC064\and the file names OS(inst)NB.BT-on_JC064_up and OS(inst)NB.BT-off_JC064_up (for narrowband, keel up and bottom track on or off. (inst) stands for 75 or 150 type) The configuration used in this cruise was: Set profile parameters checked. Number of bins = 96 (150kHz) or 48 (75kHz). Bins size: 4m (150kHz) or 16m (75kHz). Blank distance: 4m (150kHz) or 8m (75kHz). Transducer depth: 6m (for both). Set processing mode: Low resolution long range (150kHz) or Hi resolution short range (75kHz). Bottom track was on or off, depending on the measurement nature. Maximum range set as 400m (150kHz) or 800m (75kHz).

- Recording

Name: OS150_JC064 or OS75_JC064 (depending on the instrument frequency)
Number: 01 for the first dataset. It increases by one every time the recording is stopped and restarted. If the system has to be rebooted (as happened during this cruise and due to the computer freezing) or VmDas software is restarted, it is very important to set the proper sequence number following the series in order not to overwrite previous datasets. Max size: 10MB (it start a subsequent file every time its weight overwhelms this size) Primary Path: C:\Data\JC064\Backup path: C:\RDI\ADCP

- Transform

Heading source: NMEA/HDT. It is very important to set the correct heading source in order to get fine data and bottom track calibration. No tilt corrections enabled, all set up as 0.

- Averaging

Temporal averaging checked. First time interval (STA): 120 seconds. Second time interval (LTA): 600 seconds. Profile ping normalization and other corrections not enabled.

- Data screening, User Exit, Sim Input

No changes in these menus.

5.1.3 Output files

VmDas produces several output files with the same name structure but different extension, such as OS(inst)_JC032(nnn)_(filename). (ext), where (inst) is the instrument name (75 or 150), (nnn) is the dataset sequence number, (filename) is the number of the file in the sequence (adds a new one every 10MB according the set up) and (ext) is the extension of the file.

The different file extensions are:

- .ENR: binary raw ADCP data file.
- .STA: binary average ADCP data according to the set STA time.
- .LTA: binary average ADCP data according to the set LTA time.
- .ENS: binary ADCP data after screening for RSSI, correlation and navigation data.
- .ENX: binary ADCP single-ping and navigation data after bin-mapping, transforming to Earth coordinates and screening for error velocity, vertical velocity and false targets.
- .N1R: ASCII text files with NMEA navigation raw data from NMEA1 stream.
- .N2R: ASCII text files with NMEA navigation raw data from NMEA2 stream.
- .NMS: binary navigation data after screening and pre-averaging.
- .VMO: ASCII text file with the setting used for collecting the data.
- .LOG: ASCII text file all logging output and error messages.

These files are saved in the folder set in the configuration.

5.1.4 Speed of Sound Considerations

In order to calculate water velocities, VMADCPs require an estimated value of sound speed. The necessity of an accurate speed of sound at all times to obtain precise data is a frequent topic with differing opinions and it is often debated on several cruises.

In this section, speed of sound considerations are discussed. The speed of sound is affected by 3 principal factors; temperature, salinity and pressure. In all cases, they are directly related, so increasing one of them also rises sound speed. However, the changes due to salinity or pressure are slight compared to those related to temperature changes. Temperature has the largest effect on sound speed; a change of one degree in temperature affects up to 3 times more than a psu change of one unit (Emery, 2004).

The transducer calculates with every beam the water temperature surrounding it and extrapolates the speed of sound for a fixed salinity, since temperature is the main factor responsible for sound speed variability. The speed of sound at the transducers is used to compute the initial distance along beams, as well as to convert velocity data into engineering units (RDI, 1996). However, it is not calculated along the water column, for it is not needed. Variation of sound speed with depth does not affect measurement of horizontal currents. According to Snell's law, which says that horizontal wavenumber is conserved when sound passes through horizontal interfaces and because the frequency remains constant, sound speed variation does not affect the horizontal component of sound velocity. Since sound waves are continuous across the horizontal interface and because measurement of the horizontal currents depends directly on the horizontal sound speed, the horizontal current measurement is unaffected.

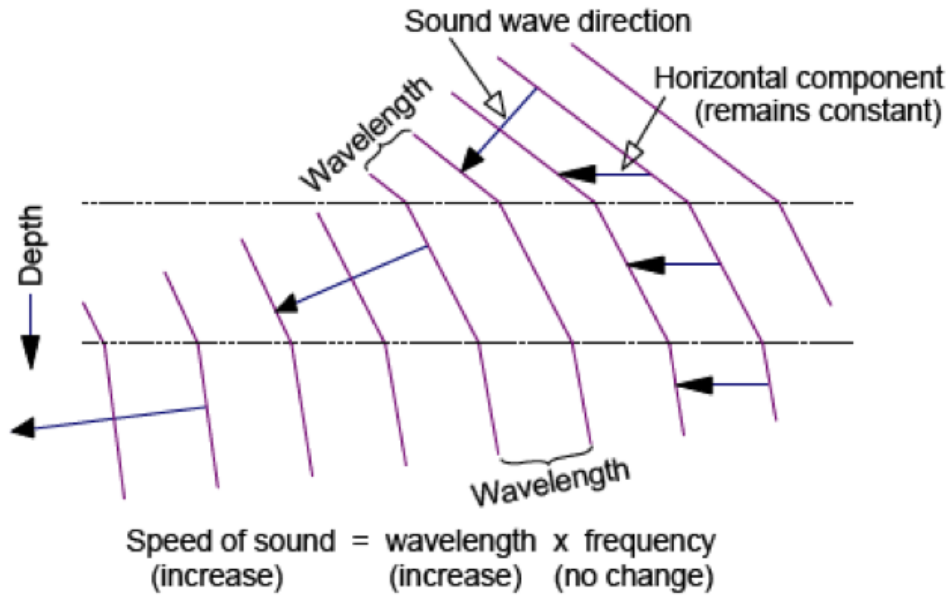


Figure 5: Sound speed refraction with depth. Even though the direction and sound speed change with depth, the horizontal sound velocity component remains constant. From ‘Principles of operation. A practical primer’.

In contrast, variations in the vertical velocity component are proportional to variations in sound speed.

Whilst sound speed is not important with depth, the initial speed at the transducers might be so, for it changes the initial beam angle and then it can mistake the distance along beams (the cell depth). This change occurs in a similar ratio as the Doppler shift, which decreases for a higher sound speed (RDI, 1996). So, for an overrated sound speed, the depth cell size is underestimated, but so is the Doppler shift. Thus, a smaller cell would generate a smaller shift with a similar proportion, compensating the error. The significance of this effect would only be important when the used sound speed diverges substantially with the real.

According to Firing (1991), the sound speed calculated by the instrument is usually sufficiently good, but it needs to be checked and corrected if the divergence is beyond certain limits. Sound speed changes by about 0.1% for each psu change in salinity, so it is not necessary to keep changing the salinity in the configuration as long it is in reasonable ranges. Regarding temperature, sound speed changes by 0.3% per °C at 0°C, and by 0.13% per °C at 30°C. Recalculating sound speed for each 1°C change in sea surface temperature would be a reasonable procedure.

Therefore, sound speed only needs to be considered at the transducer depth. Within reasonable salinity values, only the temperature is important. It needs to be checked and compared to the measured remote temperature (tsg), if the difference is over 1°C, then corrections might be considered.

Throughout this cruise, salinity was set to 35 psu, while the temperature kept a close relation with tsg temperature. It was always with a difference below 1°C. Thus no calibrations of sound speed were made.

5.1.5 Post-Processing

The final processing of the data was done using the CODAS (Common Ocean Data Access System) suite of software provided by the University of Hawaii. This suite of python and Matlab programs allows manual inspection and removal of bad profiles and provides best estimates of the required rotation of the data, either from water profiling or bottom tracking. In this cruise a new matlab script enclosing all post processing steps was made, making the processing easier and faster. Further information of this script is found in Section 5.1.6. Datasets were processed every time a new sequence was started, almost daily. The processing followed these steps:

1. Data transferring into the ship's server.

The data is compiled in the two pc lab's computers, but it needs to be transferred to the ship's file server system. In RRS James Cook, the directories on the ADCP PCs are shared. The Cookfs file server mounts these shares and then uses the Syncback software package to backup the data from the ADCP computers every fifteen minutes. This step was automatized by the ship's system.

2. Ensuring the datasets are complete.

For starting the processing of a dataset, it is very important to work with the complete sequence, so the first step should be ensuring all logged data has been uploaded into the system. On JC064, these were uploaded every 15 minutes, the available dataset might still be incomplete after stopping the log. The best way to make sure it has finished to transfer the data is checking if next sequence data is already available. That means all the previous set is complete.

These data were found in the Cook's file server, in the directory

`/cookfs/JC64/Ship_Systems/Acoustics/OS(inst)/raw_data/` ((inst) stands for OS type; 75 or 150 according to the instrument)

In case after stopping the log it is not restarted again (e.g. when mooring in port, or for the last sequence) waiting more than 15 minutes before processing would be enough.

3. Transferring the data into oceanus.

Once it has been checked, next step is copying the raw data into the cruise database. It was copied with the unix console into the directory:

`/noc/users/pstar/cruise/data/vmadcp/jc064_os(inst)/rawdata/` ((inst) stands for OS type; 75 or 150 according to the instrument)

The command `vmadcp_movescript` was run in the console, in the folder `jc064_os(inst)` (hereafter known as main directory). This command spares all the rawdata in subdirectories for every dataset sequence.

4. Making an adcptree directory.

In order to process the data, a tree directory needs to be made for every sequence. Without changing the previous directory, the command

```
adcptree.py jc064(sss)nbenx - -datatype enx
```

((sss) stands for sequence number; 001 for the first one) was applied. It sets up a tree directory for the codas dataset and an extensive collection of configuration files, text files and m files.

5. Elaborating on the control files

Throughout the processing, two control files are needed for every dataset, `q_py.cnt` and `q_pyedit.cnt`. The first file guides the data loading, routine editing and processing and it also estimates water and bottom track calibration (if available). The `q_pyedit.cnt` commands the manual editing application.

These files can be made brand new, but it is easier to download them from the CODAS software guidelines and then edit them to suit the current cruise. In this cruise, they were first obtained and edited from the CODAS guidelines and saved into the main folder. Then, every time a dataset was processed, they were copied again into their new tree directory. Once after the matlab processing script was made and used (see Section 5.1.6), both files were automatically made every time it was run.

There are also other control files such as `q_pyrot.cnt` or `q_pytvrot.cnt`, although they are for angle correction. They are further seen in calibration (Section 5.1.7).

6. Primary and manual processing

Once the control files were completed or copied into the tree directory, the command `quickadcp` was run in the terminal, inside the directory. This python command, directed by a control file, processes and applies what the file orders. `Quick_adcp` was run with `q_py.cnt` as a control file, which led the first processing steps:

```
quick_adcp.py -cntfile q_py.cnt
```

It might take a few times, if it is a large dataset. After running `quickadcp`, the averaged ADCP data are loaded in the tree directory, as well as the bottom track and water track calibrations (when available), which are stored in the `cal/` directory.

The manual editing then began. This was done with `gautoedit`, a package within CODAS that allows the user to review closely the data collected by `VmDas` and flag any data that is deemed to be bad.

Matlab was opened and then the command `codaspaths` was run to load the CODAS packages. It was necessary to change to the edit directory to run `gautoedit`. Detailed information and instructions can be found on the JC032 report (pages 130 to 133).

Once the manual editing is finished, the changes are applied running `quick_adcp` in the tree directory again, but with the control file `q_pyedit.cnt`.

```
quick_adcp.py -cntfile q_pyedit.cnt
```

Finally, the files `.asc` containing the flagged data information were stored in a directory such as `edit_files/jc064(sss)nbenx` inside the main directory. Sometimes, datasets have to be redone from the start. Saving these files elsewhere makes it possible to apply the manual edits without running `gautoedit` again.

7. Final processing

After the main processing is done, a few matlab scripts were run to read the data into Mstar. First, `mcod_01.m` was run. It loads the `vmadcp` data and stores it as a

mstar file. Next `mcod_02.m` was also run. It calculates ship's speed and expands 1D arrays into 2D. Finally, once these two scripts were run, `mcod_mapend.m` appended all processed data into a final file.

5.1.6 Processing script `vmadcp_proc.m`

During the cruise, a matlab script enclosing all processing steps was made in order to make the steps easier, faster and automate them in only one single script. This `vmadcp_proc.m` script only asks for two inputs (instrument type and dataset sequence to process) and it carries out the whole processing chain itself. Before being used for the first time on a cruise, some settings need to be changed. First, the ship's file server directory where the raw data are being loaded, then the amplitude and angle phase corrections. If bottom track data is still not available for a good calibration of the angle offset, then it should be set as 0 and be changed once after it is found.

The script generates the needed directories as well as `.cnt` control files. It also classifies the raw data, runs `quick_adcp.py` and opens the `gautoedit` interface. After the manual editing is done, the script continues just by pressing (enter) or typing (go). Then it applies all manual edits, and saves them in another folder (so they can be applied again if the dataset is deleted and reprocessed again).

Finally it reads the data into Mstar to finish the processing and to append all the cruise's `vmadcp` processed data. A diagram with all the steps the script does is found in Figure 6.

5.1.7 Calibration

In order to obtain accurate horizontal velocities, it is vital to correct for heading errors. These can either occur as a result of transducer misalignment with respect to the hull, or from errors in navigation. The navigation on the James Cook is fed directly into `VmDas` from the Applanix POSMV, which incorporates a GPS heading source that is not sensitive to many of the heading errors that occur when gyrocompasses are used in isolation (e.g. Schuler Oscillations).

The best calibration estimates are obtained when the velocity data are referenced to the bottom. However, bottom track calibration estimates are only obtainable when the water depth is within 1.5 times the depth of the ADCP profiling range.

During the first leg of the cruise (JC063), on the way from Falmouth to Tenerife, good quality bottom track could be recorded on the wide continental shelf for OS75kHz.

However, due to an incorrect setup on the OS 150kHz, heading was not being recorded on the first two sequences, hence it was not possible to get satisfactory bottom track data for this instrument at the beginning of the cruise.

Water track calibration was considered as second choice. This cruise, however, was not characterized by a large amount of transitions from on to off station. Since it is fundamental to have these transitions for an accurate estimation, data from every sequence differed significantly with each other and consequently no reliable corrections were obtained.

Finally, proper heading data was imposed to the bottom track data of the first two sequences for 150kHz. A satisfactory correction was obtained and applied. In this section all calibrations and results are discussed in detail, as well as the application of their correction.

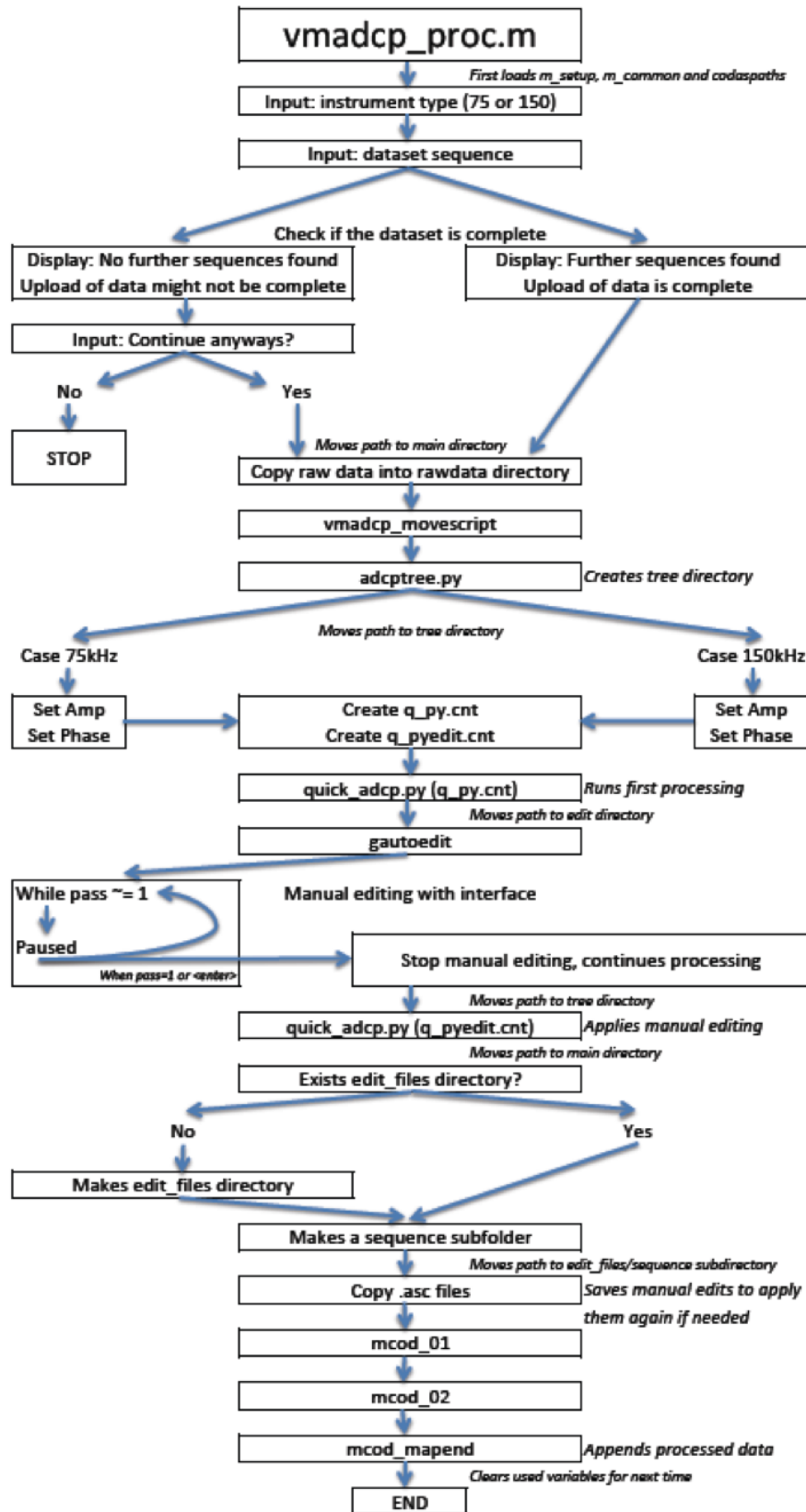


Figure 6: vmadcp_proc.m diagram

Sequence	Data points	Parameter	Median	Mean	STD
1	169	Amplitude	1.0038	1.0036	0.0015
		Phase	-8.7697	-8.7683	0.1348
2	46	Amplitude	1.0047	1.0048	0.0018
		Phase	-8.7912	-8.7774	0.1907
JC064 final corrections		Amplitude = 1.00		Phase = -8.78	

Table 3: Bottom track calibration results for os75kHz and final correction.

Sequence	Parameter	Median	Mean	STD
5	Amplitude	1.01	1.0148	0.0117
	Phase	0.1395	-0.0278	0.839
6	Amplitude	1.0165	1.017	0.0065
	Phase	0.8535	0.5355	0.9094
9	Amplitude	0.997	0.9967	0.0035
	Phase	0.329	0.145	0.3521

Table 4: Some water track results for OS150kHz.

5.1.8 Bottom track calibration

When the bottom can be detected, CODAS software automatically estimates bottom track corrections of amplitude and angle phase when running `quick_adcp.py` and store them inside the tree directory, in `cal/botmtrk/`. The file `btcaluv.out` contains the estimated deviations for amplitude and angle phase, while the file `btcaluv.ps` includes some plots such as navigation, depth and angle phase deviation (see Figure 7). Both can be read from the unix console. Data are contained in `btcaluv.out`, while the plots are available in `btcaluv.ps`.

On this cruise, sequences 1 and 2 were used to obtain bottom track calibration (corresponding to the days steaming over the continental shelf). The results are presented in the Table 3.

As expected, the amplitude does not need corrections (it should be 1).

From other cruises, it was known that the phase deviation was close to 9 degrees, as we obtained. The final correction applied was -8.78° .

5.1.9 Water track calibration

Water track is a method that compares on and off station. The software's technique consists in comparing certain number of consecutive points straddling a transition from off station to on station. It takes the first two points (streaming points) and the last two points (stationary points) and compares them to ascertain the offset.

Water track calibration was considered as alternative to bottom track calibration for OS150kHz and as a possible source to compare OS75kHz bottom track. As mentioned before, neither of them was possible due to imprecise data. Table 4 shows the range of these results:

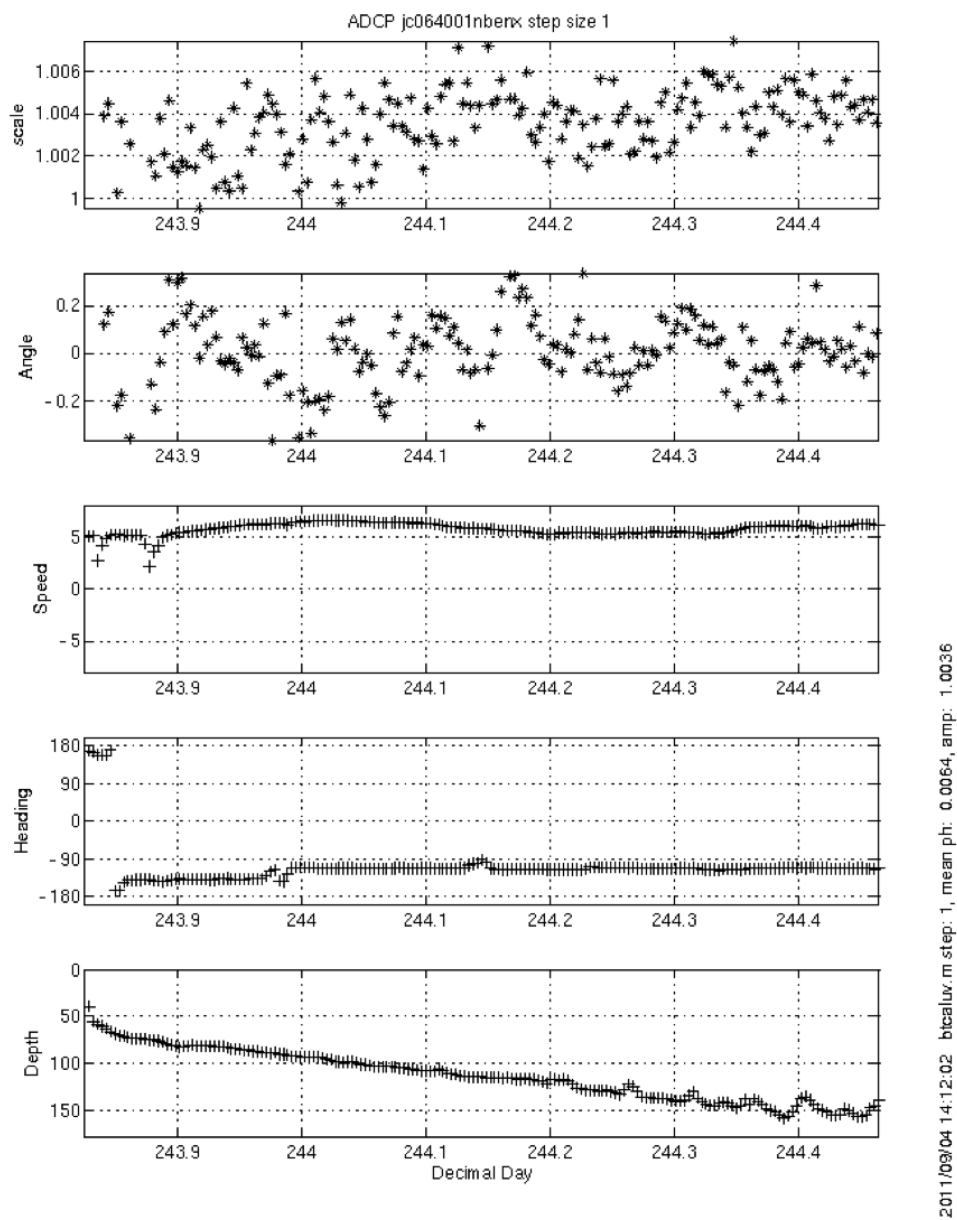


Figure 7: Plots from file btacuv.ps after correcting the angle phase

Sequence	Data points	Parameter	Median	Mean	STD
1	161	Amplitude	1.012	1.0128	0.0035
		Phase	-0.824	-0.7253	0.8771
JC064 final corrections		Amplitude = 1.0		Phase = -0.8	

Table 5: Bottom track data for os150kHz after fixing the heading and final correction. Only one decimal was taken into account, since its precision was not adequate for more than one decimal

5.1.10 Fixing heading for OS150kHz

To get the angle of rotation for OS150kHz, a new source of heading was imposed on the first two sequences, where bottom track had been recorded with an incorrect setup.

In order to apply it, a new matlab script, called `make_adcp_heading.m`, was made. It was made from the previous script `make_g_minus_a.m` but using `seapath200` (`attsea'`) as the unique source of heading. It was also modified to range from -180° to 180° instead of 0° to 360° , for it is necessary afterwards.

Once this command was run, a new file called `jc064(sss)nnx.rot` was made in the edit directory, inside the tree directory of sequence (sss). This file contains the new heading for every point of time used for bottom track. When a tree directory is made and `quickadcp` is run, a file called `rotate.tmp` is made in the directory `cal/rotate/`. This file needs to be edited (with command `edit` or `vi`) to add the path for the `.rot` file created previously. The line `time_angle_file` must be uncommented and the path and file name should be added instead of the (NOT USED) line. Then, typing the command `run rotate rotate.tmp` the new heading is incorporated.

Finally, in order to apply it onto the dataset, `quickadcp` is run with the control file `q_pytvrot.cnt` inside the tree directory. Again, this file can be copied from an older cruise (only the yearbase might have to be changed) or made brand new.

After running all these steps, new and reasonable bottom track data are acquired. In this cruise, only the first sequence had enough data points to get a precise bottom track correction (Table 5). This correction is not as accurate as it would be with its natural heading, but it is satisfactory. Some points seem to be offset, thus the median was chosen in place of the mean.

5.1.11 Application of the angle rotation

Once the angle phase correction is calculated, it can be included in `vmadcp_proc.m` matlab script to add it in the `q_py.cnt` file and therefore apply the rotation when processing further sequences of data. Nevertheless, for all the previously processed datasets the rotation needs to be applied. For that purpose, the file `q_pyrot.cnt` is made. It can also be obtained from the CODAS guidelines, but in any case, it has to be edited to include the phase correction as well as the amplitude correction (if applicable). The instrument's type and year base also have to be changed if they are unfitting. Running `quickadcp` with that control file finally amends the angle deviation.

These adjustments are cumulative, hence applying it more than once would rotate it more than once developing a wrong calibration. Checking that new phase corrections suggested by bottom track are estimated near zero, will ensure the rotation as been properly applied. Finally, to make sure the rotation is accurate, the velocity sections

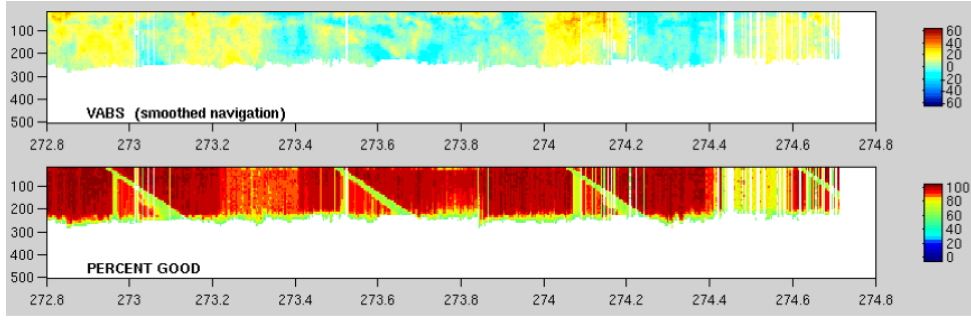


Figure 8: Periodic interferences, shown in sequence 30 of 150kHz instrument for ‘v’ velocities

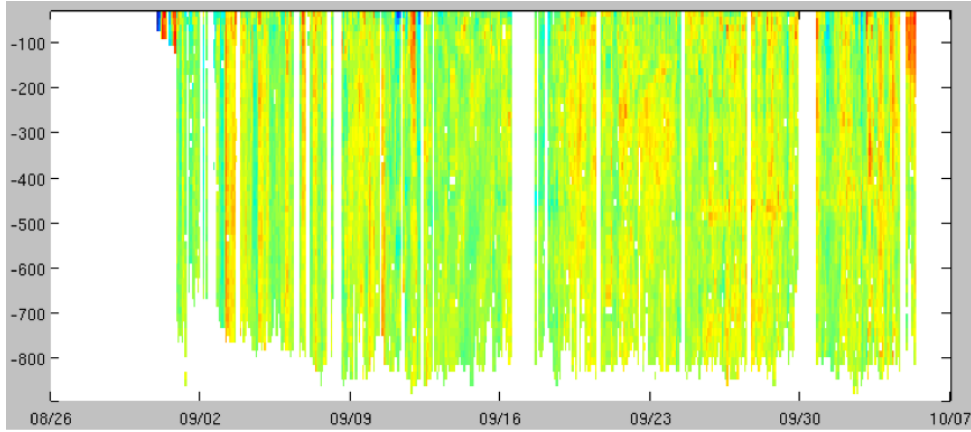


Figure 9: Uabs velocity during all cruise, for OS75kHz

should not show significant vertical stripiness when shifting from on station to off station.

5.1.12 Interference and data gaps

During the cruise, it was observed how data quality was affected periodically at a changing depth. Strips of inaccurate data appeared, moving up and down in time with depth (Figure 8).

At the beginning it was thought to be because of mooring and CTD operation. However, it was seen that they also occurred when no operations were being carried out. It was observed there is a periodicity in those interferences, thus it is thought some of them might be because of interferences with other acoustic instruments with a similar frequency, creating a phased interference.

5.1.13 Results

Despite recording data with the keel up throughout the cruise, the quality was remarkably good. Only on the days with roughest weather, the data logging was severely affected.

Some interesting features were found in this trip and are presented in this section, as well as some general results. Figure 9 shows the horizontal field of velocities. Zonal velocity is shown from the 75kHz instrument, displaying the high quality data acquired, excluding some gaps.

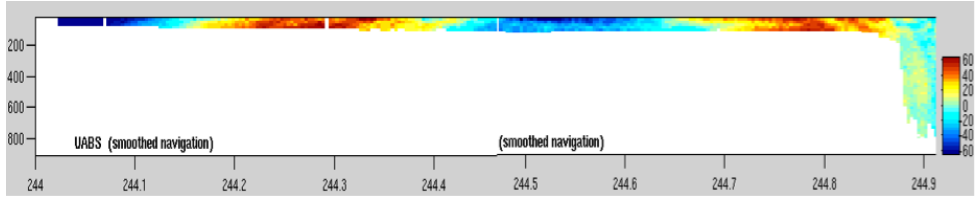


Figure 10: Tidal currents on the continental shelf. OS75kHz

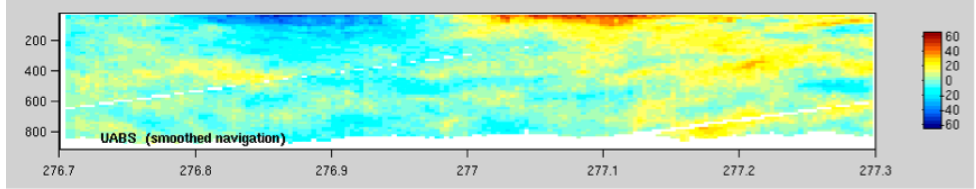


Figure 11: Counter clock eddy south off Gran Canaria Island.

On the first leg, over the continental shelf, strong tidal currents were recorded (Figure 10). It can be seen how the direction turns and how it is a semidiurnal tide, with a period of around half a day.

Another remarkable feature found was a counter clockwise eddy off Gran Canaria Island (Figure 10). This region is well known for the eddies formed south of Canary Islands due to the Canary current.

5.2 TSG

Eleni Tzortzi

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 surface temperature) at a depth of 5.5m below the sea surface. It should be mentioned that the daily housing temperature and conductivity were displaying two spikes about 12 hours apart, an example of which is shown in Figure 12 for the housing temperature. This was due to the daily change between the two pumps of the instrument. The water in this pipe warmed during the day which introduced a spike in temperature when pumped through the SBE45.

In order to calibrate the salinity derived from the SBE45 TSG data, salinity samples were collected from the non-toxic water supply outflow. Water samples from the TSG outflow pipe were collected in 200ml flat glass bottles every 4 hours. Before each collection, the hose connected to the outflow pipe was flushed with the sample water for several seconds (on occasions when the supply was not already running), and the sample bottles were rinsed twice with the sample water. Bottles were filled to halfway up the shoulder and the necks were wiped dry to prevent salt crystallisation at the bottle opening. The bottles were closed using airtight single-use plastic inserts and secured with the original bottle caps. The samples were stored in open crates and left in the controlled temperature

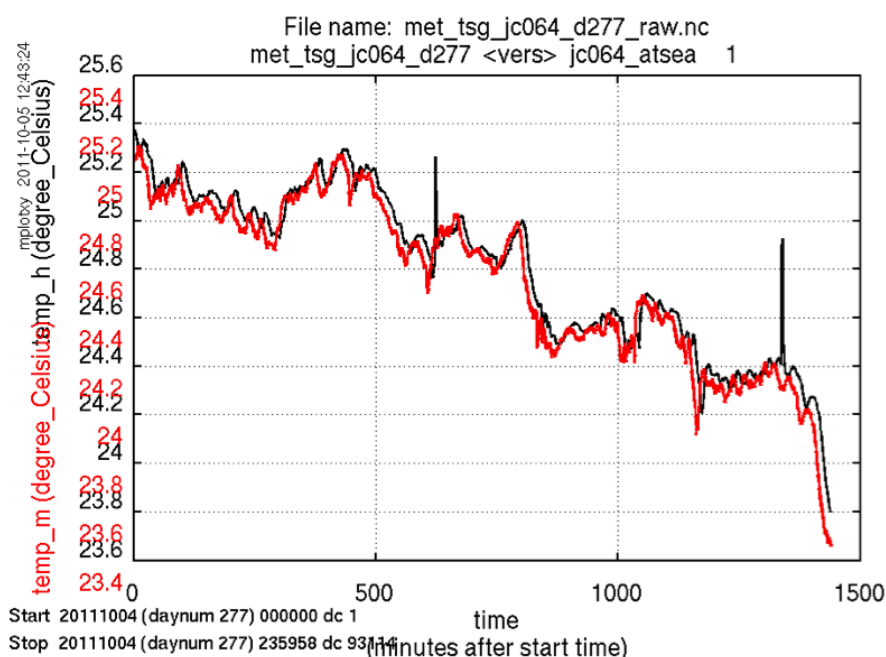


Figure 12: TSG housing temperature (temp_h, black line) and remote temperature (temp_m, red line) versus time for day 277 before manual editing. Note that the spikes in the housing temperature are due to the change between the two pumps taking place every 12 hours.

laboratory for a minimum of 24 hours before analysis. This allowed their temperature to adjust to the ambient temperature of the laboratory. A total of 104 TSG samples were taken over the duration of the cruise.

The conductivity ratio of each sample was measured using the salinometer, and the corresponding salinity value was calculated using the OSIL salinometer data logger software, and stored in a Microsoft Excel spreadsheet. The measured salinities of the samples were transferred to a text file, along with the date and time of collection. This file was converted to Mstar format, and the dates and times were converted into seconds since midnight on 1st January 2011.

In order to read the bottle samples, an extra column named ‘SamNum’ was added in the Excel spreadsheet of each crate denoting the Julian day and hour when the water sample was taken, in the form of dddhhmmss. The sample number was renamed as ‘tsg00X_NN where X stands for the crate and NN for the sample number, respectively. This spreadsheet was saved as tsg_jc064.00X.csv, where the X accordingly denoted the crate number, while the .csv format would enable the Matlab processing and reading in the TSG bottle samples.

Accordingly, the TSG salinities were read in using the script mtsg-01.m, while the batch number and bath temperature were required as input information by the user in order for the new salinities to be calculated. This procedure was producing a file named tsg_jc064.00X.nc for each crate, where X stands for the crate number, while the final data from the different crates were appended and saved as ‘tsg_jc064_all.nc’.

The bottle conductivity was computed based on the adjusted salinity and housing temperature, using the script mtsg-02.m, and the difference between the bottle and TSG conductivity was then calculated. Finally, the TSG data were merged onto the bottle

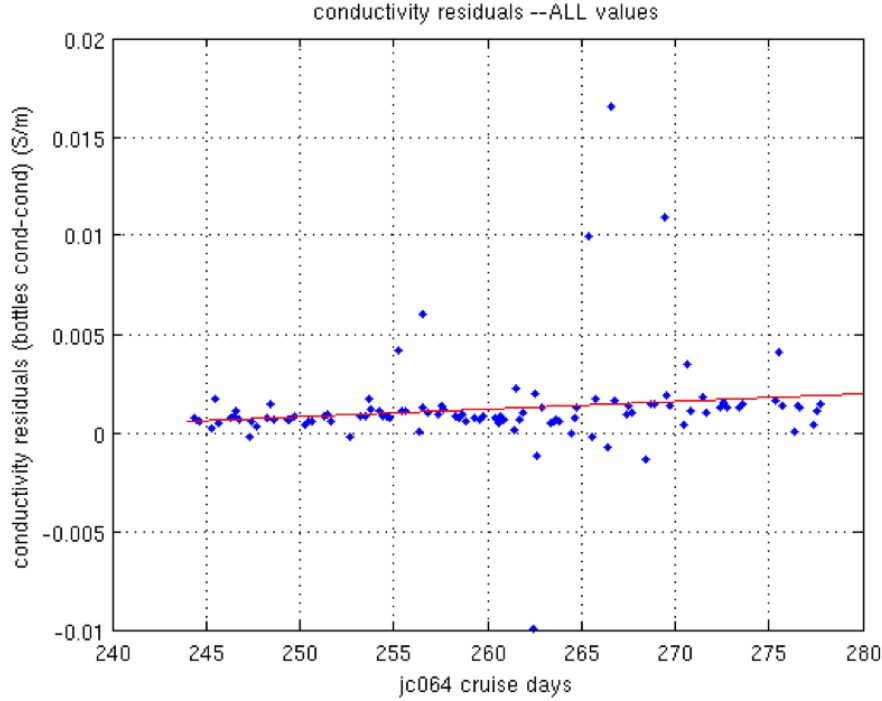


Figure 13: Bottle conductivity minus TSG conductivity for the whole cruise.

data and saved in a file named ‘tsg-jc064.001_merge.nc.’

Figure 13 shows the difference between the bottle and TSG conductivity along the duration of the cruise. It can be seen that the conductivity residuals are characterized by a relatively significant positive trend due to the existence of some very high positive values away from the bulk of the data. Therefore, the $\pm 95\%$ quantile is estimated and is applied as the criterion to remove the outliers. The remaining conductivity residuals were then plotted again (Figure 14) and a new linear regression line fitted. This was used to calibrate the data.

5.3 Surfmet

Eleni Tzortzi

The surface meteorological conditions were measured throughout the cruise. A brief reference to the performance of the meteorological sensors is given in this section. The RRS James Cook was instrumented with a variety of meteorological sensors to measure air temperature and humidity, atmospheric pressure, short wave radiation, and wind speed and direction. These are logged as part of the SURFMET system.

The meteorological instruments are mounted on the ship’s foremast in order to obtain the best exposure. The heights of the instruments above the foremast platform were: Gill WindSonic anemometer, 2.3 m; Vaisala air temperature and humidity 1.67 m and the irradiance sensors 1.38 m.

Files were transferred from the onboard logging system (TECHSAS) to the UNIX system on a daily basis, using the script mday_00_get_all.m. The raw SURFMET data files have names of the form met_jc064_dNNN_raw.nc, where NNN represents the day

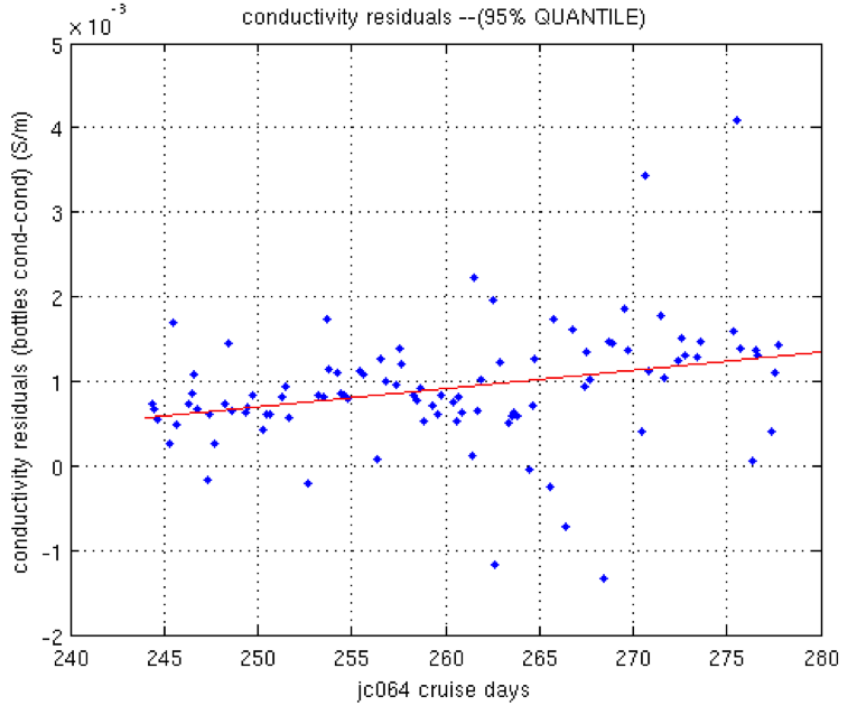


Figure 14: Bottle conductivity minus TSG conductivity for the whole cruise having applied the criterion of 95% quantile (0.004116163060023) in order to remove the outliers.

number. Wind speed units, initially labelled as knots by TECHSAS, were renamed to m/s using `mmet_01.m` and the data were plotted using `mplotxy`. Spikes were assigned an absent value using `mplxyed`.

True wind speed and direction were calculated using the scripts ‘`mbest_all`’ and ‘`mtruew_01`’. ‘`mbest_all`’ is a wrapper for the 4 `bestnav` scripts; ‘`mbest_01`’ creates a 30-second ‘`nav`’ file from 1-Hz positions, while the speed, course and distance run are calculated using ‘`mbest_02`’. A 30-second heading file is created from 1-Hz positions using ‘`mbest_03`’. Here it should be noted that Seapath heading (i.e. ‘`attsea`’) is added instead of ‘`gyros`’ for James Cook cruises due to its better accuracy. Accordingly, `bestnav` navigation data were merged on to the SURMET data using ‘`mbest_04`’ which merges the vector-averaged heading onto the average speed and course. Finally, the true wind speed and direction were calculated using ‘`mtruew_01`’ which added the smoothed ‘`nav`’ to the wet wind to calculate the true wind data. To avoid problems associated with averaging wind direction over time, the relative wind speed, ship’s heading and course made good were converted to eastward (u) and northward (v) components, using the script `muvsd.m`. The true wind direction was calculated and the data were averaged into 1-minute bins. The average directions were calculated by their respective u and v components and contained in the file (`met_jc064_trueav.nc`).

5.3.1 Air Temperature and Humidity

The Vaisala sensor was located on the starboard side of the foremast platform.

5.3.2 Wind Speed and Direction

The Gill Windsonic was located on the foremast platform. As mentioned also in the JC032 Report, only data from one anemometer was logged so no comparisons with other anemometers were made. A large spotlight has been placed on the front edge of the foremast platform potentially increasing the flow distortion in that region. This will bias the wind speed measurements made from foremast anemometers, especially when the anemometers are directly downwind of the spotlight.

5.3.3 List of significant events

Days 253 and 254: 'dps116', 'seapos', 'surflight', 'surfmet' and 'surftsg' data failed to be logged in Techsas NetCDF files. The NetCDF files were regenerated from the Level C by Jon Seddon for these days (Section 4.1). The approach taken was to process these days in subdirectories of a specially created directory: 'met_regen'. 'm_setup', 'mtnames' and 'mday_00' were edited to accept the regenerated variables. 'mday_00' was then run on the regenerated files for the missing days. The metadata of the regenerated files was edited using 'mheadr' to match the missing files. The regenerated files were then moved to the original location as replacements for the missing files. They then fell back in with the routine processing.

5.4 Navigation

Eleni Tzortzi and Cristian López

5.4.1 POSMV

The Applanix POSMV is the primary GPS system used for science on JC064. It 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 the ships position whilst the 'posmvtss' contains heading information. The 'gyropmv' data stream contains the posmvtss heading information rounded to 1 decimal place and is not analysed in this report. The 'posmvpos' data were used in the VMADCP processing and for position in the bathymetry, in the SBE45 data files, as well as for the position of the moorings and CTDs.

5.4.2 Seapath System

The Seapath 200 system serves as another source for GPS position and ship's attitude. Similarly to 'posmvpos', the Seapath 200 antenna is located to the bridge mast and has its common reference point in the gyro/gravimeter room. Although it is a reliable system, it is not as good as the 'posmvpos' system. Two data RVS streams are available, the seapos and attsea for the ship's position and attitude, respectively.

5.4.3 DPS116

The dps116 is located in the bridge mast. Contrary to Seapath 200, it has one antenna i.e. dps116, for the ship's position. Data are logged in the Techsas NetCDF files.

5.4.4 Ashtech

The Ashtech instrument is located on the Bridge deck on the starboard side. Two data streams are output by the RVS system: ‘adu5pat’ and ‘adupos’, for the attitude and the position of the ship, respectively. The Ashtech system is not used for science as there are better quality systems for heading and position.

5.4.5 CNAV

The cnav instrument is located on the antenna, on the ship’s mast. It only provides the ship’s position and the data are characterized by good resolution, i.e. about 5 cm. This should provide the best GPS when bugs described in Section 4.1 are fixed.

5.4.6 Ship’s Gyro

The ship’s gyrocompass provides a reliable estimate of ship’s heading (i.e. not dependent on transmissions external to the ship). However, the instrument is subject to a latitudinal dependent error, heading dependent error and has an inherent oscillation following a change in heading.

Ship’s gyrocompass data was logged every second in the TECHSAS system via the RVS data stream as ‘gyro_s’. Incremented files were created every day and the gyrocompass data were extracted and processed using the script `mgyr_01.m`, including the removal of data with headings outside the 0-360 degree range. The gyro data were used to remove any large outliers in the Ashtech system.

5.4.7 Routine processing

All data streams were processed in a similar manner. Data were transferred daily from the TECHSAS system using the script `mday_00_get_all.m`. Any data cycles that were non-monotonic in time were cleaned up using the script `mgyr_01.m`, while further cleaning up and smoothing of the ash data were followed using the scripts `mash_01.m` and `mash_02.m`, Spikes were assigned an absent value using `mplxtyed`. Data were averaged into 1 minute bins.

Finally, using the script `mjoin.m`, the data were appended into final files named `NNN_jc064_01.nc` where NNN denotes the kind of data, i.e. ‘`met_light_jc064_01.nc`’, ‘`met_jc064_01.nc`’ or ‘`met_tsg_jc064_01.nc`’.

Before averaging, the headings were split into east and north components to prevent errors arising from averaging a direction.

5.4.8 GPS Accuracy

A small study of the accuracy of the GPS systems was made. Position data while moored in Tenerife were plotted in order to see their distribution, deviation and differences from the other systems.

The data ranged from 10:00:00 to 13:20:00 GMT on 10th September 2011. Figures 15 and 16 show the difference in latitude and longitude with a reference point. Figure 15 subplots all GPS systems individually, taking the median of their latitude and longitude as the reference point (0,0). Figure 16 plots all the systems together, in order to see the

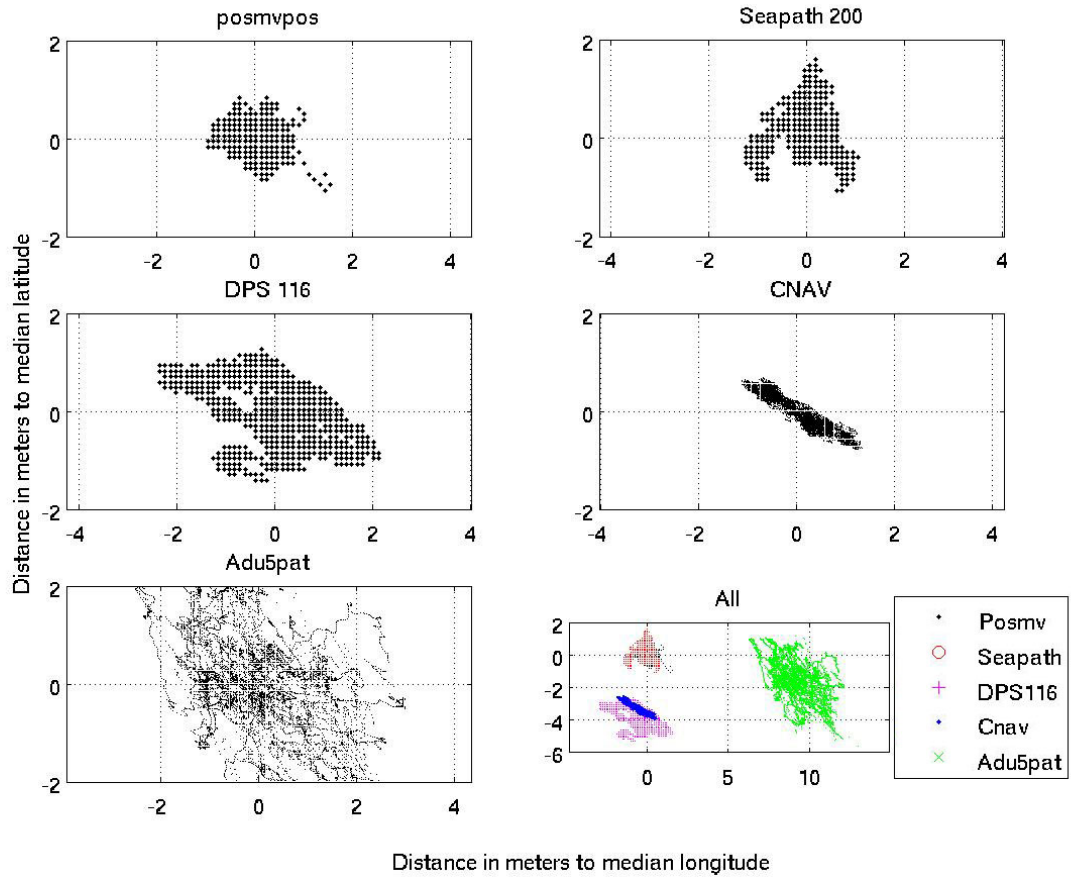


Figure 15: Scatter of the individual GPS systems on the James Cook while moored in Tenerife.

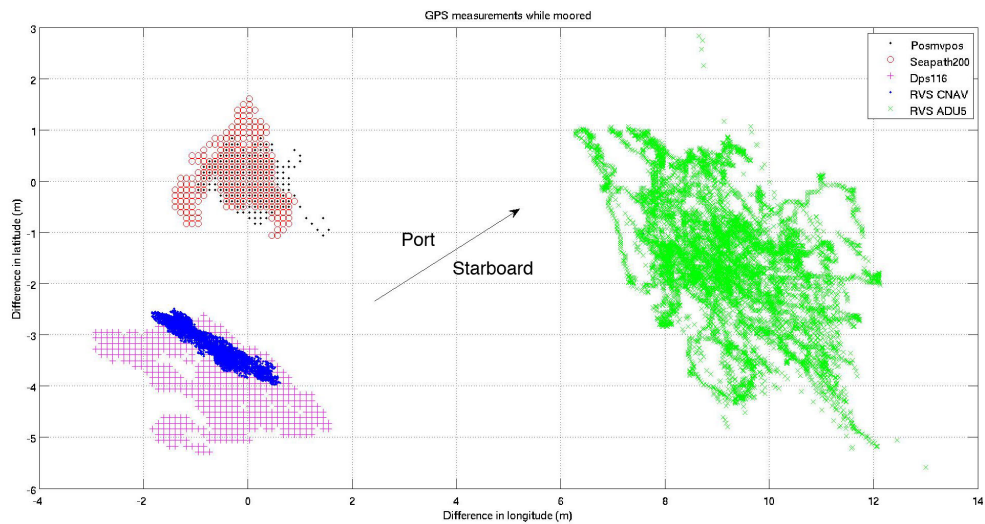


Figure 16: Comparison of different GPS systems on the James Cook. Ship's orientation is indicated using an arrow.

deviation from one another. This time the reference point was the median of Posmvpos, since this is the main GPS system.

It is seen that Posmvpos, Seapath200, DPS116 all log data in beams, with a similar resolution (Figure 15). CNAV shows a much more detailed resolution. Adu5pat shows good resolution, but it seems to have a more random location.

Concerning the accuracy and consistency, Adu5pat is certainly the least accurate, with deviations higher than 2 meters with a large spread. Posmvpos and Seapath both show quite concentrated points with excursions seldom over 1 meter. Conversely, the other systems have larger deviation toward the sides. This is due to the location of the GPS systems. While Posmvpos and Seapath translate the position to a common reference point in the ship's centre, the other systems do not. Hence, these two systems subtract the effect of rolling and pitching, whereas the ship's moving significantly influences the other ones.

A comparison between the five GPS systems is shown in Figure 16 for the period of mooring in Tenerife. An arrow indicates the ship's position during this time. DPS116, CNAV and Adu5pat show a deviation perpendicular to the ship due to the ship's rolling. Furthermore, the deviation to the median is larger towards starboard side, rather than port side. It is due loading operations in port. The cranes operated by starboard, mainly leaning the ship towards that side.

Finally, considering distance differences between one another in Figure 16. It is perceived a significant difference between some of them, larger than the their deviations. It can be explained taking into account the ship's orientation, by the location of every system on the ship. Seapath200 and Posmvpos data overlap, since they are translated to the gravimeter room. DPS116 and CNAV also overlap, though with a slight offset, as their antennas are located on top on the ship's mast, CNAV being slightly closer to bow. Regarding Adu5pat, it is located closer to bow, by starboard side, as shown by its data location.

The most accurate GPS system is Posmvpos. Even though CNAV has the finest resolution, it lacks the rolling correction. Seapath has good accuracy, close to Posmvpos, so it can be used when Posmvpos fails or for comparison and correction. Adu5pat is an obsolete instrument, not reliable for accurate measurements.

5.5 Bathymetry

Eleni Tzortzi and Jon Seddon

The EA600 and EM120 echo sounders both transmit at 12 kHz and so could interfere with communications to 12 kHz moorings transducers and so were shut off whenever the vessel was communicating with moorings. The ADCPs run at much higher frequencies and were left running.

5.5.1 Kongsberg EA600 Single Beam Echo Sounder

The EA600 echo sounder was run for the duration of the cruise. Data were logged as usual to Techsas and Level-C, but additionally raw data were saved in Kongsberg's proprietary binary format and also bitmap images. Hard copy printouts were generated on the Terminal Room laser printer, which were retained by the scientific party to assist with interpolating between gaps in the EA600 data.

The EA600 was used with a constant sound speed velocity of 1500 ms^{-1} . Data were post-processed to correct for sound speed by the scientific party. The Level-C data stream `prodep` was created with the raw EA600 data corrected using Carter table corrections.

Bathymetry data are measured at 1Hz by an EA600 echo sounder and are processed daily. The raw data were initially copied into a file named `sim_jc064.dNNN.raw.nc` (where NNN refers to the 3 digit Julian day number) using `mday_00('sim',day)`. During the cruise, there were occasions where the EA600 instrument could not locate the bottom and either reported zeros and thus, gaps in the data (Figure 17) or inaccurate depths, which biases the mean towards a shallower value. Therefore, a preliminary clean up of the echo sounder data was made, setting an acceptable depth range between 5 and 10000 m depth, and smoothing the data by calculating the median over a period of 5 minutes using `msim_01`. The smoothed data, i.e. `sim_jc064.dNNN.smooth.nc`, were then plotted using `msim_plot` and the output was compared to a hard copy screen dump of the 4-hour depth trace from the EA600 to manually remove any remaining spurious depths.

After having manually removed any spikes, the bathymetry data were appended to `sim_jc064_01.nc` using the script `mapend_sim`. The depths were then corrected to be equivalent to sounding at 1500 m/s using `mfix_depth`. Finally, the position data from the `posmvpos` system and the distance run data calculated from the navigation files were merged onto the bathymetry data and the corrected depths were calculated based on carter tables which provide the climatological latitude/longitude dependence. The data were then averaged over 5 km bins using `mmerge_sim_nav_jc064` and a file named `sim_jc064_nav_merged.nc` was created.

5.5.2 Kongsberg EM120 Swath System

The EM120 multibeam sonar was run throughout the cruise but the EA600 was not synchronised to the SSU as it was found on the JC063 passage that allowing the EA600 to ping as frequently as it liked produced the best results. When the EA600 was synchronised to the SSU it pinged infrequently and struggled to obtain a bottom track and output depths. Interference from the EM120 was seen on the EA600's screen but it did not appear to affect its ability to track the sea bed.

The EM120 (serial number 203) was run continuously throughout the cruise. Data for two specific sites were processed in Caris and data for the rest of the cruise were exported in an `ascii xyz` format. The following sound velocity profiles were installed at the date and time specified and were used thereafter.

The EM120 swath system was running throughout the cruise recording the centre beam depth directly beneath the hull via the TECHSAS system. It is known that the flow of water over the ship's hull produces bubbles that are detrimental to the swath depth measurements, and thus it is considered more reliable in calm seas or on station when the number of bubbles passing over the hull is reduced. During the cruise, the instrument was generally more constant in measuring the actual station depth than the single beam EA600 when the sea floor was steeply sloped, e.g. the EA600 depth measurements were occasionally 400m shallower than the actual bottom depth. This was primarily due to the unadjusted sound speed in the EA600.

The EM120 centre beam swath data were preliminarily cleaned up and smoothed using a 5 min median, and the acceptable depth range was set between 5 and 10000 m, using the script `mswath_01`. A file named `em120_jc064.dNNN.smooth.nc` was created. Accordingly,

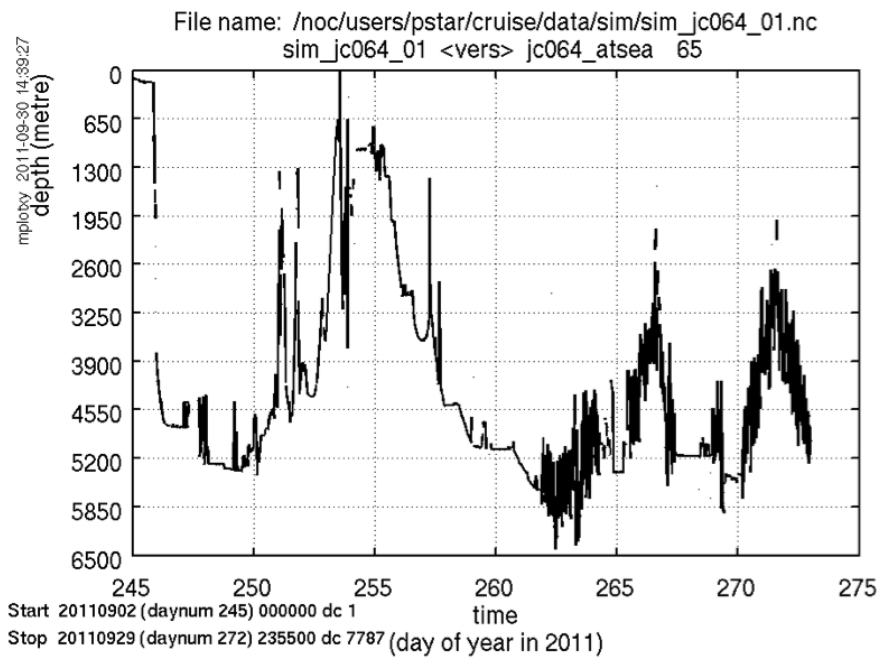


Figure 17: Five minute averaged bathymetry data up to day 272.

the swath data were merged using `msim_02` to aid visual editing which was performed using `msim_plot`. A file named `sim_jc064.01_merged.nc` was created.

The EM120 was off between 18:23 and 18:30 on 29th September to experiment with gridded data export.

The EM120 PC crashed overnight and so no EM120 data was logged from 20:22 on 1st October until 09:09 on 2nd October.

The EM120 was suffering from an ongoing fault causing steps of around 6 m at either edge of the data. Kongsberg have been investigating this fault and have replaced the timing circuit boards in the previous year and the back plane circuit boards in July 2011. They examined data from JC062 during this cruise and are due to visit the vessel for further work at the end of JC064. An example is shown in Figure 17.

5.5.3 Bathymetric Surveys on JC064

Jon Seddon

All Caris data are saved in `/JC64/Ship_Systems/Acoustics/EM-120/EM120_Caris.Processed` of the cruise data structure, with the ASCII output in the export subdirectories.

5.5.4 Eastern Boundary Glider Site

Starting at 19:15 UT on 11th September 2011 a swath survey was carried out in the Eastern Boundary area where there is currently a glider operating. The brief for the survey was to survey the largest possible coverage of the operational area of the SeaGlider Bellatrix in the time available before moorings operations resumed at 06:30 the following morning. Maximising coverage was to be preferred to perfect data quality. The scientists supplied a historical sound velocity profile from mooring data rather than gathering a

Line Number	Start Time, UT	Heading, °(T)	Start Lat.	Start Long.
7	1:50	90	27°51.42' N	013°45.58' W
18	19:15	30	27°52.41' N	013°30.87' W
19	20:37	End of line (eol)	28°00' N	013°27' W
20	21:07	180	28°00' N	013°30' W
21	22:41	eol	27°47' N	013°30' W
22	23:02	0	27°47' N	013°33' W
23	0:33	eol	28°00' N	013°33' W
24	0:55	180	28°00' N	013°36' W
25	2:35	eol	27°45' N	013°36' W
26	2:59	0	27°45' N	013°39' W
27	4:23	eol	27°57' N	013°39' W
28	4:47	180	27°57' N	013°42' W
29	5:12	eol	27°52.44' N	013°42' W

Table 6: Lines run during Eastern Boundary swath survey

current sound velocity profile using the CTD or sound velocity profiler. There was no time available either to check the calibration of the swath bathymetry system.

The water depth was around 1000 m and so the James Cook's EM120 system (serial number 203) was used. To maximise data coverage the beam width was set to $\pm 70^\circ$, giving a swath width of 4000 to 5000 m. The survey speed was initially 6 knots but was rapidly increased to 8 knots and then 9 knots for the final line to make sure that the ship was back at the mooring site for the following mornings work. The sea conditions were calm and at 8 and 9 knots there appeared to be few gaps in the data. Additional data were incorporated from a line when the ship was transiting to the area earlier in the day.

A summary of the lines run appear in Table 6 and Figure 18(l).

No tidal correction was added to the data during its processing as it was suggested that tidal variations in this area are minimal, particularly when compared with the depth of the water.

Despite no calibration being performed before the survey, enough suitable data was identified to check the pitch and roll alignment of the EM120. For pitch a trench between lines 018 and 020 was used and the Caris calibration module showed no pitch error (Figure 18(r)).

For the roll calibration overlapping data between lines 024 and 026 were used. Using the Caris calibration module a roll error of $+0.86^\circ$ was identified. When this was applied to the vessel file it could be seen in the overlap between lines 018 and 020 that this estimate of the roll error was too great. The roll error was then manually adjusted and an error of $+0.30^\circ$ gave the best fit. The overestimation from the calibration module was because of the known problem with the EM120 that Kongsberg are investigating that causes a step in the data (Figure 19(l)).

This step was observed between lines 024 (peach) and 026 (blue) and the magnitude of the step in line 024 was 6 metres.

The data were manually cleaned using Caris' swath editor. Spikes in the data were marked as rejected. Figure 19(r) shows typical cleaning performed. The data were from line 020. Green data were captured by the starboard half of the transducer and red by the port side. Data marked as rejected are grey. Care had to be taken to not remove

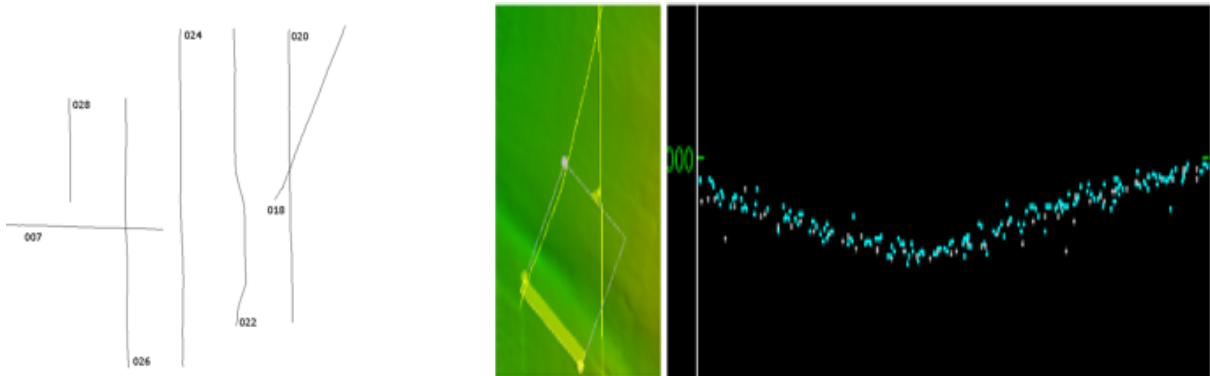


Figure 18: (l) Swath lines run during the eastern boundary swath survey described in Table 6. (r) Pitch error between lines 018 and 020.

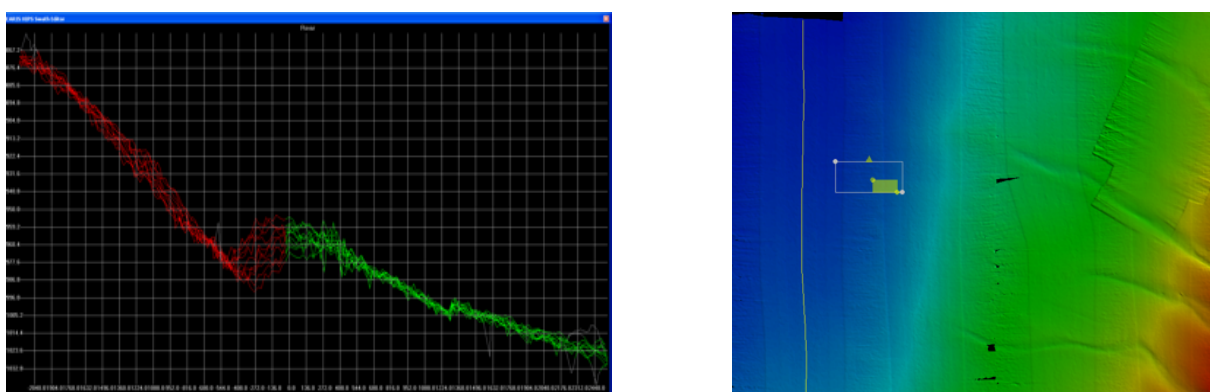


Figure 19: (l) Step in the data. (r) Spikes in the data.

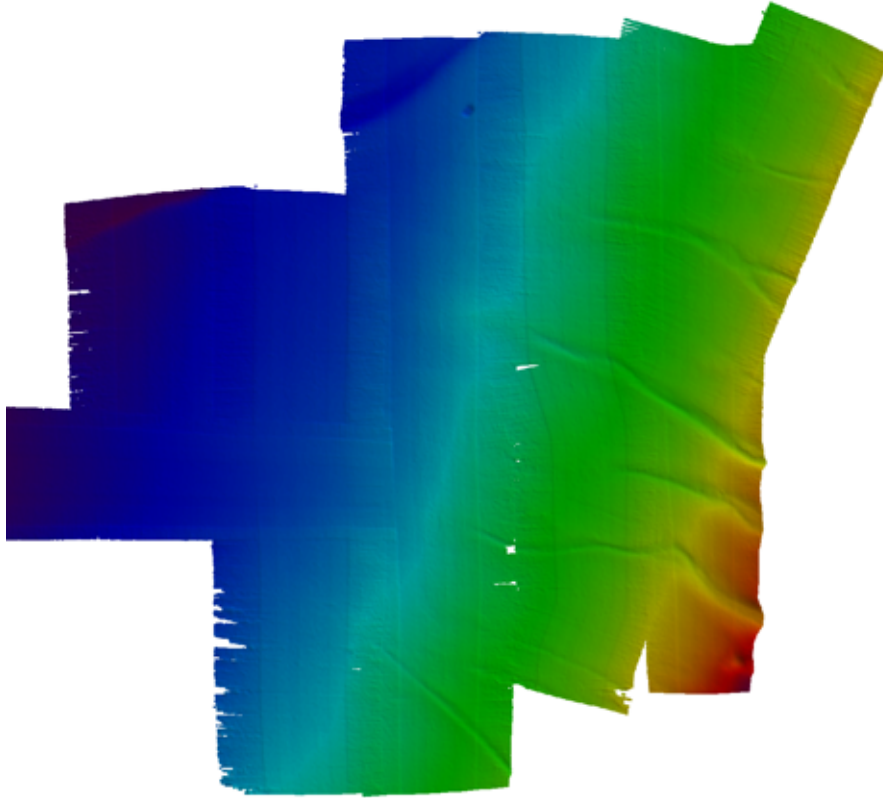


Figure 20: Final data from swath survey at the Eastern Boundary.

objects such as the deep hole in the north of the area that can look similar to noise in the swath editor.

The depths were produced from an Uncertainty BASE surface, which was found to give the results.

A geo-referenced TIFF image file was produced along with a gridded xy-depth text output, with depths at 25 m intervals. The positions in the gridded text output are in decimal degree latitude and longitude format.

5.5.5 MAR0 Mooring Site

The EM120 data from the MAR0 mooring site was also processed in Caris. A dedicated survey of the MAR0 was not performed and data from the EM120 running continuously at the mooring site was used. As the vessel was either sat on station under DP control, or steaming slowly during mooring deployment and recovery there were a large number of overlapping data points. These were cleaned using swath and TPU order 2 filters, and some manual editing in the swath editor. A CUBE surface was used as its hypothesis generation was found to generate the most accurate surface from the overlapping data points. Because of the large number of data points the CUBE surface generation was able to eliminate the problems caused by the EM120's step fault apart from the eastern most area, which was only sampled by a single line. The data were again exported in a geo-referenced TIFF image and decimal degree comma separated ASCII.

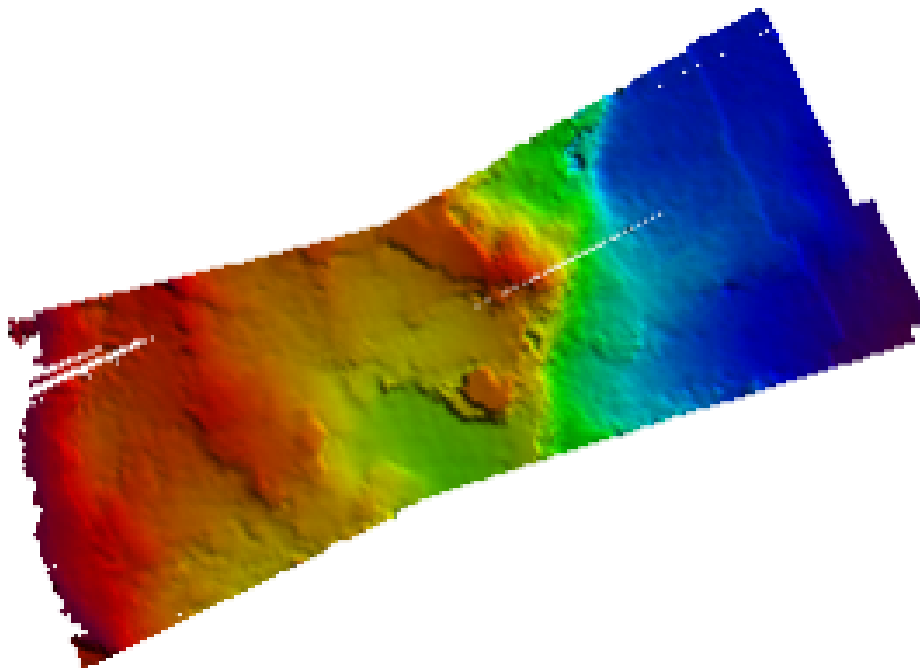


Figure 21: Final data from swath survey at the MAR0.

5.6 WAMOS Wave Radar

The WAMOS wave radar was operated from the start of the cruise until it began to have problems rotating its antenna at 00:00 on 22nd September. The antenna failed completely later that day. A crane and a man cage is required to access the antenna. A radar engineer has been arranged to visit the vessel in port at the end of JC064.

5.7 Waterfall System

One of the JC064 PIES landers that was recovered was fitted with a beacon that pinged every 4 seconds at a frequency of 12 kHz. An attempt was made to track this beacon using the ship's fitted waterfall display system.

The waterfall display is designed to operate with 10 kHz pingers and due to damage to the 12 kHz moorings transducer the only transducer that could be used was the single element of the 10 kHz EA500 echo sounder. However, by using the maximum possible gain on the waterfall system and tuning the gains on the display the beacon was tracked to the surface. Considerable noise was encountered when the azimuth thruster was operating. The weather conditions at the time were calm and so the bridge were happy to disable the azimuth thruster, allowing continuous tracking of the beacon.

The waterfall system acquires 3900 samples every four seconds and these are displayed along the x-axis with the start of the sampling period on the left hand side of the screen and the last sample at the right hand side. At the end of four seconds these samples are shifted down one row and the next 3900 samples are displayed across the top row. If a pinger is stationary in the water column then a vertical line will be drawn on the screen. If the pinger is rising to the surface then the trace will be go from the bottom-right to the

top-left with a faster ascent rate producing a trace closer to the horizontal. A descending pinger will result in a trace from the bottom-left to the top-right. This assumes that the pinger's ping period is exactly 4 seconds.

On later recoveries of Ixsea releases, experiments were made using the pinger mode of the 12 kHz EA600 echo sounder. The EA600 has the facility to track a pinger by detecting the pinger and the bounce of its pulse off the sea floor, or the doppler of the beacon. The EA600's pinger mode requires the initial depth of the pinger to be known. However, the EA600 was unable to track the beacon. If this functionality is required on future cruises then time should be made available on a trials cruise to test the EA600's pinger mode with a 12 kHz pinger on a wire to allow the technicians to gain experience of using this mode of the EA600. The Ixsea's ping repetition rate was 5 seconds. They could be heard on the Waterfall display's speaker and seen on its analogue display, but could not be tracked because the Waterfall software has sampling periods of 4, 2, 1, 0.5 and 0.25 seconds and so could not synchronise with the Ixsea pinger.

5.8 Moorings Transducers

The new 12 kHz moorings transducer fitted to the starboard drop keel during the July 2011 refit had not been tested due to the cancellation of the trials cruise. Prior to the start of JC064 its capacitance was measured in the main lab as 29.3 nF. It was used unsuccessfully to communicate with the first mooring and the EA500's 10 kHz single element was successfully used for the rest of the cruise instead. After this first use the 12 kHz transducer's capacitance had increased to a value in the order of microfarads. The transducer and wiring will be tested during the next port call to establish what happened.

5.9 Development of RAPID-WIDGIT

Patrick Farrell

RAPID-WIDGIT is a MATLAB chart plotter used to provide planning support to the science program. Over the course of JC064, some minor improvements were made to the program.

- When the user clicked a point on the map, the program displayed the longitude and latitude of the point clicked. This has been extended so that it also displays the bathymetry of the point clicked. The algorithm cycles through all of the zoom bathymetry files first, and if none of these return a value, the large-scale background bathymetry dataset is used. The value is computed using the `interp2` MATLAB routine (in `src/plotetopo2fn_dham.m`).
- Previously, the axes were labelled in `DD.dddd°` format (e.g., 26.5°). This has been changed so that it displays `DD°MM.mmmm'` format instead (e.g., 26° 30.0'). This logic is encapsulated in the new `plot_etopo2_set_axis_ticks` function, which is now called wherever the axes are updated (`plot_etopo2_zoomin`, `plot_etopo2_zoomout`, `plot_etopo2_plot_map`, `plot_etopo2_mask_tiles`).
- When the user scrolls the mousewheel, the bathymetry plot now zooms in or out. This does not work when the mouse mode is set to 'pan', but works for all others.

- At one point during the cruise there was concern over the proximity of tropical storm Philippe. The program (`/noc/users/pstar/atlantic_storms/parse_at.py`) in Python fetches the NOAA RSS feed for the storms currently present in the North Atlantic, parses the NOAA report for its location and velocity, and records this data in a plain text file (`/noc/users/pstar/atlantic_storms/atlantic_storms.txt`). A button was added to RAPID-WIDGIT to invoke this program and to plot the storm locations on the chart.

No.	Date	Time	Lat	Lon	Pmax (db)	Dmax (m)	Corr. Depth (m)	Depth corr.
1	9/5/11	9:15:37	42.326	-14.584	5309.9	5203.8	5225.9	52.1
2	9/5/11	14:31:38	42.327	-14.584	5308.1	5201.8	5253.8	52
3	9/14/11	22:42:58	24.922	-21.318	4573.4	4495.7	4552.6	26.9
4	9/15/11	3:14:05	24.922	-21.318	4575	4497.3	4524.2	26.9
5	9/16/11	4:35:32	23.733	-24.105	5158.6	5064.8	5107.7	42.9
6	9/16/11	21:51:53	23.701	-24.226	5202	5106.9	5151.1	44.2
7	9/17/11	3:24:00	23.701	-24.226	5201.5	5106.4	5150.5	44.1
8	9/21/11	22:16:28	23.842	-41.067	5302.4	5204.3	5251.4	47.1
9	9/22/11	3:32:22	23.842	-41.067	5303	5204.8	5251.9	47.1
10	9/25/11	4:18:25	24.179	-49.718	5301.9	5203.7	5254.8	51.1
11	9/26/11	14:10:04	24.114	-52.017	3038.3	2997.3	3005.2	7.9
12	9/26/11	18:40:25	25.106	-52.012	5636.3	5527.5	5590.3	62.8
13	9/27/11	1:20:04	25.113	-52.014	5300	5201.5	5252.5	51

Table 7: Deployment information for CTD stations. Time and position are given when the CTD is at the bottom of the cast.

6 Lowered CTD Programme

The ships CTD and rosette were used for performing calibration dips, for which the standard RAPID procedure was used: every other Niskin bottle was removed so that 12 MicroCATs could be mounted with the Niskin bottle hardware for in situ calibration. One cast (station 12) used 24 Niskin bottles, as additional samples of Antarctic Bottom Water were desired.

A total of 13 CTD casts were made for MicroCAT calibration or pressure release testing. The stations are summarised in Table 7.

On CTD 9, the primary conductivity sensor suffered from biological fouling on part of the downcast, causing a large spike in the T-S plot. The problem resolved itself after a short period, so no further action was taken.

For CTD 10, the plan was to begin the cast at approximately 21:00 (GMT), and to follow that with an additional overnight CTD cast. However, technical difficulties were encountered with the winch, and the CTD could not be hauled overboard until 02:00 (GMT). Therefore, only one cast was performed that night. The same issue with the winch occurred at the beginning of CTD 11, but the problem was quickly resolved as the deck crew recognised the fault.

7 CTD Operations

Jeff Benson

The initial sensor configuration was as follows:

- Sea-Bird 9plus underwater unit, s/n: 09P-0943

- Frequency 0 - Sea-Bird 3 Premium temperature sensor, s/n: 03P- 2674
- Frequency 1 - Sea-Bird 4 conductivity sensor, s/n: 04C-2231
- Frequency 2 - Digiquartz temperature compensated pressure sensor, s/n: 110557
- Frequency 3 - Sea-Bird 3 Premium temperature sensor, s/n: 03P - 4872
- Frequency 4 - Sea-Bird 4 conductivity sensor, s/n: 04C-3258
- V0 - Sea-Bird 43 dissolved oxygen sensor, s/n: 43-0363
- V2 - Benthos PSA-916T 7Hz altimeter, s/n: 41302
- V3 - Free
- V4 - Free
- V5 - Free
- V6 - Free
- V7 - Free

Ancillary instruments & components:

- Sea-Bird 11plus deck unit, s/n: 11P-24680-0587
- Sea-Bird 24-position Carousel, s/n: 32-19817-0243
- 12 x Ocean Test Equipment 10L water samplers, s/n: 1A, 3A, 5A, 7A, 9A, 11A, 13A, 15A, 17A, 19A, 21A, 23A

13 CTD casts were made and they were primarily carried out for SBE 37 MicroCAT calibration and release tests. Log sheets were scanned and included with the data from this cruise.

The pressure sensor was located 30cm below the bottom and approximately 75cm below the centre of the 10L water sampling bottles.

The carousel was fitted with 12 water samplers in alternate positions, excepting cast 012, which included the remaining even numbered samplers (2A through 24A).

The configuration file used was JC064_NMEA.xmlcon, and JC064_NMEA_oxy.xmlcon (see Appendix A).

8 CTD Data Processing

Patrick Farrell and Gerard McCarthy

CTD cast data were post-processed according to guidelines established with BODC (ref. Moncoiffe 7th July 2010). Additional post-processing was undertaken for RAPID; these files were created separately from standard BODC processed files, and are designated by rapid appended in the file names.

Raw CTD files	
CTD_JC064_XXX.CON	Configuration file
CTD_JC064_XXX.bl	Bottle file
CTD_JC064_XXX.hdr	Header file
CTD_JC064_XXX.hex	Data, in ASCII format but data is in hex
Processed CTD files	
CTD_JC064_XXX.btl	Bottle summary file
CTD_JC064_XXX.cnv	Data, in plain text arranged in columns
CTD_JC064_XXX.ctm.cnv	Data, corrected for the conductivity cells thermal mass
CTD_JC064_XXX.ros	Rosette file

Table 8: Example CTD files (where XXX is replaced with the cast number, e.g. 001) that are copied from the PC that runs the CTD and deck unit rosette to cookfs.

Crucial to this setup was to ensure that the begin archiving immediately option was selected. When not selected it causes a timing discrepancy of up to ten minutes. This causes problems when compared with microCATs on caldips.

Variables and units were selected as:

- Time
- Depth
- Pressure (dbar)
- Temperature, 1&2, °C
- Conductivity, 1&2, mS/cm
- Scan
- Altimeter

The CTD casts were processed with the MEXEC routines written by Brian King. These routines are higher-level processing programs that depend on the MSTAR library. MSTAR is a replacement to PSTAR, runs in MATLAB and uses NetCDF as its native format. The base directory for CTD processing on oceanus is /noc/users/-pstar/cruise/data/ctd.

The raw data files e.g. CTD_JC064_XXX.bl and CTD_JC064_XXX.hex, where XXX is the CTD cast number – are converted with Seabird processing software (SBE Data Processing, v7.20g) to CTD_JC064_XXX.cnv, CTD_JC064_XXX.ros, and CTD_JC064_XXX.ctm.cnv. The data in CTD_JC064_XXX.ctm.cnv are corrected for cell thermal mass effects using an adaptive filter with $\alpha = 0.03$ and $\tau = 7.0$. All the files from the Seabird processing are shown in Table 8.

In MATLAB, the MEXEC routines are initialised with m_setup. The following routines are run in the order given (all written and described by Brian King, except for mplotud):

1. msam_01
2. mctd_01

3. mctd_02
4. mctd_03
5. mdcs_01
6. mdcs_02

At this point, the bottom pressure identified is compared against the recorded depth of the CTD cast with `sw_dpth`.

1. mdcs_03, which requires user input for identifying the start of the downcast and the end of the upcast.
2. mctd_04
3. `mplotxy_ctdck`, which plots the data from a given CTD cast against previous CTD casts. This required significant debugging to get it working again.
4. `mplotud` (newly written), which plots the T-S profile of the primary and secondary sensors, for both the downcast and upcast. This allows the primary and secondary sensors to be compared, and the downcast and upcast to be compared.
5. mdcs_04, which requires the daily processing to have been performed for the day of the CTD cast.
6. mfir_01
7. mfir_02
8. mfir_03
9. mfir_04
10. mwin_01
11. mwin_03
12. mwin_04
13. mdcs_05

This is all the processing that can be done without the bottle salinity data. Once the bottle salinity data is available, the following scripts are run:

1. msal_01
2. msal_02

All output files from these routines are saved in the base CTD directory. On inspection, it was found that `msal_01` (which applies the offsets given in table 4 to the bottle sample data for each cast) had hardcoded the bath temperature of the salinometer to be 24°. Furthermore, this parameter was not displayed anywhere in its output, which could lead to errors in the calibration if the bath temperature was not 24° (on JC064, it was 21°). The `msal_01` script was modified so that it requests the bath temperature from the operator.

Date	Crate No.	CTD No./TSG No.	Start offset	Mid offset	End offset	Comments
9/7/11	7	CTD1/CTD2	0	2.60E-05	4.80E-05	P153
9/9/11	3	TSG1	0	2.40E-05	2.10E-05	P151
9/19/11	6	TSG2	-1.50E-05	3.50E-05	6.60E-05	P153
9/19/11	8	CTD3/CTD4	6.60E-05	4.90E-05	7.40E-05	P153
9/19/11	7	CTD5/CTD6	7.40E-05	6.90E-05	8.90E-05	P153
9/25/11	3	TSG3	-3.00E-05	1.20E-05	4.00E-06	P153
9/25/11	25	CTD7/CTD8	4.00E-06	4.10E-05	3.20E-05	P153
9/30/11	7	CTD9/CTD10	3.20E-05	4.60E-05	7.10E-05	P153
9/30/11	8	CTD11/CTD12	7.10E-05	8.20E-05	8.10E-05	P153
9/30/11	25	CTD12/CTD13	8.10E-05	1.08E-04	9.70E-05	P153

Table 9: Salinometer offset data. Offset is measured conductivity of standard seawater - known conductivity of standard seawater.

9 Salinometry

Jeff Benson and Patrick Farrell

A Guildline Autosol 8400B salinometer, s/n: 68426, was used for salinity measurements. A total of 218 salinity samples were taken during the cruise for CTD analysis. The salinometer was sited in the Constant Temperature Laboratory, with the bath temperature set at 21°C, the ambient temperature being 20 – 22°C. A bespoke program written in Labview called Autosol was used as the data recording program for salinity values.

Before the salinometer may be used to calibrate the CTD casts, the salinometer itself must be calibrated by measuring the conductivity of standard seawater and comparing the value obtained against the known true value. For all measurements, the salinometer bath was maintained at 21°.

Due to confusion over the supply of standard seawater, the salinometer was standardised three times over the course of JC063/JC064:

1. On 2011-09-07, the salinometer was standardised against standard seawater batch P153 (2K15=1.99958, salinity=34.992). The salinometer was then used to measure the conductivity of the seawater samples taken on CTD casts 1 and 2.
2. On 2011-09-09, the salinometer was standardised against standard seawater batch P151 (2K15=1.99994, salinity=34.999). The salinometer was then used to measure the conductivity of the seawater samples taken while underway on JC063.
3. On 2011-09-10, the salinometer was standardised again against standard seawater batch P153 (2K15=1.99958, salinity=34.992). The salinometer was then used for the remainder of the measurements performed on the cruise without any re-standardisation.

On 2011-09-28, it was observed that the constant temperature laboratory was not, in fact, at a constant temperature. Over the night of the 27th/28th, the temperature in the room had dropped to 12.5°. The apparent cause of this anomaly was maintenance performed by the ETO without the knowledge of the Deck/E, who is responsible for the maintenance of the laboratory. The minimum temperature at which the salinometer can

CTD No.	Start offset	Mid offset	End offset	Offset applied
1	0	N/A	2.60E-05	1.30E-05
2	2.60E-05	N/A	4.80E-05	3.70E-05
3	6.60E-05	N/A	4.90E-05	5.75E-05
4	4.90E-05	N/A	7.40E-05	6.15E-05
5	7.40E-05	N/A	6.90E-05	7.15E-05
6	6.90E-05	N/A	8.90E-05	7.90E-05
7	4.00E-06	N/A	4.10E-05	2.25E-05
8	4.10E-05	N/A	3.20E-05	3.65E-05
9	3.20E-05	N/A	4.60E-05	3.90E-05
10	4.60E-05	N/A	7.10E-05	5.85E-05
11	7.10E-05	N/A	8.20E-05	7.65E-05
12	8.20E-05	8.10E-05	1.08E-04	9.03E-05
13	1.01E-04	N/A	9.70E-05	9.89E-05

Table 10: Salinometer offset for each CTD cast. The offset applied is (measured conductivity of standard seawater) - (known conductivity of standard seawater). Only CTD12 has a middle value, as only CTD12 used 24 Niskin bottles. Salinity adjustment is measured in PSU.

be used is 15°. In the attempt to restore the temperature of the room to 20°, the heater was left on too long and the room temperature rose to 22°. As the temperature must remain stable for at least 24 hours before the salinometer is used, this caused a delay of several days to the science program.

The processing of the salinity data proceeds as follows. Conductivity data from the salinometer are entered into Excel files (e.g., BOTTLE_SALTS/JC064 CTD crate 7 19 September 2011.xls). These Excel files are exported to comma-separated value (CSV) format (e.g., BOTTLE_SALTS/sal_JC064_001.csv). The first column of the data must be ctdXXX, where XXX is the station number (e.g. 001 or 002). This allows for the data for several CTD casts to be stored in the same Excel/CSV file, as the salinometer is usually run for two or three casts in one sitting. The last column is entered by hand: it contains the CTD cast, followed by the bottle number (e.g. 105 for the bottle in position No. 5 on cast 1). These data are derived from the CTD logsheet. The Excel/CSV file also contains the measurement of the conductivity of the standard seawater, which is used to measure the instrument drift.

9.1 Calibration of CTD casts against the salinometer

The CTD conductivity measurements are calibrated against the water samples measured by the salinometer. The conductivity measurements typically drift the fastest of the three quantities measured by a CTD (compared to temperature and pressure, Seabird CTD Calibration Manual), and conductivity usually reads low compared to bottle samples by a constant multiplicative factor.

Before the calibrations are calculated, the bottle samples have to be inspected carefully and data points removed that are statistically different from the other bottle samples. This is done by considering the residual difference ΔC between the bottle conductivities CBOT and CTD conductivities CCTD. Data points are removed if the residual exceeds certain

limits (> 0.005 or < -0.002 mS/cm) or if it is larger than three standard deviations from each station average. Out of 168 bottle samples, 30 are removed by the first criterion and none by the second. The data points picked for analysis are shown in Figure 22.

The first correction is to correct for a multiplicative factor between the bottle conductivity and the CTD conductivity, which is called a slope correction. As no distinct groups of casts were identified, all 13 stations were treated as one block in the `ctd_cal` script. The CTD data were multiplied by a correction factor of 1.000027 for all stations. Applying this correction produces residuals that are better centred around zero (Figure 23).

After the ratio correction there still remains an increase of residual with depth (Figure 23). As employed in the CTD processing of cruise D344, a quadratic fit of residual difference against pressure was computed and applied to the CTD cast data. The quadratic polynomial computed by `ctd_cal` was

$$\Delta C = (1.6028 \exp^{-11})p^2 - (3.6391 \exp^{-07})p + 0.0007507.$$

As on D344, the procedure for applying the calibration consisted of the following steps.

1. `ctd_cal` (which computes the slope correction and quadratic polynomial)
2. `calibrate_ctd` (which loops through all of the stations and calls `apply_calibration`)

Several bugs were discovered and fixed in each of these scripts (`ctd_cal`, `calibrate_ctd`, and `apply_calibration`).

- `ctd_cal` was hardcoded for D344, with many cruise-specific filenames. More importantly, there were many cruise-specific branches to specially treat casts 3, 16 and 26. These were removed.
- `ctd_cal` was unable to apply the slope correction to all of the casts together; in several places, it assumed that the casts were divided into at least two blocks. These assumptions were removed.
- `ctd_cal` assumed it was to be called from the `cruise/data/ctd` directory. This assumption was removed.
- `ctd_cal` was not safe when called multiple times. Running `ctd_cal` once in a matlab session and then running it again would lead to errors to do with locked NetCDF files. Additionally, the script checked whether its output already existed and behaved differently in that case. These issues were fixed: the script should now behave the same when called repeatedly.
- `ctd_cal` had the number of stations hardcoded in several places, including the paths of the files to inspect. This was replaced with a call to `dir`, which identifies the files without having to edit the script.
- The block of code which saved the calibration constants had been disabled by placing it inside an `if 1 == 0` block. This was removed.
- The `calibrate_ctd` script was again hardcoded for D344. This was changed to use a cruise variable defined by the operator at the top of the script.

- `calibrate_ctd` called `ctd_all_part2`, which includes the insertion of the winch cable data. However, CTD casts 1 and 2 were formally part of JC063, and the winch data was not available (`mwin_*` could not be successfully run). Therefore, `calibrate_ctd` was modified so that it executes all of the steps of `ctd_all_part2` except for the `mwin_*` steps.
- `apply_calibration` was again hardcoded for D344. This was replaced with a cruise variable defined at the top of the script.
- `apply_calibration` uses the unix `cp` command to copy files around. However, the invocation of `cp` lacked the `f` flag, which meant that if the script were run more than once, it required operator intervention to give consent to the overwriting of temporary internal intermediate files. This was fixed by adding the `f` flag to the invocation of `cp`.
- `apply_calibration` was not safe when called multiple times. If the execution of the script were aborted due to a bug, it would fail to execute due to the locks placed on files during the previous execution, or due to the existence of temporary files that the script would fail to overwrite. The script was modified so that it could be invoked multiple times safely.
- `apply_calibration` assumed that the conductivity was stored in a variable called `cond` in the CTD file. This was not true on JC064: instead, there are two variables, `cond1` and `cond2`, for the primary and secondary sensor respectively. This required several changes to the script to enforce. Now, the script uses the `mctd_sensor_choice` function to decide which sensor to use, and uses that choice as the basis for the calibration.
- The use of `mheadr` to rename the computed calibrated conductivity (`cond_corr`) to the appropriate variable name for use in downstream processing (`cond1` or `cond2`, as appropriate) did not work. I hypothesise that at some point between D344 and JC064, `mheadr` was modified so that if the user attempted to rename a variable to have the same name as an already existing variable, it failed. The invocation of `mheadr` was changed to work with the currently existing version.

Once these issues were fixed, the `calibrate_ctd` script executed successfully. The calibrated data can be seen in Figure 24.

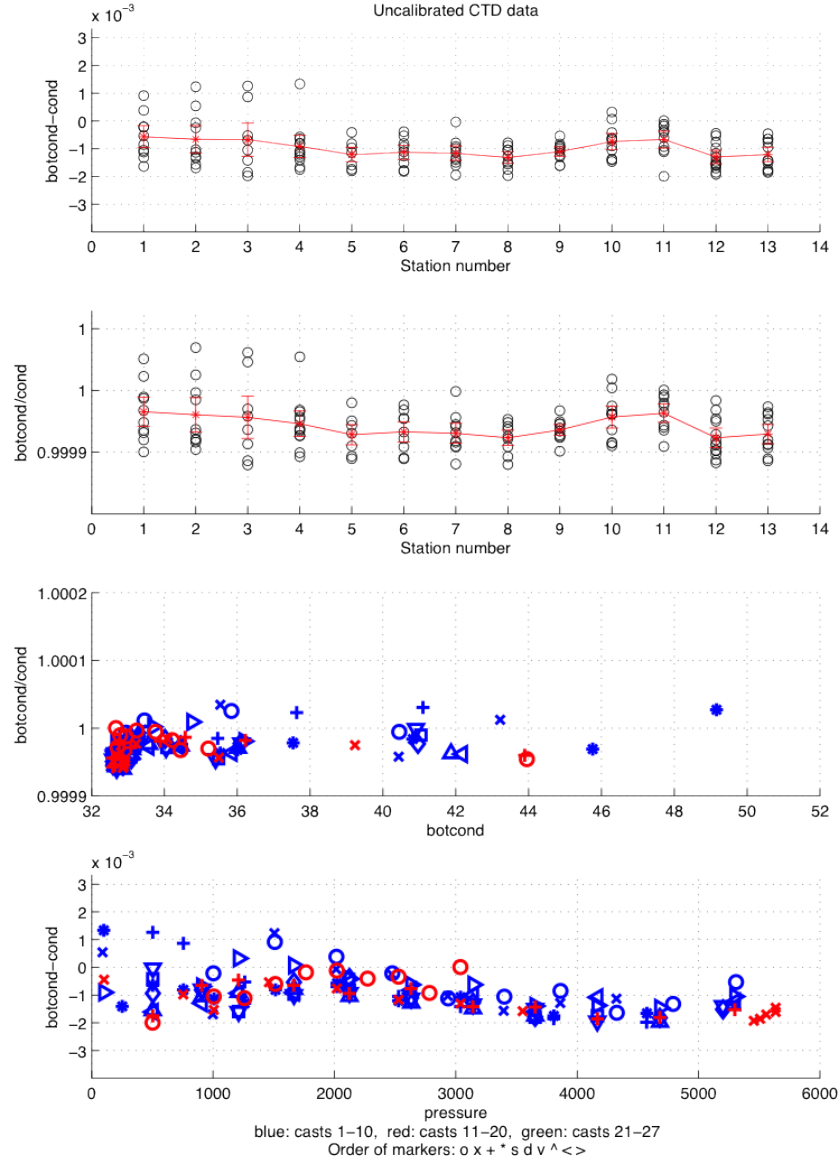


Figure 22: Uncalibrated CTD data. a) The conductivity difference for each station. b) The conductivity ratio for each station. c) The conductivity ratio plotted against conductivity. d) The conductivity ratio plotted against pressure.

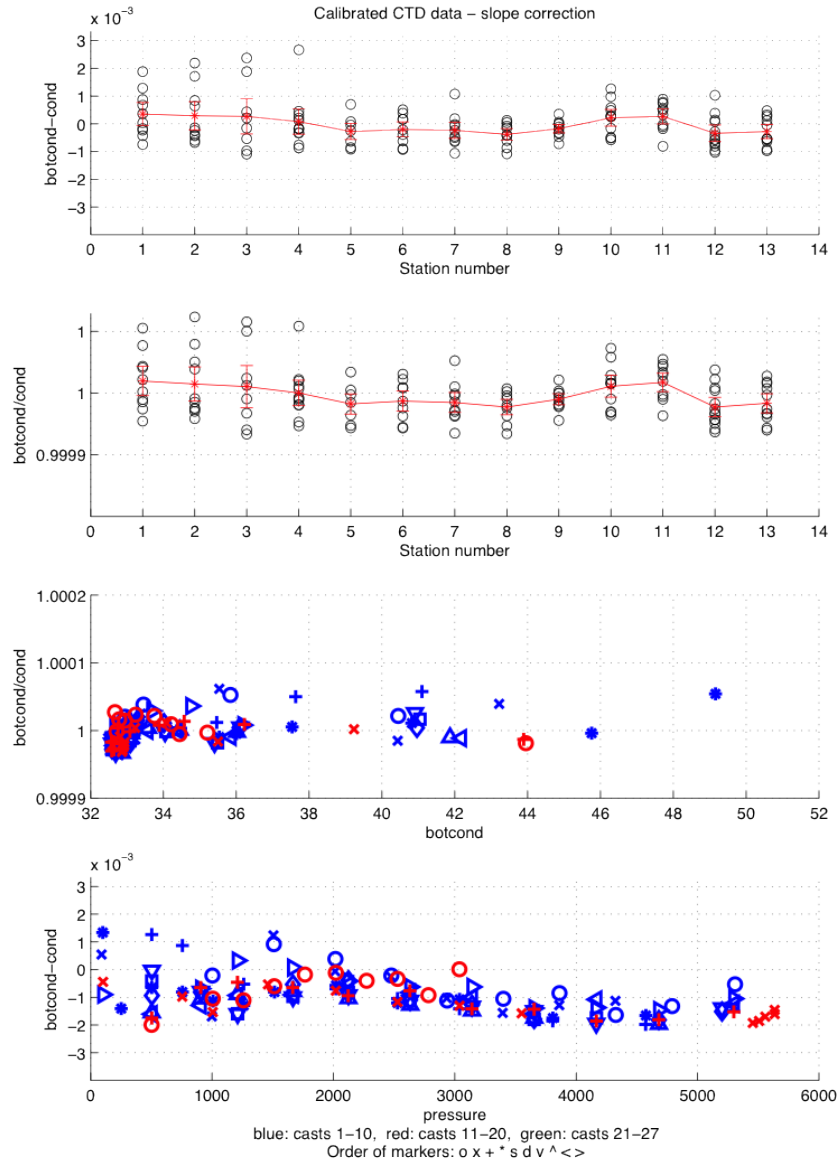


Figure 23: CTD data calibrated with the slope correction. Otherwise, a)-d) are as in Figure 22

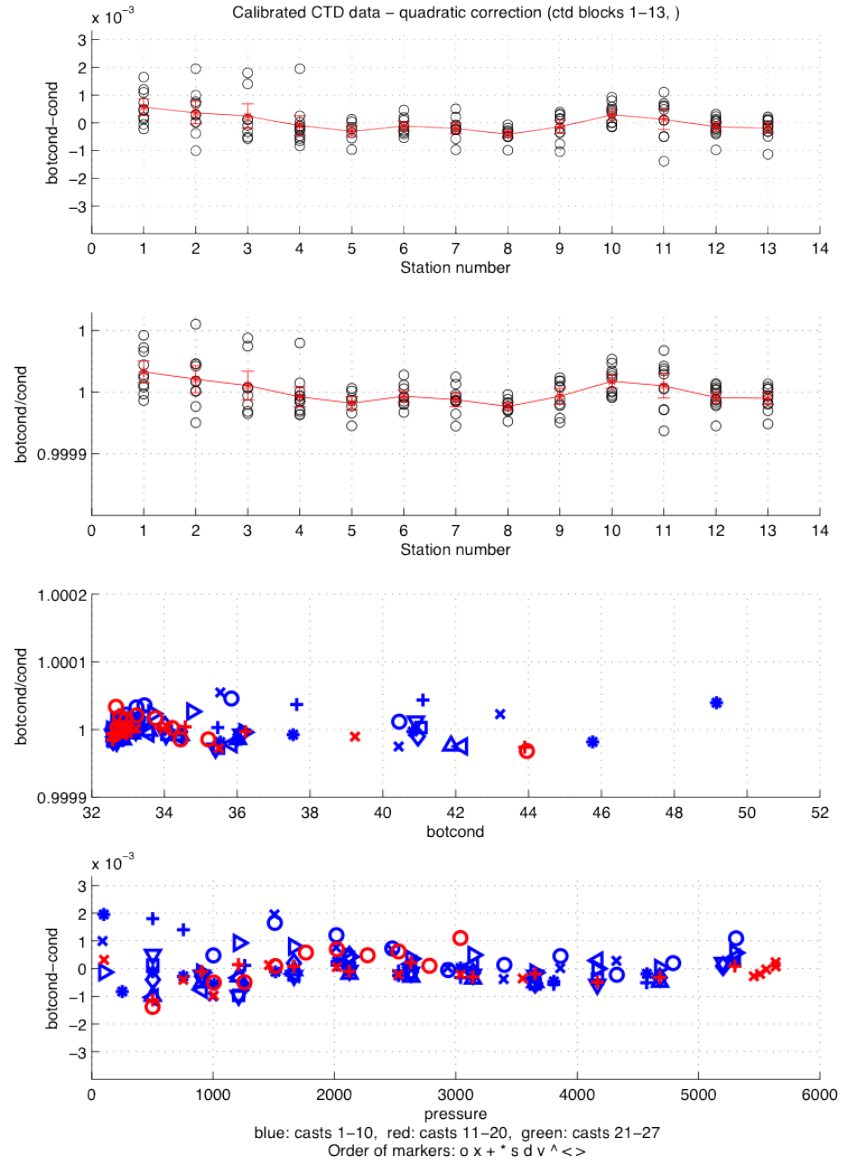


Figure 24: CTD data calibrated with slope correction and quadratic pressure fit. Otherwise, a)-d) are as in Figure 22

10 Mooring Operations

Robert McLachlan

Mooring recovery and deployments were carried out using the Double Barrel winch with two reelers; one placed forward of the winch and one to the STBD side utilising a diverter sheave. The AFT pedestal crane was used with a hanging block on for the mooring wires/ropes and hardware to pass through. During deployments both AFT pedestal cranes were used to deploy the anchor; one to take the load of the outboard mooring and one to lift the anchor in to the water. Both were then released using two Seacatch release hooks.

The smaller rope moorings were deployed by hand out of baskets with the anchor being deployed using the crane. A stopper anchored to the deck was used to transfer the loads of the mooring when needed and the carpenters stop was used on occasion when tangles impeded the use of the stopper.

10.1 Design changes

During the cruise the need arose on occasion to alter the design of the moorings.

1. Landers. The first Lander deployed, EBH4L3, did not sink so it was recovered. Investigation showed that the anchor was of the wrong dimensions and therefore not as heavy as it should have been. It also became apparent that even with the correct dimensions the anchor was still not heavy enough. It was decided to remove one glass sphere from each of the three packs. This design change was adopted for all of the Lander deployments on this expedition. For future Lander deployments the larger 600kg anchors will be used and the buoyancy returned to three packs of four.
2. MAR0. The original design had only glass spheres at the top with no place to locate a recovery beacon. It was decided that a Billings float would be incorporated in to the design along with a location beacon. It was also noted that there is now a double release Lander at the anchor; so more back up buoyancy was needed. The final design therefore consisted of removing one glass sphere from the top three pack of glass and inserting a Billings float and the bottom six pack of glass was increased to eight.
3. EBH1. The ascent of the bottom pack of glass spheres on EBH1 was noted as being quite slow and was subsequently noticed being partially submerged when on the surface. It was decided to insert one glass sphere in to the bottom pack of three.
4. Releases. All of the moorings and Landers deployed on this expedition have two releases.

10.2 AutoSBE

Patrick Farrell

AutoSBE is a suite of six programs used for automating the programming of Sea-Bird MicroCATs.

Over the course of a cruise, the MicroCATs are programmed on the order of one hundred times: for deployment on a mooring, and for pre- and post-mooring calibration. Typically, many devices must be programmed uniformly so that their behaviour is homogenous. Up to now, these devices have been programmed manually, following printed instruction sheets. There are several difficulties with this approach:

- As RAPID is a longstanding project, there are several generations of MicroCATs used, with varying firmware versions, names for analogous commands, and methods for physically communicating with the device. This inhomogeneity makes it difficult to program the devices so that they behave in a uniform manner.
- The correct configuration of the MicroCATs is crucial to the success of the deployment, but programming them is laborious, tedious and error-prone. It is very easy to make a mistake and forget one command when you have typed the same commands twenty times.

Programming the MicroCATs is repetitive and laborious: therefore, it is a natural candidate for automation. However, the SeaTerm and SeaTermV2 software used to program the devices offer no mechanism for scripting them. Therefore, if SeaTerm/V2 are to be automated, an external program must drive them by sending the appropriate mouse clicks and keyboard events. This is precisely the strategy employed in AutoSBE.

AutoSBE is built upon the pywinauto library, a module for the Python programming language that uses the Win32 API to drive graphical Windows programs. As pywinauto is written in Python, AutoSBE is also written in Python. AutoSBE starts the SeaTerm/V2 executable under its management and then operates the program exactly as a trained human operator should: starting a capture file, connecting to the device, issuing the appropriate commands, and disconnecting from the device. The software was developed over the course of the cruise and put into operational deployment. It was found that the approach worked well and that it led to large efficiency gains for the technicians responsible for the MicroCATs.

10.2.1 Installation

Installation of the AutoSBE software is straightforward. The entire project is contained in one directory (called autosbe). To install it onto a computer, merely copy this directory onto the hard drive of the machine. AutoSBE will happily run from a USB memory stick. To delete the software, delete the directory.

The only dependency of AutoSBE is SeaTerm/V2. Note that AutoSBE relies on the installation of SeaTerm/V2 in the default directory suggested during the SeaTerm/V2 installation procedure.

10.2.2 Operation

There are essentially three kinds of MicroCAT used in the RAPID project:

- Devices with firmware < 3.0 that are connected via inductive modem

- Devices with firmware < 3.0 that are connected via RS232
- Devices with firmware >= 3.0 that are connected via RS232

All three have slightly different requirements for what software should be executed and how it should be managed. Furthermore, there are two cases for which the devices must be configured:

- Mooring deployment
- Pre-/Post-calibration deployment

As there are three kinds of device and two configurations, there are six executables in the AutoSBE directory:

- run_seatermV1_caldip.exe
- run_seatermV1_IM_caldip.exe
- run_seatermV2_caldip.exe
- run_seatermV1_moor.exe
- run_seatermV1_IM_moor.exe
- run_seatermV2_moor.exe

where caldip refers to a hard-coded configuration for calibration dips, and moor refers to a hard-coded configuration for mooring deployments. The moor and caldip versions are almost identical: they differ only in the commands hard-coded in the executables, and the filename of the configuration files they read.

The AutoSBE executables read a configuration file (caldip.cfg or moor.cfg for caldip and moor respectively) in the same directory as the executables. These configuration files contain additional commands for the software to execute on the MicroCAT. This feature is necessary because it would be impossible to hard-code MicroCAT start times/dates, or to hard-code the STARTLATER command.

These files contain commands in V1 format: AutoSBE translates between the V1 and V2 syntax when operating SeaTermV2.

These commands are hard-coded in the moor configuration:

- SAMPLENUM=0
- STORETIME=Y
- OUTPUTSAL=N
- NAVG=1
- INTERVAL=1800
- PUMPINSTALLED=Y
- OUTPUTSV=N

- SYNCMODE=N
- TXREALTIME=N

These commands are hard-coded in the caldip configuration:

- OUTPUTSAL=N
- NAVG=1
- INTERVAL=10
- PUMPINSTALLED=Y
- OUTPUTSV=N
- SYNCMODE=N
- TXREALTIME=N

Additionally, these commands are hard-coded for operating SeaTermV2:

- OutputExecutedTag=n
- Outputformat=3
- BAUDRATE=38400

The basic operation of the executables may be summarised as follows:

1. Start a capture file so that the commands issued to the device are logged. The capture file is initially created with a temporary filename (the timestamp). At the end of the program, it is renamed to SERIALNUMBER_DATE_TIME.cap. This temporary filename is used because, before connecting to the device, the serial number is unknown.
2. Connect to the device. Note that for inductive modem MicroCATs, the inductive modem must be switched on before the AutoSBE executable is ran. The software does not explicitly configure SeaTerm for an inductive modem as the software recognises the microCAT as soon as the modem is switched on.
3. Display the initial status of the device (DS).
4. Set the clock of the device to the system time (the time displayed in the bottom-right corner in the system tray). As accurate timekeeping is important, it is crucial that the system clock of the computer running AutoSBE is updated beforehand (by NTP or manually).
5. Execute the hardcoded instructions, translating from V1 to V2 syntax if running SeaTermV2.
6. Execute the instructions in caldip.cfg or moor.cfg, translating from V1 to V2 syntax if running SeaTermV2.

7. Display the final status of the device (DS).
8. Disconnect from the device.
9. Stop the capture file and rename it as described above.

The inductive modem version was the most difficult to get working. It was found that the communication became garbled, with the MicroCAT returning gibberish. The problem was resolved when Christian Crowe hypothesised that it was caused by the speed at which AutoSBE was delivering keypresses: the program was typing far faster than a human could, and the time between keystrokes was insufficient for the MicroCAT to distinguish between them. This was remedied by configuring pywinauto to deliver keystrokes at a slower rate (0.2 s between keystrokes, instead of 0.05 s).

The program displays the email address (patrick.farrell06@imperial.ac.uk) and telephone number (0044 7726 646965) of the author upon each invocation, so that the author may be contacted if necessary.

10.2.3 Rebuilding from source

It may become necessary in the future to edit the source code of AutoSBE to deal with changes in the underlying SeaTerm software. For this reason, the source code to AutoSBE is distributed with it.

The source is contained in the src directory of autosbe. While running AutoSBE has no dependencies other than SeaTerm, there are several dependencies that must be installed if one wishes to recompile AutoSBE from the source code. Full instructions are given in the README.txt, but are reproduced here for completeness.

The developer must install: Python 2.x (<http://python.org>); last used version 2.7.2. Note that this must be the 32-bit version, even on 64-bit Windows. Do not download Python version 3.x. pywinauto (<http://code.google.com/p/pywinauto>); last used version 0.40. py2exe (<http://www.py2exe.org>); last used version 0.6.9.

All of the installation executables are available in the src directory, so that users at sea do not need to download them.

One small modification was necessary to the pywinauto sources in order to make compilation with py2exe possible. The developer must edit Lib\site-packages\pywinauto\tests__init__.py (relative to the directory of the Python installation, C:\Python27 by default) to remove the call to `__init__tests()` right at the bottom of the file.

Once this setup is done, AutoSBE may be recompiled by opening a command terminal (cmd.exe), navigating to the autosbe\src directory, and executing

```
python setup.py py2exe
```

This compiles the Python scripts (run_seaterm*.py) into executables, and bundles all of their dependencies (the Python interpreter, pywinauto, etc.). The output of py2exe may be found in the autosbe\src\dist directory. Once the developer is happy with the changes made to the Python scripts, these compiled executables can be copied from autosbe\src\dist into the autosbe directory to overwrite the old version.

11 Mooring Instrumentation and Data Processing

11.1 MicroCATs

Stuart Cunningham

A total of 78 Sea-Bird SMP-37/IMP-37 MicroCAT CTDs were recovered from 11 moorings. The two instrument types (SMP/IMP) differ in their communication modes for programming and data retrieval being serial and inductive respectively. These are pumped CTDs with a temperature specification (initial accuracy: stability: resolution) of 2mC: 0.02mC/month: 0.01mC; conductivity specification 0.003mS/c: 0.003mS/cm/month: - 0.0001mS/cm and; Pressure specification of 0.1% full-scale:0.05% of full scale range per year:0.002% of full scale range. The CTD instruments are fitted with one of three types of pressure sensor: Druck; Paine and; Kistler. The pressure sensors differ in their characteristics and the order of quality is Kistler, Druck and Paine, where the Paine is close to the specification above but typically has worse stability than quoted. The full scale for pressure is also different for the three pressure sensors but is around 7000 dbar.

Each instrument on recovery is downloaded using Sea-Bird Seaterm software appropriate to the firmware version of the SMPs. The IMPs are downloaded in HEX using our own software that allows multiple downloading of IMP instruments and is considerably quicker than the Sea-Bird software: the HEX files are subsequently converted to ascii format.

Subsequent to data download the instruments are then prepared for calibration. Calibration consists of lowering the instruments with the shipboard CTD. A comparison is then made between the microCATs and the shipboard CTD, using data from five minute stops on the CTD upcast, made at 12 depths throughout the water column. This provides a post mooring deployment calibration of each MicroCAT CTD sensor. The same calibration procedure is adopted for instruments to be deployed. By this method we obtain in situ pre and post deployment calibrations that can correct for sensor drift during their (typically) year long deployment. The pre deployment calibration also serves as a function test of the instrument. During the cruise 156 microCATs were lowered on 13 CTD casts.

For mooring deployments the microCATs sample once every 30 minutes and for calibration cast once every 10 seconds (their highest sampling rate).

Raw ascii microCAT data are collected together on a linux workstation for subsequent processing. Processing

The RAPID-MOC/MOCHA project uses instruments from a number of different manufacturers and measurements utilised by three science teams within the project. At the outset we adopted a common data format, to which we ensure all instrument data conform. The format is ascii and is referred to as RODB and the processing software is MATLAB. The programmes utilised are (briefly):

- `mc_call_2_jc064.m` : Performs stage 1 processing, converting microCAT raw ascii data to the common RODB format.
- `microcat_raw2use_003.m` : Performs stage 2 processing, eliminating data at mooring launch and recovery; interpolates data gaps; saves file; creates diagnostic plots.

- `mc_call_caldip_jc064.m` : Plots all microCAT data from one CTD cast with the CTD data. Used during the cruise for a function check of the micoCATS, and a qualitative assessment of sensor performance and post cruise provides quantified calibration information.

11.2 Bottom Pressure Recorders

Patrick Farrell

RAPID uses the Sea-Bird SBE26 Seagauge and/or the Sea-Bird SBE53 BPR to measure bottom pressure. They are mounted to frames that hold the anchor and the acoustic releases. Some moorings have two devices, while others have only one. No modifications were made to any of the file structures, formats or processing of the BPR records on this cruise. The following is based on the BPR processing documentation in the D344 cruise report, and uses `EBH4L1_1_200927` as an example.

11.2.1 Stage 0

Raw instrument data are downloaded from the BPR using Sea-Bird's software and saved as `.hex` files. These are converted to `.tid` files using the same software. After downloading, the files are transferred to the seagauge directory in `raw/(cruise)/` under filenames based on the serial number of the instrument recovered.

11.2.2 Stage 1

Stage 1 processing takes the ASCII `.tid` file, reads the `info.dat` file containing information about the mooring location, start and end times, and outputs the bottom pressure data to RODB format. The units are converted from psi to dbar. If there has been a clock offset recorded, then this is applied at this point. The code is found in the `stage1` executable directory:

- `seagauge2rdb_003.m`, which produces RODB output saved in the `proc/(mooring)/seagauge/` with filenames e.g. `ebh4l1_1_200927_00040.raw`

A `stage1.log` file is created that records the options chosen by the processing operator. If the data has been wrapped, this may be fixed at this point; this did not prove necessary on JC064. A postscript graph is created of the raw data.

11.2.3 Stage 2

Stage 2 processing takes the `.raw` file and trims off the deployment and recovery sections and calculates some basic statistics. Additionally, the routine applies an exponential-linear drift removal to the data to remove the effect of sensor drift. The two programmes are found in the `stage 2` executable directory:

- `seagauge_processing_003.m`
- `purge_bp_003.m`, which calculates the exponential-linear fit.

The output file is a `.use` file located in the `moor/proc/seagauge` directory, e.g. `ebh4l1_1_200927_0040.use`. Two postscript graphs are created of the processed data.

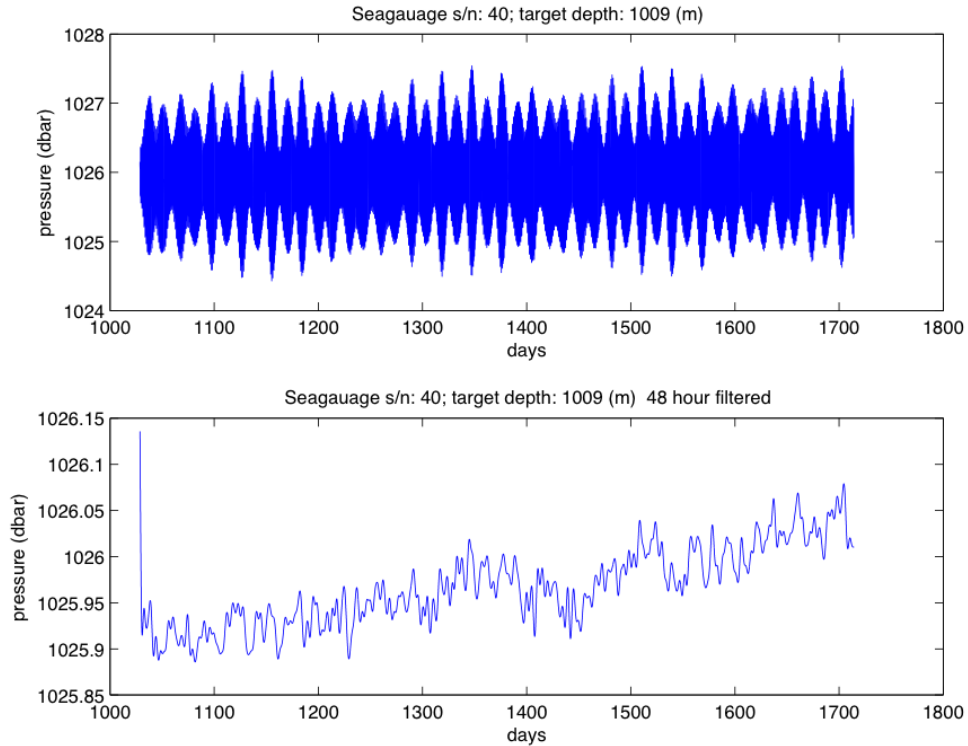


Figure 25: Output of Stage 1

11.2.4 Stage 3

The data is two-day low-pass filtered, and interpolated onto a 12 hour grid. A fit for removing fortnightly and monthly tides is calculated. The script is found in the stage 3 executable directory:

- `bpr_stage3_2011_09_12.m`
- `bottom_pressure_grid3.m`, performs most of the heavy lifting.

11.2.5 Problems

- One of the BPRs on EB1L6_6_200936 (s/n 0392) suffered from battery failure and recorded no data.
- One of the BPRs on MAR1L5_5_200941 (s/n 0420) suffered from flooding. Some data were recovered from the device, but on inspection proved to be not physically meaningful. We hypothesise that a small leak led the device to record incorrect measurements, before the leak grew and flooded the device.

11.3 PIES Processing

Patrick Farrell

One PIES (Pressure and Inverted Echo Sounder) device was recovered on JC064, EBP1_2_200832 (s/n 136). The processing of the PIES data to yield bottom pressure measurements followed the description by Zoltan Szuts in the cruise report of D334.

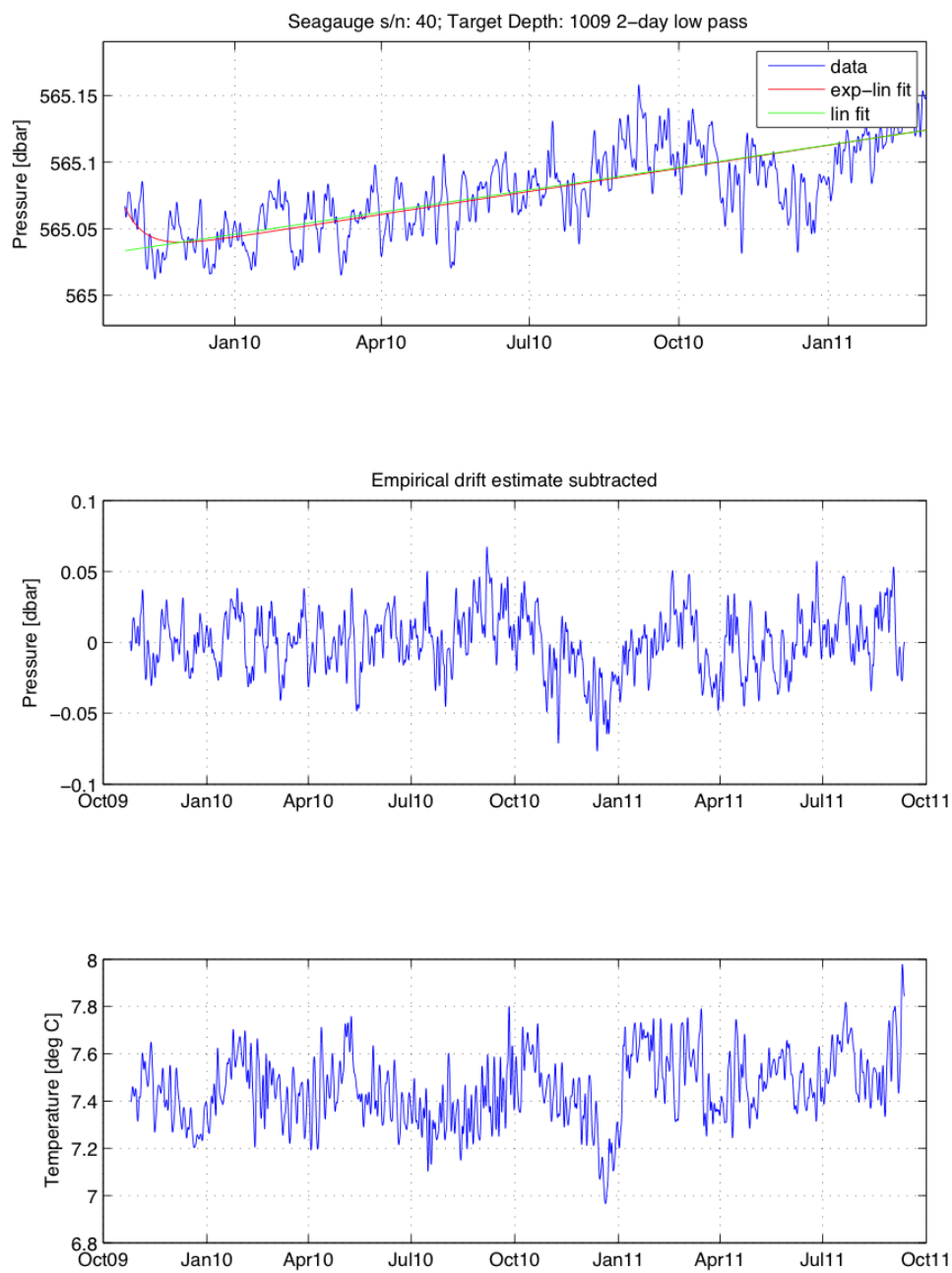


Figure 26: Output of Stage 2

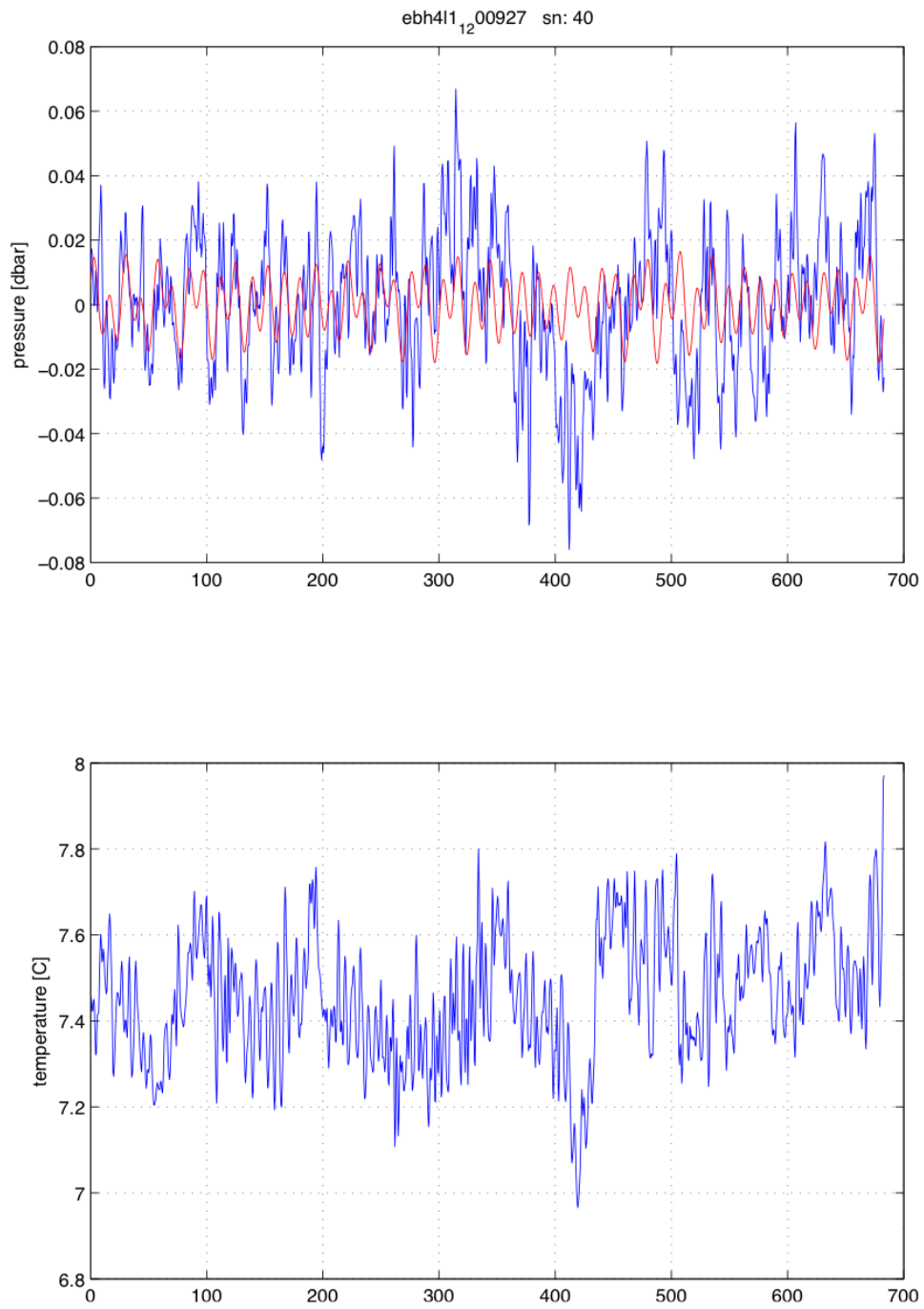


Figure 27: Output of Stage 3.

11.3.1 Stage 0

Stage 0 consists of transferring the raw data from the memory card of the PIES device to the raw cruise directory. The raw data consists of three .DAT files: T136_1.DAT (containing the temperature record), P136_1.DAT (containing the pressure record) and E136_1.DAT (containing engineering data).

11.3.2 Stage 1

Stage 1 processing consists of reading the raw ASCII files and converting it to RODB format. The script is found in stage 1 cruise executable directory:

- pies2rodb.m

11.3.3 Stage 2

Stage 2 processing consists of smoothing the travel time data by calculating hourly medians of each of the transmission channels, and processing the bottom pressure record to correct for exponential-linear drift. The script is found in the stage 2 cruise directory:

- bpr_processing/pies_processing_002.m

Due to the complexity of the further analysis of the travel time data (cruise report D344), this was not conducted.

11.4 Current Meters

Gerard McCarthy

Three different types of current meters were processed on this cruise: RCM11, S4 and Sontek Argonaut. Three Sontek instruments were recovered from EBH5 (950m), EB1 (1500m) and MAR1 (1500m). Six RCM11 instruments were recovered from many of the eastern boundary moorings, where they had been deployed near to the base of the moorings. Five S4 instruments were recovered primarily from MAR moorings, where again they had been deployed near the base of the moorings. These current meter deployments on the eastern boundary and mid-Atlantic, ridge in regions not renowned for strong currents, offer a useful database of reference currents for hydrographic currents including, for example, Argo velocity estimates.

11.4.1 Sontek Argonaut Processing

The Argonaut data were downloaded and then converted to an ASCII file format. This data file was stored in the mooring raw data folder under jc064/arg/. Stage 1 processing was undertaken with the argocat2rodb_004 script, which was modified for pathnames and cruise names specific to JC064.

As Argonaut files are non-conventional, a file linking the serial number of the Argonaut with the data file is created in the same directory as the data file. This file is called mooring_filenames.txt, where mooring refers to the full mooring name, for example ebh3.6_201109. Stage 2 processing was undertaken with the script argocat_raw2use_003, which again was edited for JC064. This converts the raw RODB data to useable RODB

data, chopping off the period of the mooring during deployment and recovery. The parameters for chopping off were set during the microCAT processing and were not amended specifically for the current meters. This script also plots the two-day low pass filtered data.

11.4.2 RCM11 Processing

The RCM11 data were downloaded and then converted to an ASCII file format. This data file was stored in the mooring raw data folder under jc064/rcm/ as nnn.asc where nnn is the serial number of the instrument. Stage 1 processing was undertaken with the rcm2rodb_05 script, which was modified for pathnames and cruise names specific to JC064. This script read the raw ASCII to RODB format, producing figures of the currents and offers the opportunity to correct for wrapped conductivity. This was not performed on JC064. Stage 2 processing was undertaken with the script rcm11raw2use, which eliminates the launching and recovery periods and saves the data in .use format.

11.4.3 S4 Processing

Two S4 instruments, 35612577 and 35612574 failed to record any data. It is believed that they had not been set up to log correctly.

The S4 data were downloaded in ASCII file format. This data file was stored in mooring raw data folder under jc064/s4/ as nnnnnnnn_data.asc where nnnnnnnn is the serial number of the instrument. Stage 1 processing was undertaken with the s42rodb_v5_scr which calls the function s42rodb_v5. These were modified for pathnames and cruise names specific to JC064. This script read the raw ASCII to RODB format, producing figures of the currents, temperature, conductivity, pressure and instrument heading. Stage 2 processing was undertaken with the s4raw2use_v2_script_version, which calls the s4raw2use_v2 function. This produces two-day low pass filtered versions of the raw figures.

Argo float No.	Date	Deployment Time	Lat	Lon
4861	9/28/11	1038	26.1124	-45.0678
4862	9/29/11	1100	26.4146	-40.486
3908	9/30/11	955	26.5682	-36.2506
3907	10/1/11	956	26.7134	-31.9094
4860	10/2/11	1008	26.96	-27.765
4863	10/3/11	1003	27.0151	-23.312
4864	10/4/11	852	27.1525	-19.2581

Table 11: Argo deployments

12 Apex Argo Float Deployments

Patrick Farrell

Argo is an array of around 3,000 profiling floats that provide observations from the global oceans with an average spacing of around three degrees in latitude and longitude (approximately 300 km). Since 2000 the Argo programme, which involves more than 30 countries, has deployed more than 6,000 floats into the ice-free deep oceans around the world. The floats measure ocean temperature, salinity (dissolved salt content) and pressure (depth) between the surface and 2,000 metres depth.

As part of the UK's commitment to the Argo programme, 8 Apex Argo floats were deployed on JC064. Before deployment, each float was connected to a computer using the supplied communication cables, and the recommended pre-deployment tests run. These checks include testing the satellite transmission, the high pressure pump, the battery voltage and internal vacuum, the pneumatic system, and the CTD sensor. Each float was activated via the terminal connection, rather than the magnetic reset. As expected, the 6 beeps 8 seconds apart were followed by inflation of the bladder and subsequent periodic satellite transmissions.

After deployment, confirmation emails were sent to the relevant project handlers at the BODC, Met Office and National Oceanography Centre. The Met Office confirmed that floats 4861, 4862, 3908, 4860 and 4863 were communicating successfully. However, while test messages were heard from 3907, no communication was received subsequently: the Met Office speculate that its 'deep profile first' programming was at fault and that it should report on 2011-10-11.

13 SeaGlider Bellatrix Recovery

Gerard McCarthy

Following a highly successful first deployment, the SeaGlider Bellatrix was recovered from the James Cook on the 5th October. The glider had been providing data for over three months and almost 600 dives from a region of the ocean between the Canary Islands and Morocco. These data are used as a virtual mooring to supplement the data of the RAPID project. It was the first time that NOC had undertaken a deployment of this type of glider.



Figure 28: Recovery of SeaGlider Bellatrix. Pictured are, from left to right, Phil Allison (Bosun's Mate), Gerard McCarthy (NOC Scientist) and Vanessa Laidlow (3rd Officer)

The captain and crew were professional and enthusiastic in the undertaking of this unexpected operation. In good weather, the ship's boat was launched. 3rd Officer, Vanessa Laidlow, undertook the piloting. Bosun's Mate, Phil Allison and scientist, Gerard McCarthy undertook the recovery (Figure 28). Due to the unexpected nature of the operation, no specific equipment was available for the operation. The glider's aerial was damaged in the recovery; this would likely have been avoided had recovery equipment been available on the ship. In spite of this, the recovery was a success and the glider was functional on recovery.

The RAPID project has undertaken seven glider deployments in this area since 2008, totaling a full year's worth of data.

Appendices

A Details of Sea-Bird SBE 911plus CTD

Instrument configuration file: C:\Program Files\Sea-Bird\SeasaveV7\JC064\JC064_NMEA.xmlcon
Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed:	0
Voltage words suppressed:	0
Computer interface:	RS-232C
Scans to average:	1
NMEA position data added:	Yes
NMEA depth data added:	No
NMEA time added:	No
NMEA device connected to:	deck unit
Surface PAR voltage added:	No
Scan time added:	No

1. Frequency 0, Temperature

Serial number :	03P-2674
Calibrated on :	13 April 2011
G :	4.35675162e-003
H :	6.42193937e-004
I :	2.34494364e-005
J :	2.29940020e-006
F0 :	1000.000
Slope :	1.00000000
Offset :	0.0000

2. Frequency 1, Conductivity

Serial number :	04C-2231
Calibrated on :	12 April 2011
G :	-1.07697431e+001
H :	1.69453083e+000
I :	-2.49118239e-003
J :	2.97276980e-004
CTcor :	3.2500e-006
CPcor :	-9.57000000e-008
Slope :	1.00000000
Offset :	0.00000

3. Frequency 2, Pressure, Digiquartz with TC

Serial number : 110557
 Calibrated on : 26 April 2009
 C1 : -6.010548e+004
 C2 : -1.565601e+000
 C3 : 1.823090e-002
 D1 : 2.668300e-002
 D2 : 0.000000e+000
 T1 : 3.020528e+001
 T2 : -6.718318e-004
 T3 : 4.457980e-006
 T4 : 1.203850e-009
 T5 : 0.000000e+000
 Slope : 0.99994000
 Offset : -1.08250
 AD590M : 1.280700e-002
 AD590B : -9.299644e+000

4. Frequency 3, Temperature, 2

Serial number : 03P-4872
 Calibrated on : 19 April 2011
 G : 4.34380421e-003
 H : 6.38106056e-004
 I : 2.07199354e-005
 J : 1.68084099e-006
 F0 : 1000.000
 Slope : 1.00000000
 Offset : 0.0000

5. Frequency 4, Conductivity, 2

Serial number : 04C-3258
 Calibrated on : 12 April 2011
 G : -1.06523753e+001
 H : 1.35929693e+000
 I : 4.08972236e-004
 J : 4.40882550e-005
 CTcor : 3.2500e-006
 CPcor : -9.57000000e-008
 Slope : 1.00000000
 Offset : 0.00000

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

Serial number : 43-0363
Calibrated on : 26 January 2011
Equation : Sea-Bird
Soc : 3.51500e-001
Offset : -6.48800e-001
A : -8.26610e-004
B : 1.10740e-004
C : -2.48860e-006
E : 3.60000e-002
Tau20 : 1.12000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7. A/D voltage 1, Free

8. A/D voltage 2, Altimeter

Serial number : 41302
Calibrated on : 20 April 2007
Scale factor : 15.000
Offset : 0.000

9. A/D voltage 3, Free

10. A/D voltage 4, Free

11. A/D voltage 5, Free

12. A/D voltage 6, Free

13. A/D voltage 7, Free

Scan length : 37

B Instrument Record Lengths

Inst	s/n	Start	End	Mean press (dbar)
ebh4l1_1_200927	40	25/10/2009	11/09/2011	1026
ebh4.8_201108	4719	12/01/2011	11/09/2011	337
	4717	12/01/2011	11/09/2011	404.3
	4720	12/01/2011	11/09/2011	505.6
	4721	12/01/2011	11/09/2011	612.3
	6824	12/01/2011	11/09/2011	705.5
	6825	12/01/2011	11/09/2011	811
ebh5.6_201109	6826	12/01/2011	11/09/2011	108.3
	6827	12/01/2011	11/09/2011	174.6
	3282	12/01/2011	11/09/2011	251
ebh3.7_201107	4708	11/01/2011	12/09/2011	893
	4709	11/01/2011	12/09/2011	1000.6
	5782	11/01/2011	12/09/2011	1112.8
	4711	11/01/2011	12/09/2011	1215.7
	4715	11/01/2011	12/09/2011	1427.6
ebh2.7_201112	4473	11/01/2011	12/09/2011	1608.3
	5775	11/01/2011	12/09/2011	1818.8
	4475	11/01/2011	12/09/2011	2037.7
ebh1.7_201106	5787	10/01/2011	13/09/2011	2509.3
	5786	10/01/2011	13/09/2011	3056.3
ebh1l6_6_200933	395	26/10/2009	13/09/2011	3057.7
ebhi_7_201104	5783	08/01/2011	15/09/2011	3484.4
	5784	08/01/2011	15/09/2011	4040.1
	5785	08/01/2011	15/09/2011	4578.7
ebp1.2_200832	136	15/11/2008	16/09/2011	5200.101
eb1l6_6_200936	419	29/10/2009	17/09/2011	5200.5
eb1_9_201103	5240	07/01/2011	16/09/2011	24.5
	5241	07/01/2011	16/09/2011	76.3
	5762	07/01/2011	16/09/2011	146.3
	5763	07/01/2011	16/09/2011	227.8
	5766	07/01/2011	16/09/2011	302.7
	5767	07/01/2011	16/09/2011	378.1
	5768	07/01/2011	16/09/2011	582.7
	5770	07/01/2011	16/09/2011	778.1
	5771	07/01/2011	16/09/2011	982.1
	5773	07/01/2011	16/09/2011	1186.3
	5774	07/01/2011	16/09/2011	1590
	4474	07/01/2011	16/09/2011	2000.2
	5776	07/01/2011	16/09/2011	2511.1
	5778	07/01/2011	16/09/2011	3029.3
	5779	07/01/2011	16/09/2011	3559.7
	5780	07/01/2011	16/09/2011	4080.2

	5781	07/01/2011	16/09/2011	4598.5
	4710	07/01/2011	16/09/2011	5090.5
mar3l5_5_201031	13	03/11/2009	23/09/2011	5149.9
	38	03/11/2009	23/09/2011	5149
mar3_7_201032	6125	31/12/2010	21/09/2011	2498.7
	3933	31/12/2010	21/09/2011	3047.2
	6333	31/12/2010	21/09/2011	3558.5
	6332	31/12/2010	21/09/2011	4048
	4472	31/12/2010	21/09/2011	4602
	7363	31/12/2010	21/09/2011	5119.5
mar1_7_201028	6331	27/12/2010	24/09/2011	59.1
	3902	27/12/2010	24/09/2011	109.6
	4068	27/12/2010	24/09/2011	198.5
	6121	27/12/2010	24/09/2011	269.6
	6129	27/12/2010	24/09/2011	343.4
	4722	27/12/2010	24/09/2011	427.2
	4071	27/12/2010	24/09/2011	631.1
	6122	27/12/2010	24/09/2011	806
	4072	27/12/2010	24/09/2011	1024
	6828	27/12/2010	24/09/2011	1231.7
	7468	27/12/2010	24/09/2011	1832.7
	6123	27/12/2010	24/09/2011	2043.2
	6124	27/12/2010	24/09/2011	3076.6
	4180	27/12/2010	24/09/2011	3560.8
	6327	27/12/2010	24/09/2011	4081
	4305	27/12/2010	24/09/2011	4630.6
	6126	27/12/2010	24/09/2011	5129.9
mar1l5_5_200941	393	06/11/2009	27/06/2011	5333.1
	420	06/11/2009	27/06/2011	5215.6
mar2_7_201030	4070	28/12/2010	24/09/2011	1082.2
	4468	28/12/2010	24/09/2011	1388.8
	3934	28/12/2010	24/09/2011	1583.8
	6137	28/12/2010	24/09/2011	1803.1
	6320	28/12/2010	24/09/2011	2269.2
	6322	28/12/2010	24/09/2011	2777.4
	4470	28/12/2010	24/09/2011	3303.8
	6323	28/12/2010	24/09/2011	3808.4
	6325	28/12/2010	24/09/2011	4331.1
	6326	28/12/2010	24/09/2011	4853.1
	4471	28/12/2010	24/09/2011	5281.8
mar0_4_201029	4306	27/12/2010	26/09/2011	5254.6
	6127	27/12/2010	26/09/2011	5378.6
	4307	27/12/2010	26/09/2011	5542.6
	6128	27/12/2010	26/09/2011	5654.9

C Lost or Damaged Instruments and Hardware

Serial number	Instrument	Problem
919	AR861	Dropped during deployment, internal damage.
911	AR861	Dropped during deployment, internal damage.
821	AR861	Corrosion.
258	AR861	Not working at depth.
223	RT661	Not working at depth.
35612577	S4 current meter	no data, possibly not set up correctly.
642	RCM11 NMEP	no data, suspect electronics.
6826	SBE37	conductivity reads low by 0.01
5246	SBE37	pressure sensor reads 30db low
5766	SBE37	data record time base has jumps
6118	SBE37	bad pump
6116	SBE37	pressure sensor reads 30db low
3913	SBE37	bad pump
6819	SBE37	pressure overreads by 300 db
5784	SBE37	pressure overreads by 30 db
6331	SBE37	battery died on up cast needs cal lab
4178	SBE37	did not record data
4466	SBE37	battery shorted
6803	SBE37	flooded
3918	SBE37	flooded
3890	SBE37	bad conductivity reads high 0.06
3229	SBE37	bad pump
5246	SBE37	Bad pressure
0392	BPR	no data
0420	BPR	flooded
	glass spheres	3 implosions
	Billings floats	1 implosion

D Mooring deployment table and Acoustic Releases

Mooring	Sequential mooring number	UKORS Mooring number	Lat (°N)	Lon (°W)	U/C depth (m)	Corr depth (m)	Date	Time (GMT)	Rel. 1	Rel. 2
EBH4	9	2011/29	27°51.01'	13°32.45'	1058	1062	11/09/2011	13:05:55	264	906
EBH5	7	2011/31	27°49.65'	13°33.22'	1057	1061	11/09/2011	15:23:00	249	256
EBH3	8	2011/38	27°48.30'	13°44.81'	1419	1421	12/09/2011	13:31:39	908	925
EBH2	8	2011/27	27°36.88'	14°12.65'	from swath	2022	12/09/2011	18:41:14	1242	927
EBH1*		1st deploy- ment	27°16.73'	15°24.65'	2985	2988	13/09/2011	09:04:31	1200	827
EBH1L8*		1st deploy- ment	27°16.48'	15°24.61'	2954	2957	13/09/2011	12:31:00	282	354
EBHi	8	2011/32	24°55.98'	21°16.39'	from swath	4505	15/09/2011	10:34:47	819	923
EB1	10	2011/22	23°45.46'	24°9.31'	5049	5096	17/09/2011	12:58:30	1203	1197
EB1L8	8	2011/23	23°47.47'	24°6.80'	from swath	5088	17/09/2011	16:33:26	930	253
MAR3	8	2011/37	23°48.42'	41°5.90'	5019	5061	21/09/2011	14:43:35	917	322
MAR3L7	7	2011/38	23°51.90'	41°5.64'	5013	5054	22/09/2011	09:25:00	1198	262
NOGST			23°46.26'	41°5.93'	4226	4247	22/09/2011	12:04:44	822	
MAR1	8	2011/34	24°10.08'	49°44.81'	5165	5215	25/09/2011	15:54:09	920	316
MAR2	8	2011/36	24°11.10'	49°45.39'	5166	5216	25/09/2011	19:37:01	1194	928
MAR1L7	7	2011/35	24°11.57'	49°44.71'	5172	5222	25/09/2011	20:57:10	1202	921
MAR0	5	2011/33	25°6.28'	52°0.61'	from swath	5529	26/09/2011	23:24:10	826	1199
EBH1		2011/24	27°8.61'	15°22.66'	2994	2997	06/10/2011	16:58:29	1200	827
EBH1L8	8	2011/26	27°8.12'	15°21.85'	3002	3005	06/10/2011	18:36:54	282	354
EBH1L7	7	2011/25	27°8.34'	15°22.23'	2997	3000	06/10/2011	18:12:16	824	281
EBH4L3	3	2011/30	27°51.86'	13°30.85'	994	998	05/10/2011	19:10:07	922	926

* Moorings were recovered and redeployed in order to move further away from submarine cables.

E Mooring Recovery Table

Mooring Name	Sequential Mooring number	UKORS Mooring Number	Deployment Cruise	Lat (°N)	Lon (°W)	Deployment Date	Recovery Date
EBH4L1 (EBL5)	1	2009/27	D344	27°52.09'	13°30.87'	10/25/09	9/11/11
EBH4	8	2011/08	D359	27°50.99'	13°32.46'	1/12/11	9/11/11
EBH5	6	2011/09	D359	27°50.56'	13°32.66'	1/12/11	9/11/11
EBH3	7	2011/07	D359	27°48.47'	13°44.80'	1/11/11	9/12/11
EBH2	7	2011/12	D359	27°36.88'	14°12.66'	1/11/11	9/12/11
EBH1	7	2011/06	D359	27°16.89'	15°24.98'	1/10/11	9/13/11
EBH1L6 (EBL4)	6	2009/33	D344	27°17.17'	15°25.76'	10/26/09	9/13/11
EBH1	7	2011/04	D359	24°56.39'	21°16.13'	1/8/11	9/15/11
EBP1	2	2008/32	D334	23°49.38'	24°05.99'	11/15/08	9/16/11
EB1L6 (EBL3)	6	2009/36	D344	23°48.77'	24°06.41'	10/29/09	9/16/11
EB1	9	2011/03	D359	23°45.54'	24°09.36'	1/7/11	9/16/11
MAR3L5 (MARL2)	5	2009/38	D344	23°51.95'	41°05.56'	11/3/09	8/21/11
Mar-03	7	2010/32	D359	23°51.41'	41°05.85'	12/31/10	9/21/11
NOGST		2011/01	D359	23°46.29'	41°05.90'	1/1/11	9/21/11
MAR1	7	2010/28	D359	24°10.11'	49°43.17'	12/26/10	9/25/11
MAR1L5 (MARL1)	5	2009/41	D344	24°12.02'	49°44.26'	11/6/09	9/25/11
MAR2	7	2010/30	D359	24°11.69'	49°44.99'	12/28/10	9/25/11
MAR0	4	2010/29	D359	25°06.45'	52°00.65'	12/27/10	9/26/11
EBH1		2011/XX	JC064	27°16.73'	15°24.65'	9/13/11	10/6/11
EBH1L8		2011/XX	JC064	27°16.48'	15°24.61'	9/13/11	10/6/11
EBH1L7	5	2011/05	D359	27°16.61'	15°24.94'	1/10/11	10/6/11

F Acoustic Release Summary

Serial No	Type	Previous location	Current location	NOTES	Serviced	New batts	Bench tested	Wire tested	Depth tested
249	AR861	NOC	EBH5		YES	YES	YES	YES	5150
256	AR861	NOC	EBH5		YES	YES	YES	YES	5150
264	AR861	NOC	EBH4		YES	YES	YES	YES	5150
906	AR861	NOC	EBH4		YES	YES	YES	YES	5150
925	AR861	NOC	EBH3		YES	YES	YES	YES	5150
908	AR861	NOC	EBH3		YES	YES	YES	YES	5150
1242	AR861	NOC	EBH2		YES	YES	YES	YES	5150
927	AR861	NOC	EBH2		YES	YES	YES	YES	5150
827	AR861	NOC	EBH1	FAILED	YES	YES	YES	YES	5150
1200	AR861	NOC	EBH1		YES	YES	YES	YES	5150
282	AR861	NOC	EBH1L8		YES	YES	YES	YES	5150
354	AR861	NOC	EBH1L8		YES	YES	YES	YES	5150
258	AR861	NOC	COOK	FAILED	YES	YES	YES	FAILED	5150
223	RT661	NOC	COOK	FAILED	YES	YES	YES	FAILED	5150
911	AR861	NOC	COOK	DAMAGED	YES	YES	YES		
919	AR861	NOC	COOK	DAMAGED	YES	YES	YES		
253	AR861	EBH3	EB1L8		YES	YES	YES	YES	5200
322	AR861	EBH1L6	Mar-03		YES	YES	YES	YES	5200
819	AR861	EBH2	EBH i		YES	YES	YES	YES	4500
821	AR861	EBH5	COOK	CORROSION					
917	AR861	EBH4L1	Mar-03		YES	YES	YES	YES	5200
923	AR861	EBH4	EBH i		YES	YES	YES	YES	4500
930	AR861	EBH1	EB1L8		YES	YES	YES	YES	5200
1197	AR861	EBH4	EB1		YES	YES	YES	YES	5200
1203	AR861	EBH5	EB1		YES	YES	YES	YES	5200
1198	AR861	EBH i	MAR3L7		YES	YES	YES	YES	5200

262	AR861	EB1L6	MAR3L7		YES	YES	YES	YES	YES	5200
316	AR861	EB1L6	Mar-01		YES	YES	YES	YES	YES	5200
318	AR861	Mar-00	COOK	RETURN						
1201	AR861	Mar-00	COOK	RETURN						
1194	AR861	Mar-01	Mar-02		YES	YES	YES	YES	YES	5200
1199	AR861	Mar-01	Mar-00		YES	YES	YES	YES	YES	5500
920	AR861	Mar-02	Mar-01		YES	YES	YES	YES	YES	5200
1202	AR861	Mar-03	MAR1L7		YES	YES	YES	YES	YES	5200
922	AR861	Mar-03	EBH4L3		YES	YES	YES	YES	YES	5500
370	AR861	MAR1L5	COOK	RETURN						
216	RT661	MAR1L5	COOK	RETURN						
928	AR861	MAR3L5	Mar-02		YES	YES	YES	YES	YES	5200
826	AR861	MAR3L5	Mar-00		YES	YES	YES	YES	YES	5500
921	AR861	EB1	MAR1L7		YES	YES	YES	YES	YES	5200
822	AR861	EB1	NOG		YES	YES	YES	YES	YES	5200
926	AR861	NOG	EBH4L3		YES	YES	YES	YES	YES	5500
824	AR861	EBH1L7	EBH1L7	MOVED						
281	AR861	EBH1L7	EBH1L7	MOVED						

G RAPID mooring and hydrographic cruises

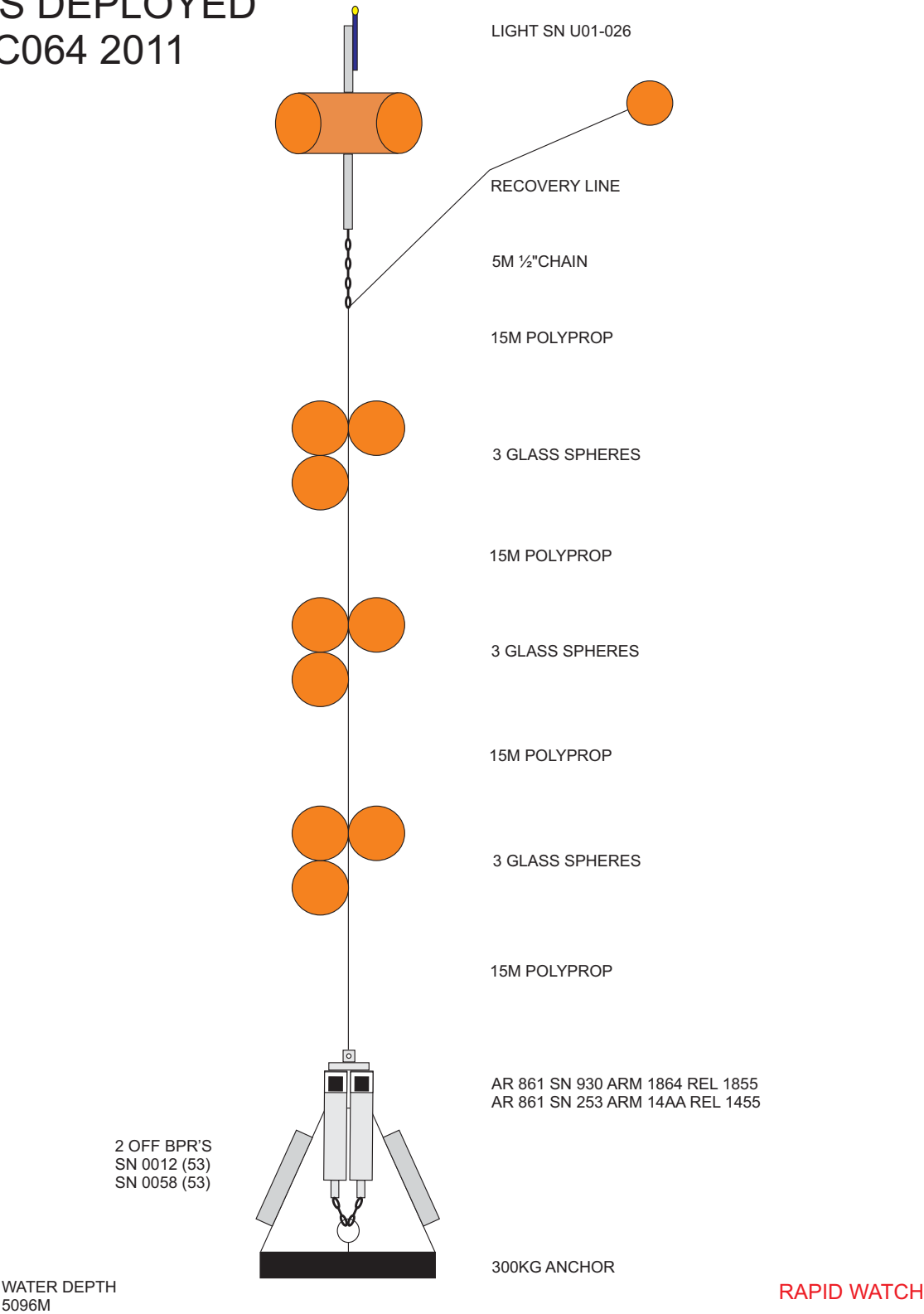
Cruise	Vessel	Date	Objectives	Cruise Report
D277	RRS Discovery	Feb - Mar 2004	Initial Deployment of Eastern Boundary and Mid-Atlantic Ridge moorings	RRS Discovery Cruise D277 and D278. Southampton Oceanography Centre Cruise Report, No 53, 2005
D278	RRS Discovery	Mar-04	Initial Deployment of UK and US 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

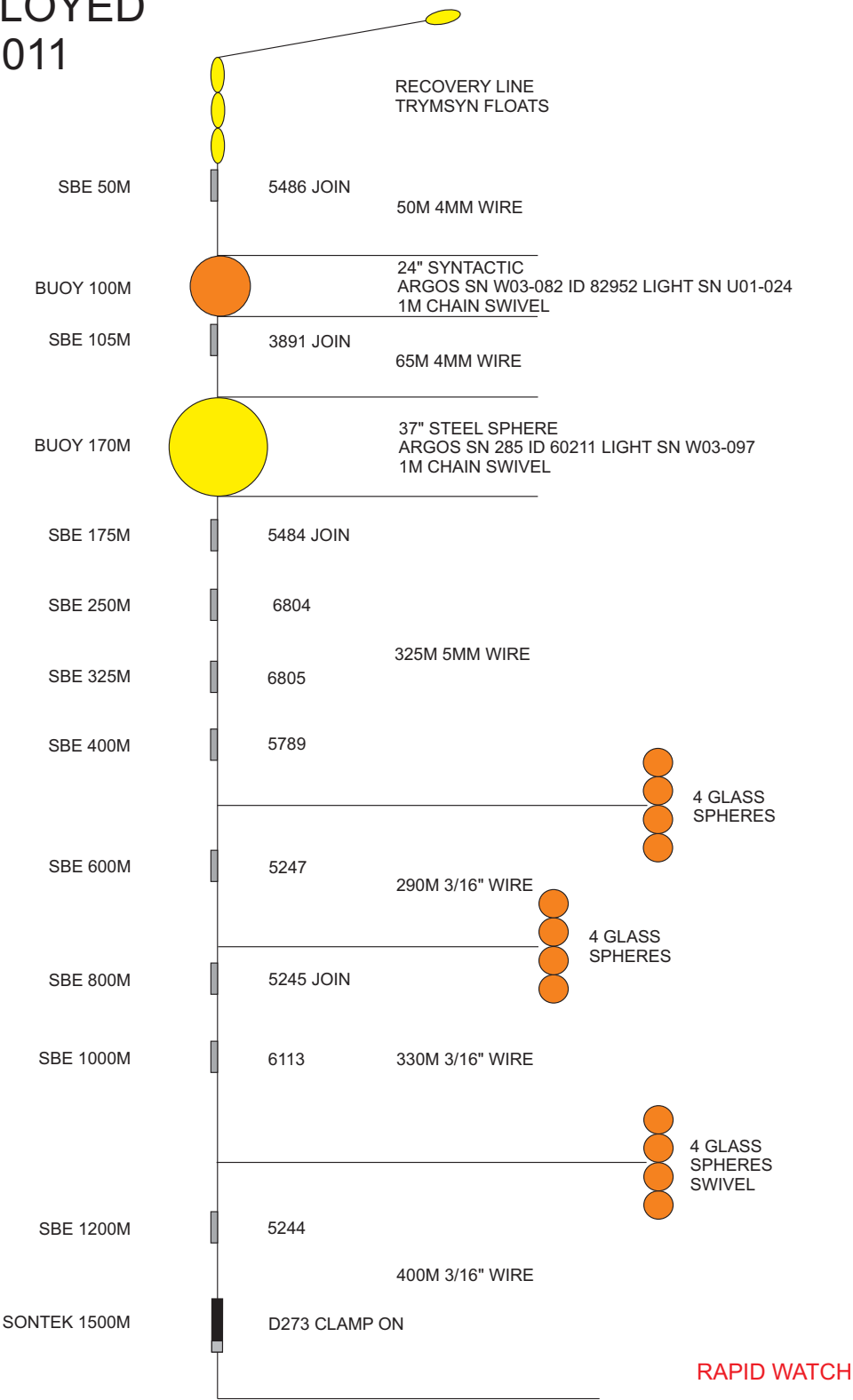
D344	RRS Discovery	Oct - Nov 2009	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings	RRS Discovery Cruise, D334, National Oceanography Centre, Southampton Cruise Report No. 51, 2010
D345	RRS Discovery	Nov - Dec 2009	Recovery and redeployment of US Western Boundary moorings, 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	This report
RB1201	RV Ronald H Brown	Feb-12	Recovery and redeployment of US Western Boundary moorings, and WBTS hydrography section	Cruise report pending

H Deployed Mooring Diagrams

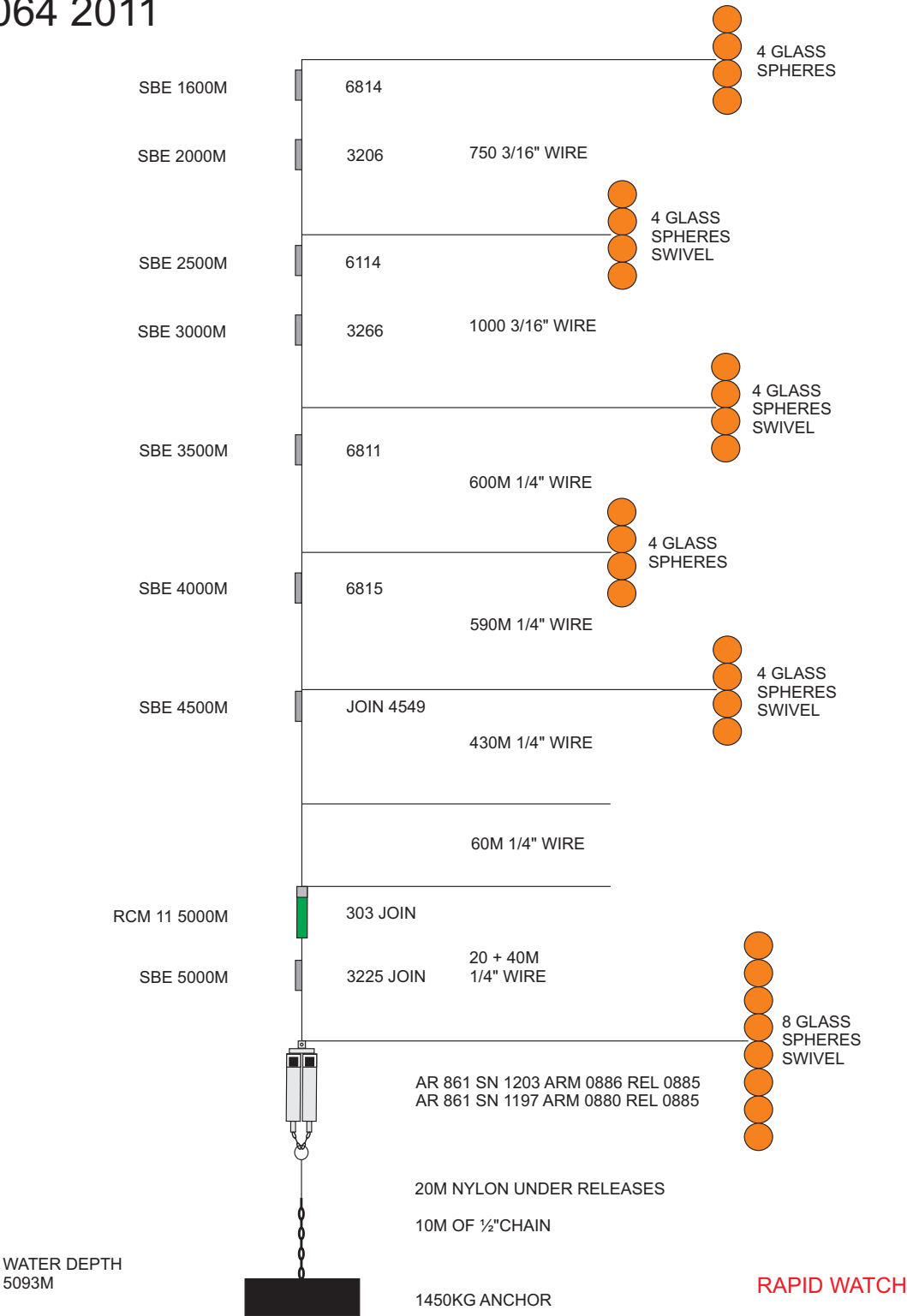
EB1L8
AS DEPLOYED
JC064 2011



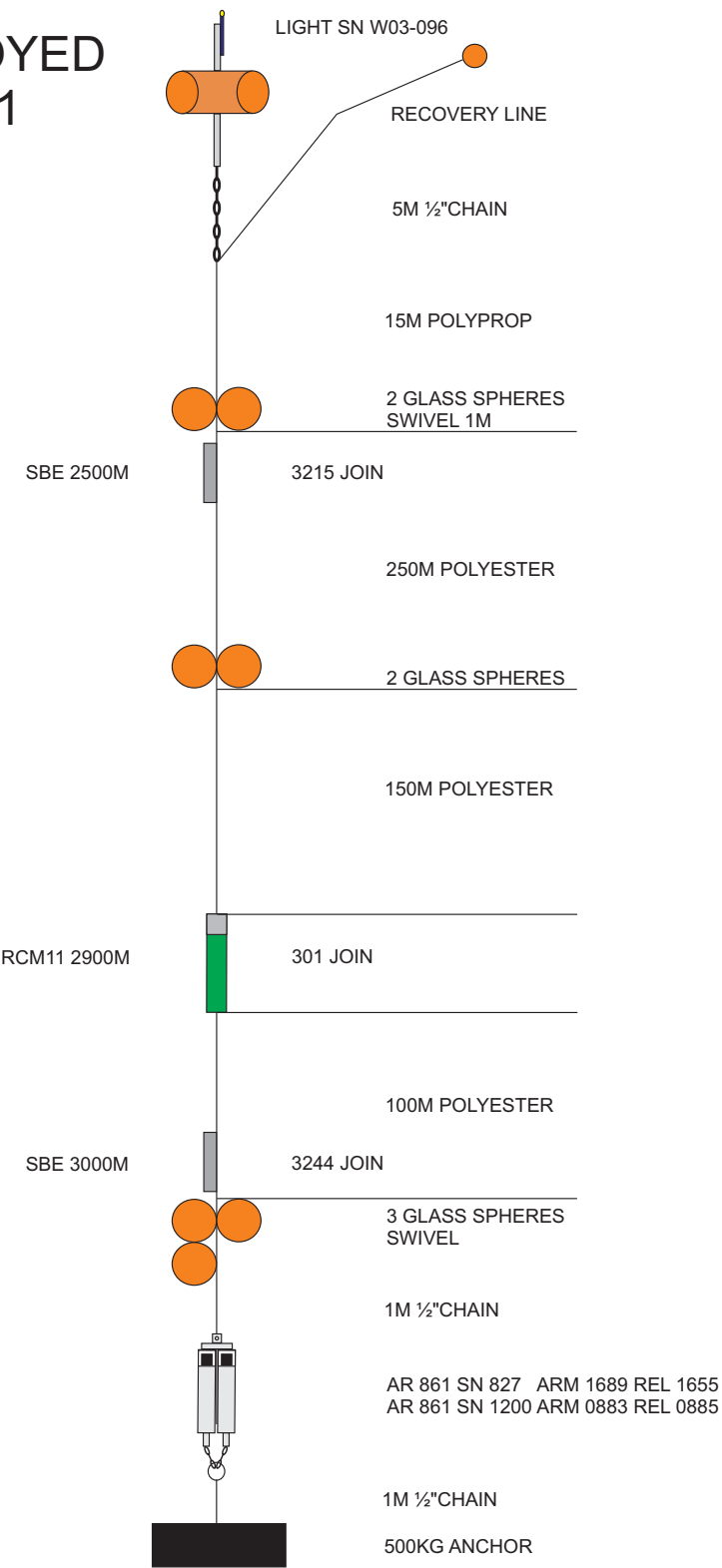
EB 1
AS DEPLOYED
JC064 2011



EB 1
AS DEPLOYED
JC064 2011



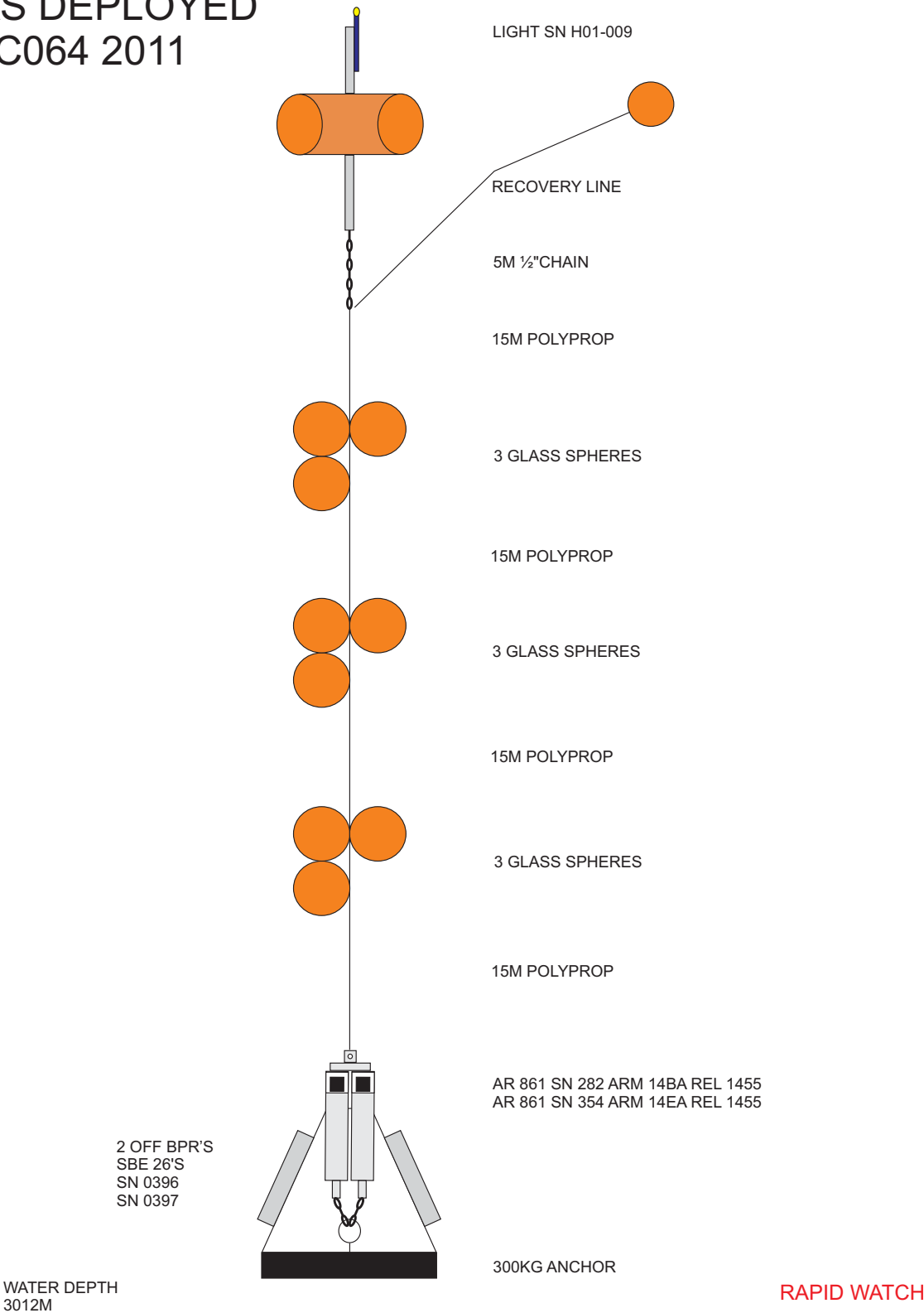
EBH1
AS DEPLOYED
JC064 2011



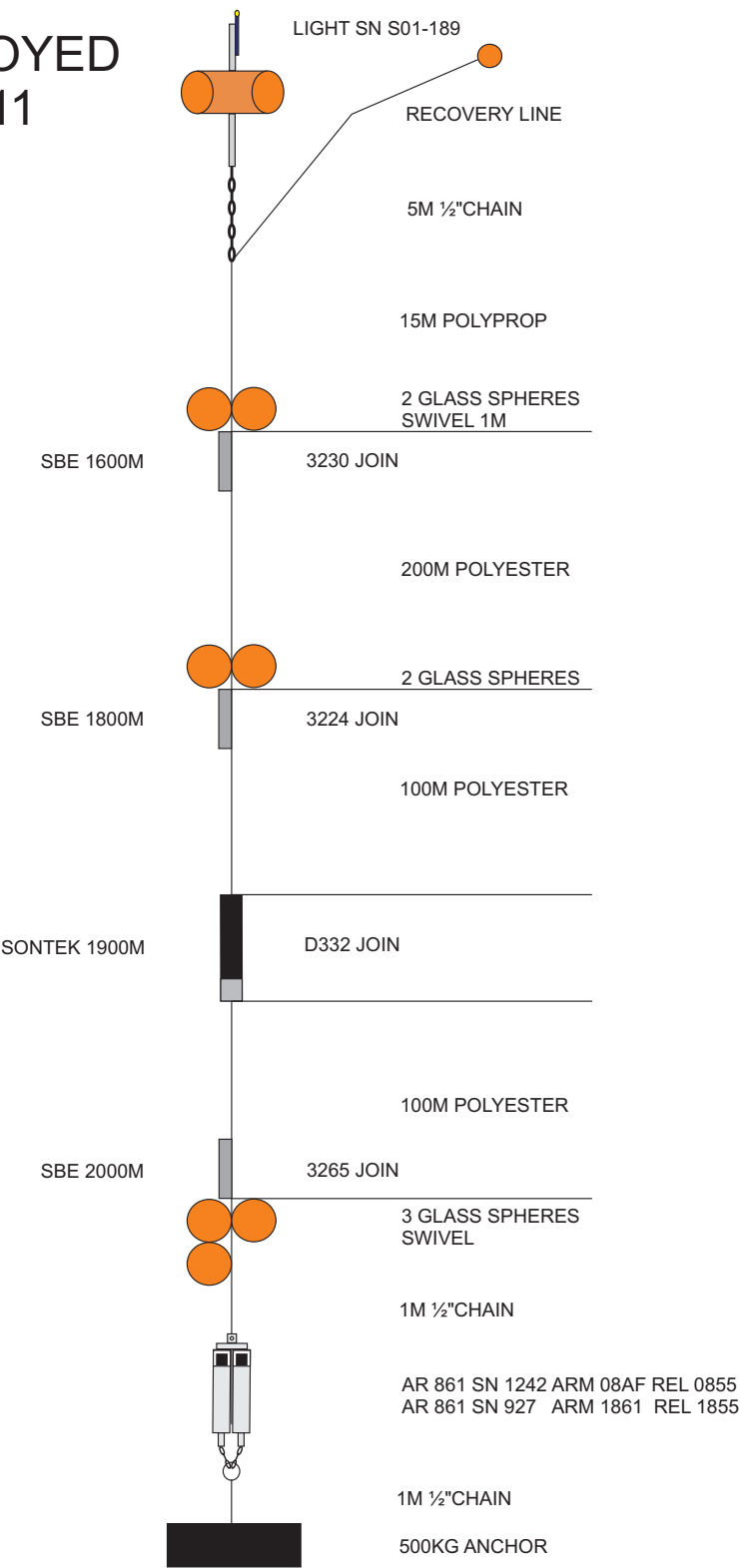
WATER DEPTH
3012M CORR

RAPID WATCH

EBH1L8
AS DEPLOYED
JC064 2011



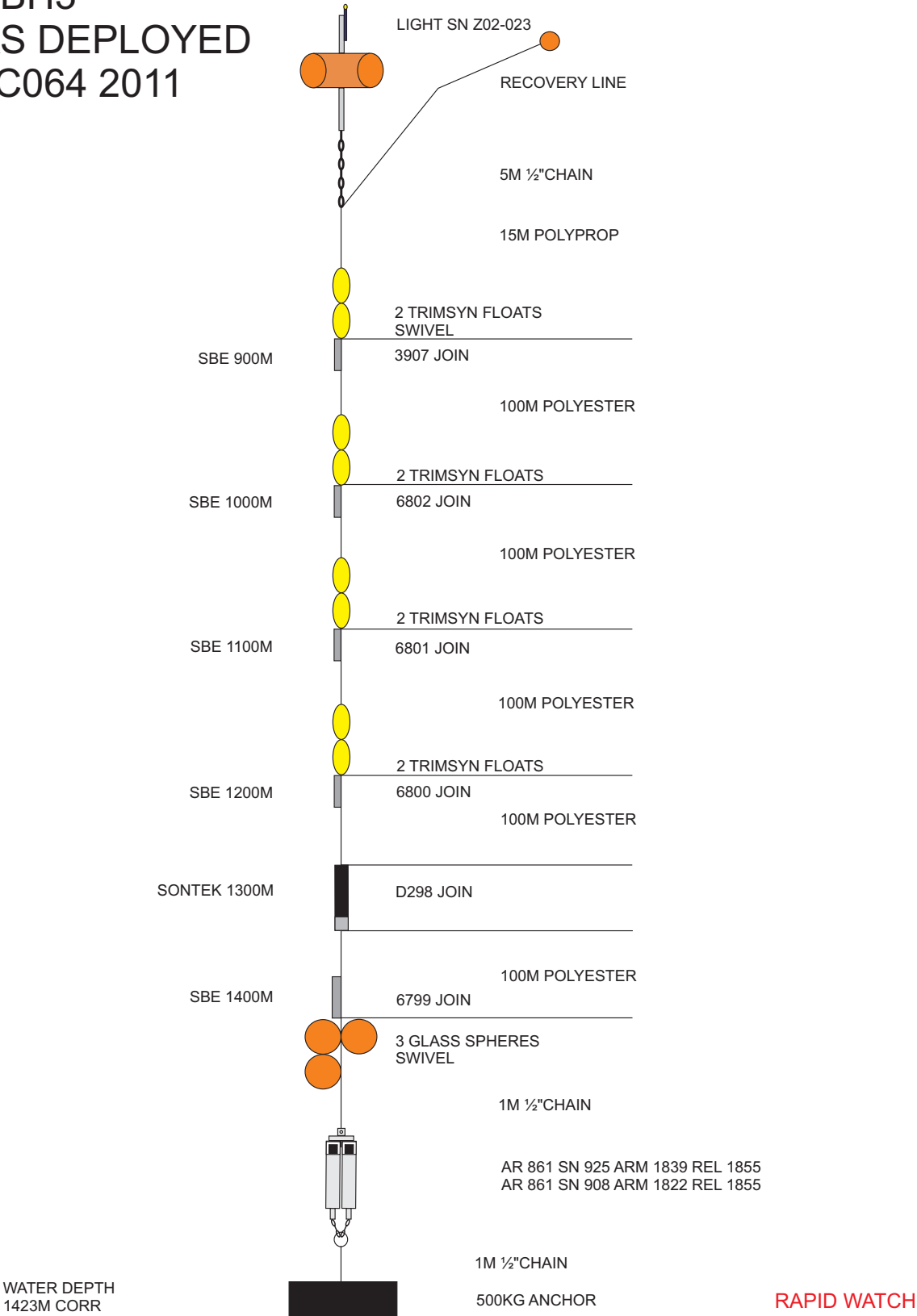
EBH2
AS DEPLOYED
JC064 2011



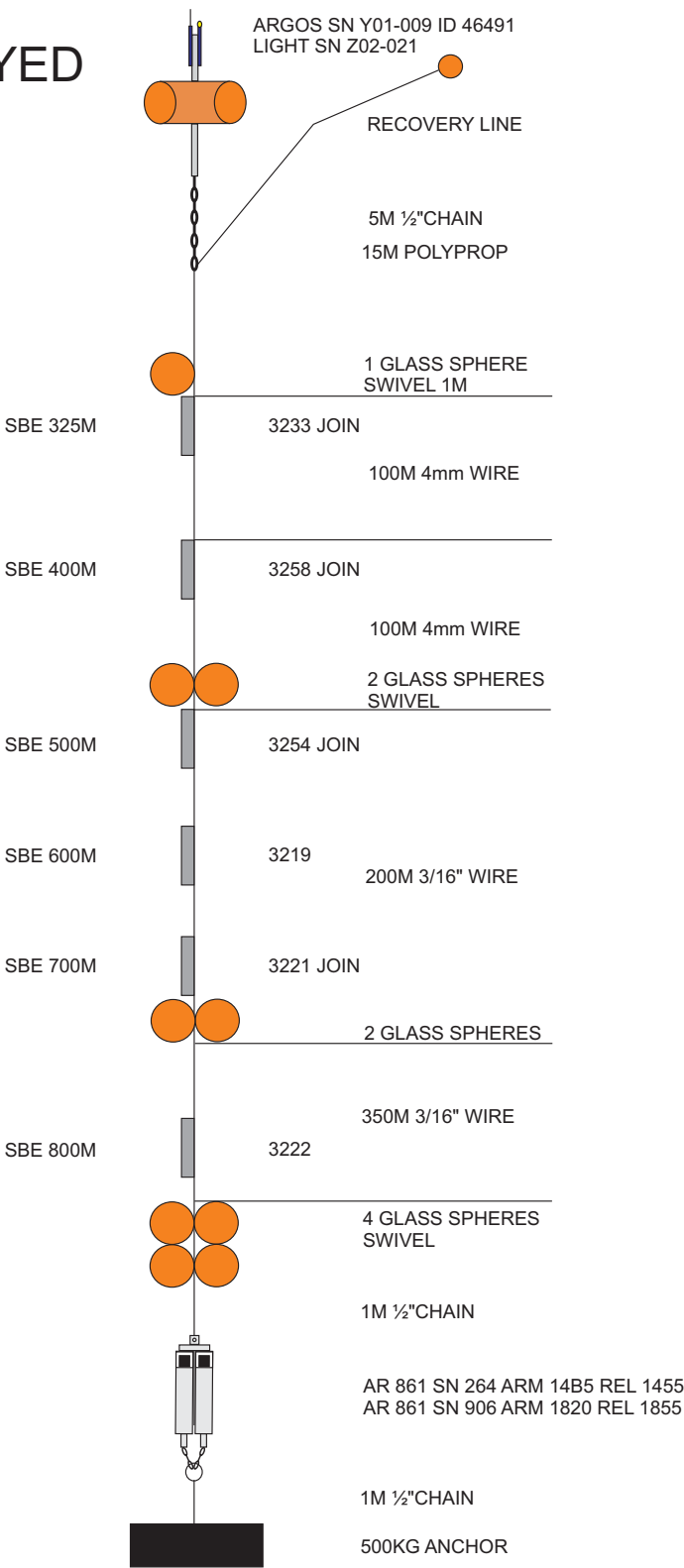
WATER DEPTH
2023M CORR

RAPID WATCH

EBH3
AS DEPLOYED
JC064 2011



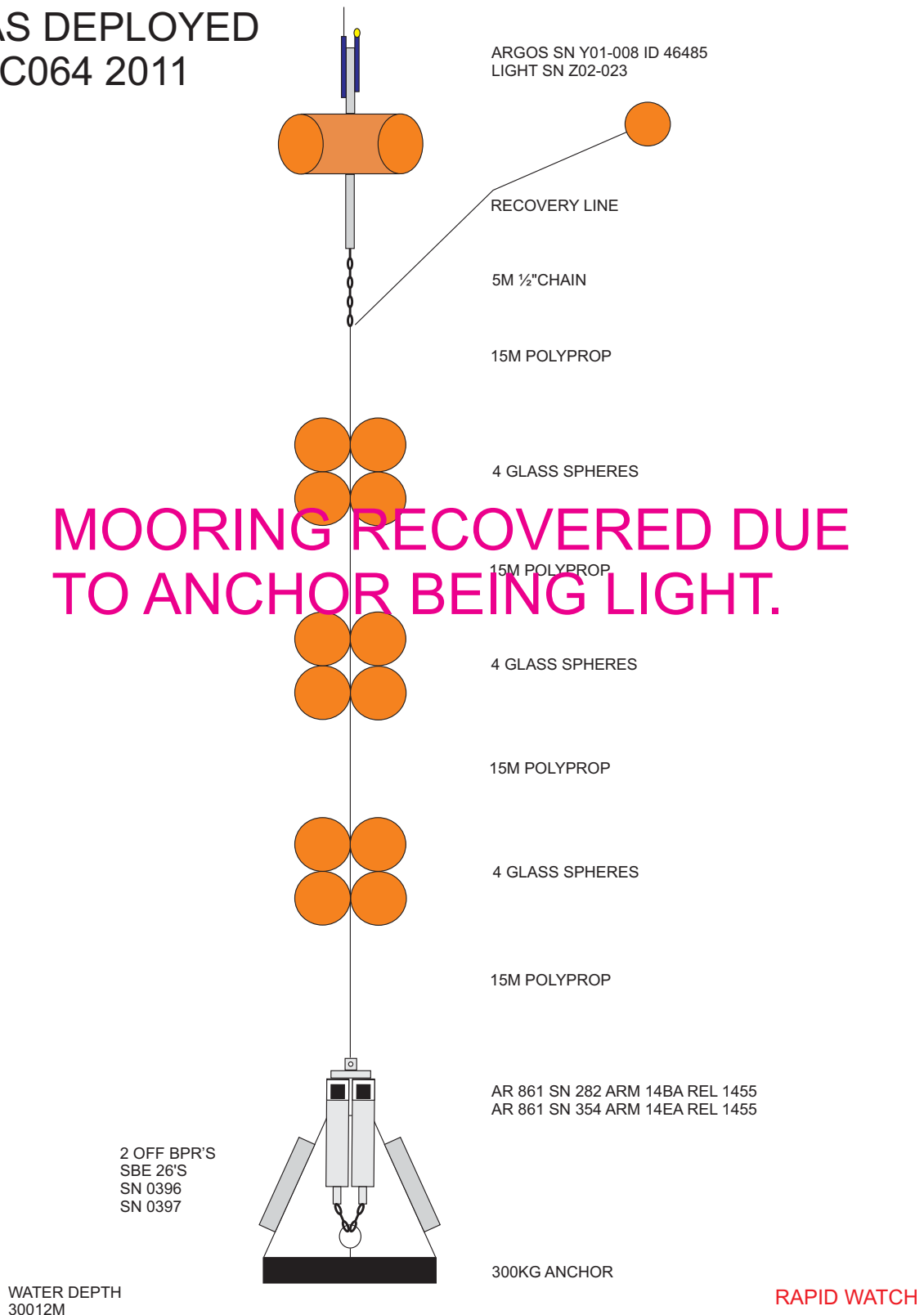
EBH4
AS DEPLOYED
JC064 2011



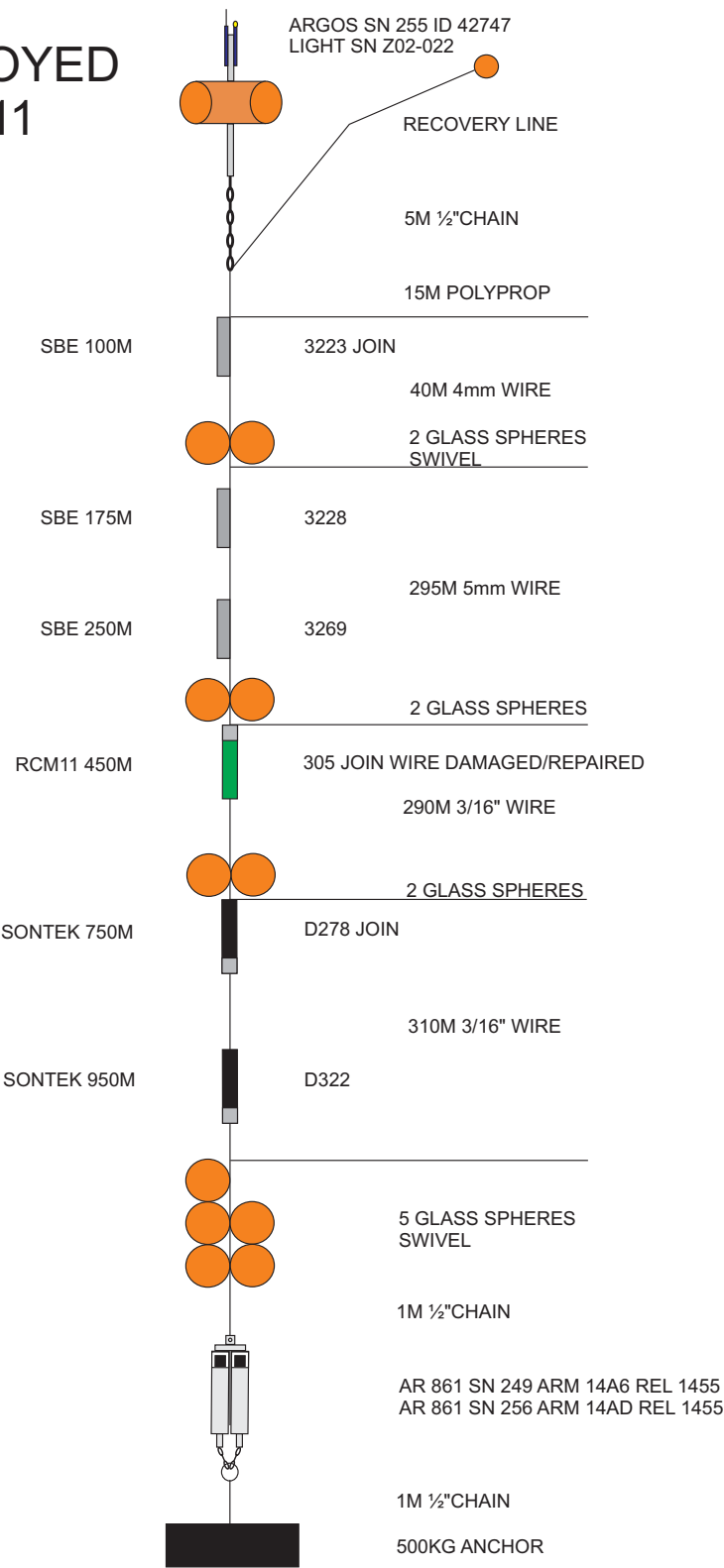
WATER DEPTH
1050M CORR

RAPID WATCH

EBH4L3
AS DEPLOYED
JC064 2011



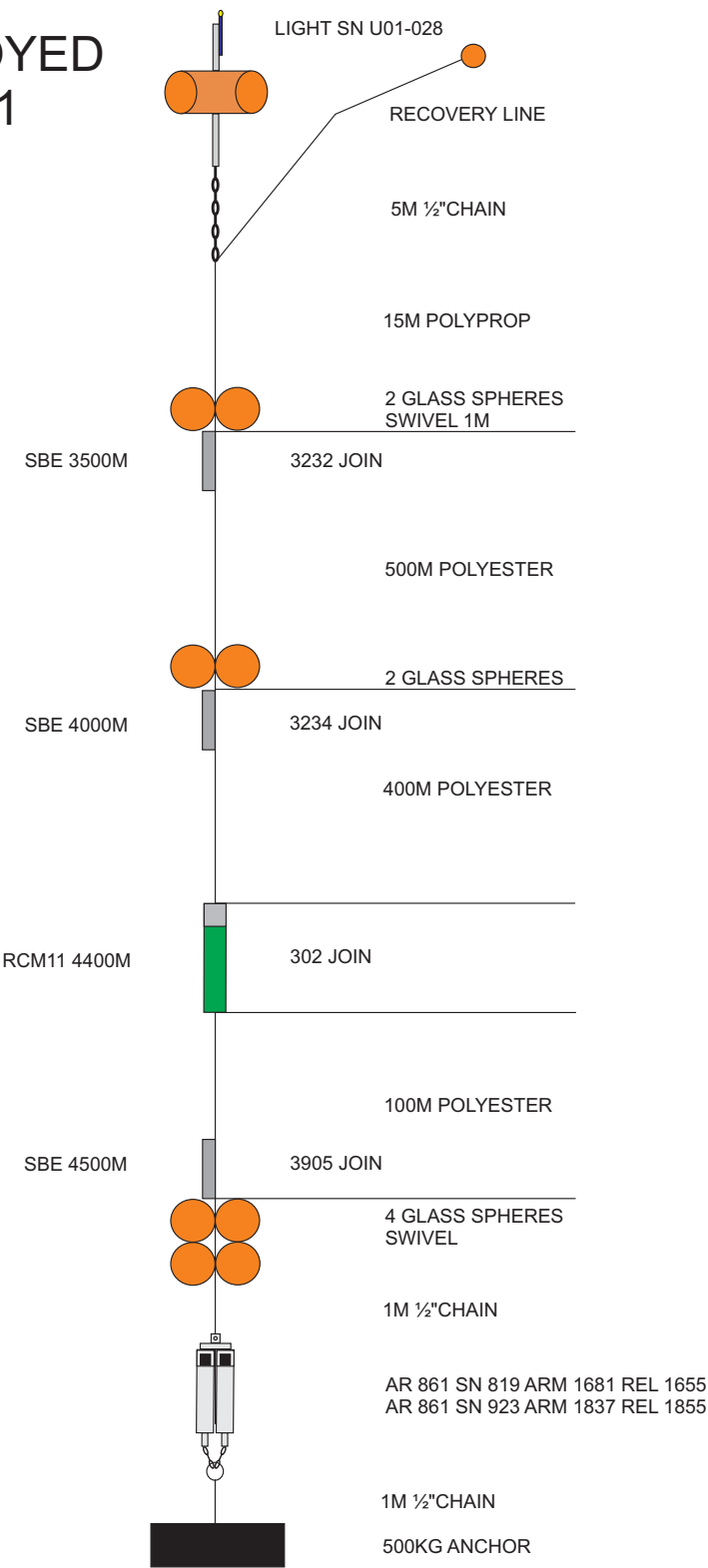
EBH5
AS DEPLOYED
JC064 2011



WATER DEPTH
1060M CORR

RAPID WATCH

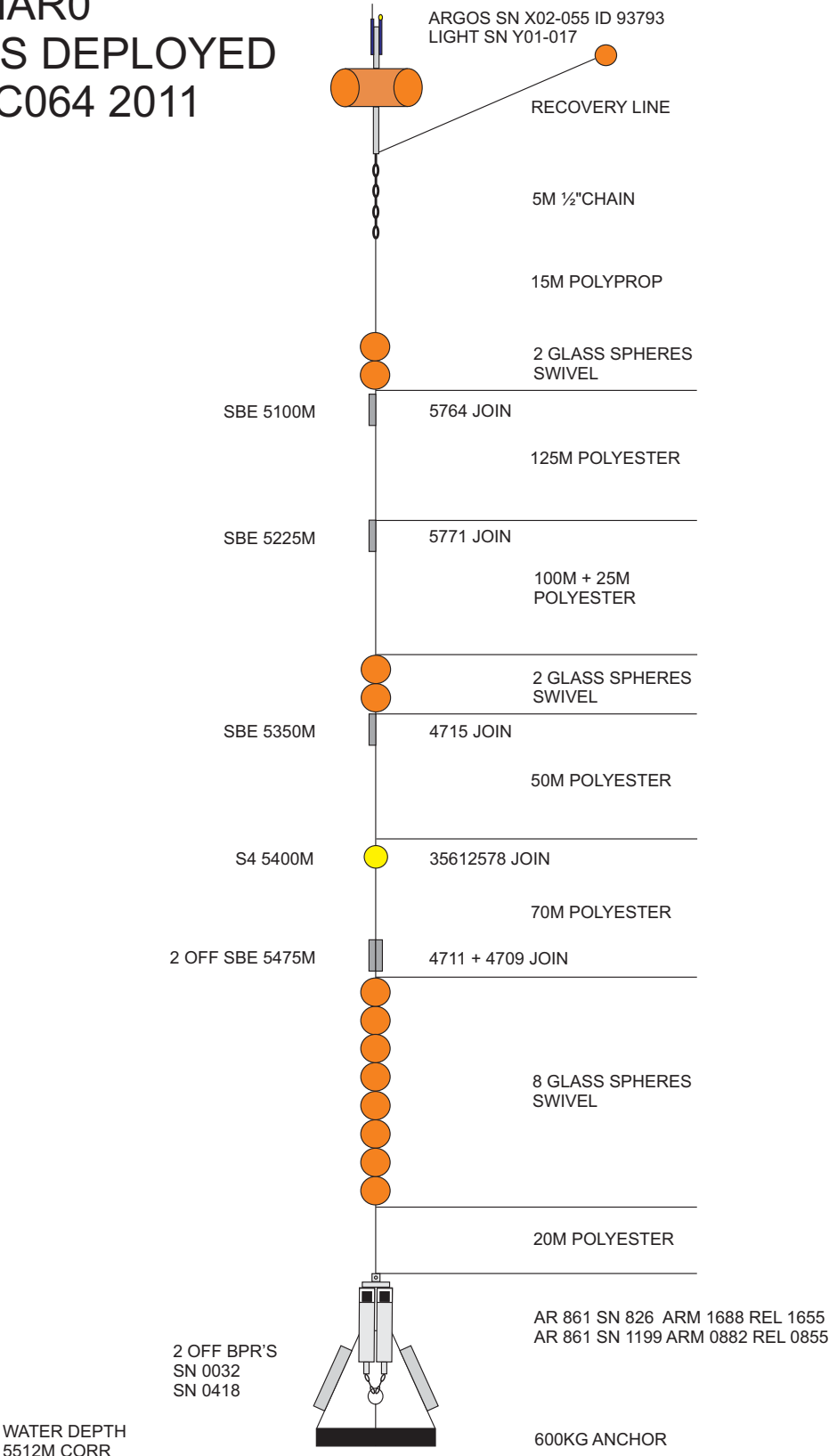
EBHi
AS DEPLOYED
JC064 2011



WATER DEPTH
4505M CORR

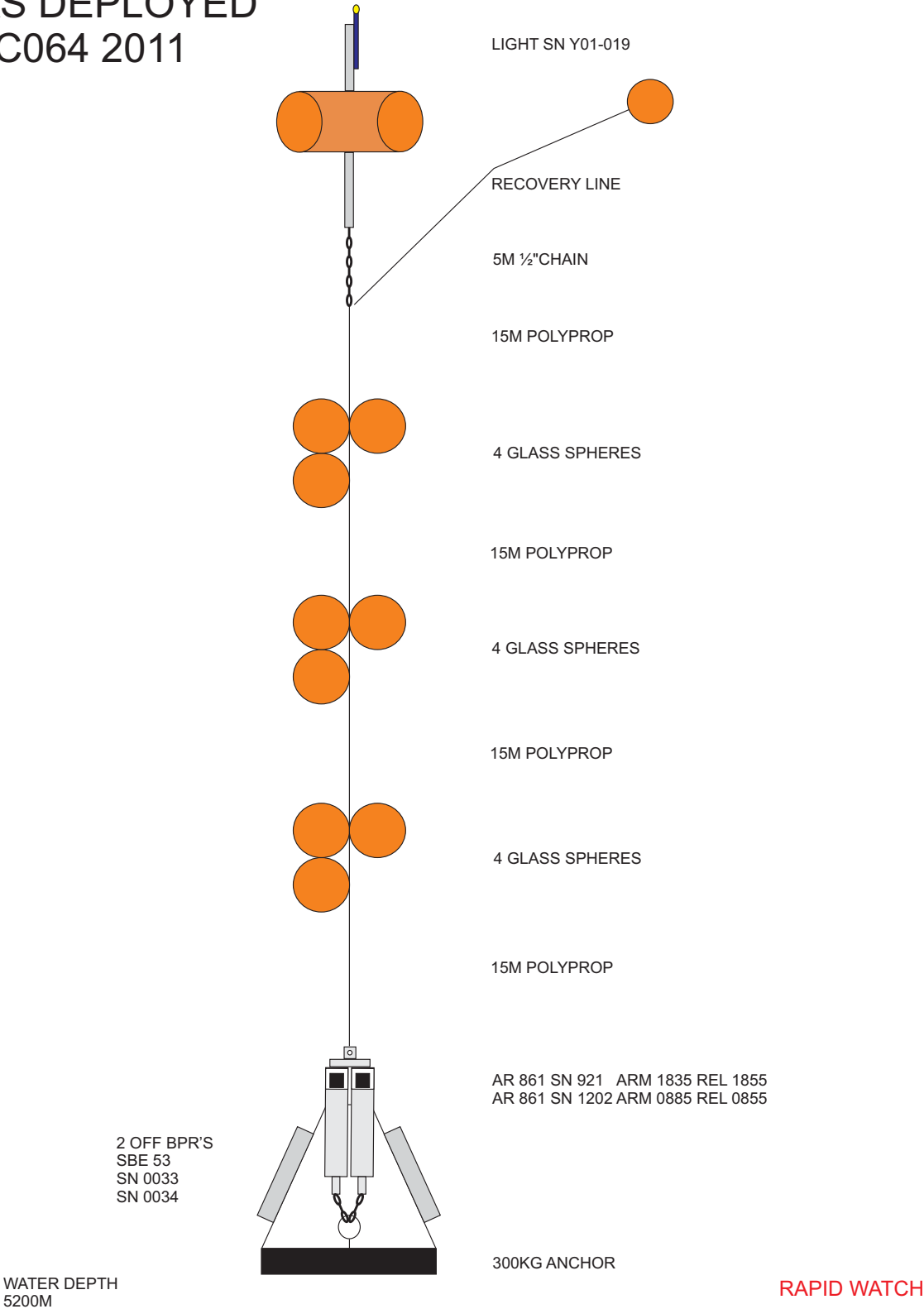
RAPID WATCH

MAR0
AS DEPLOYED
JC064 2011

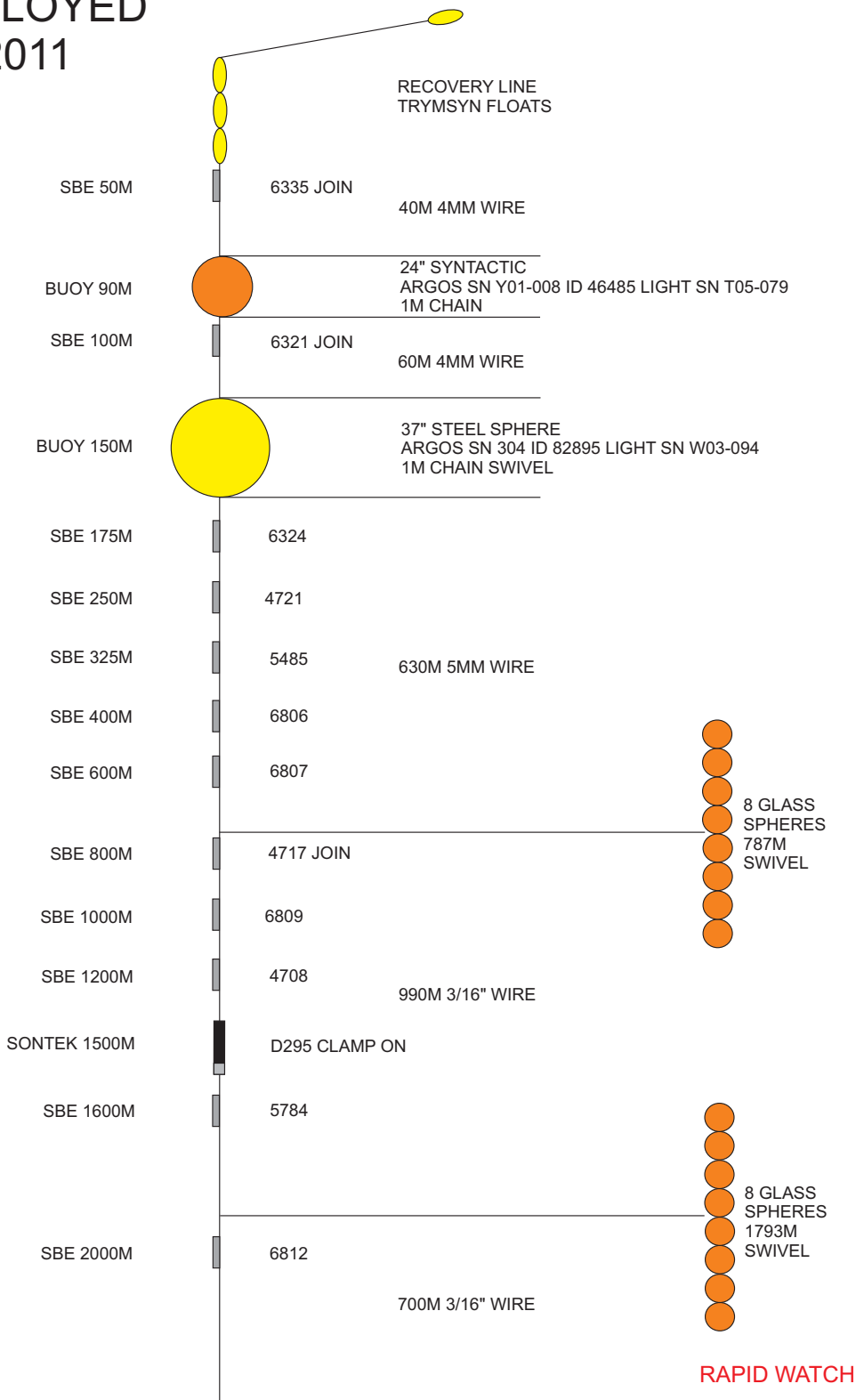


RAPID WATCH

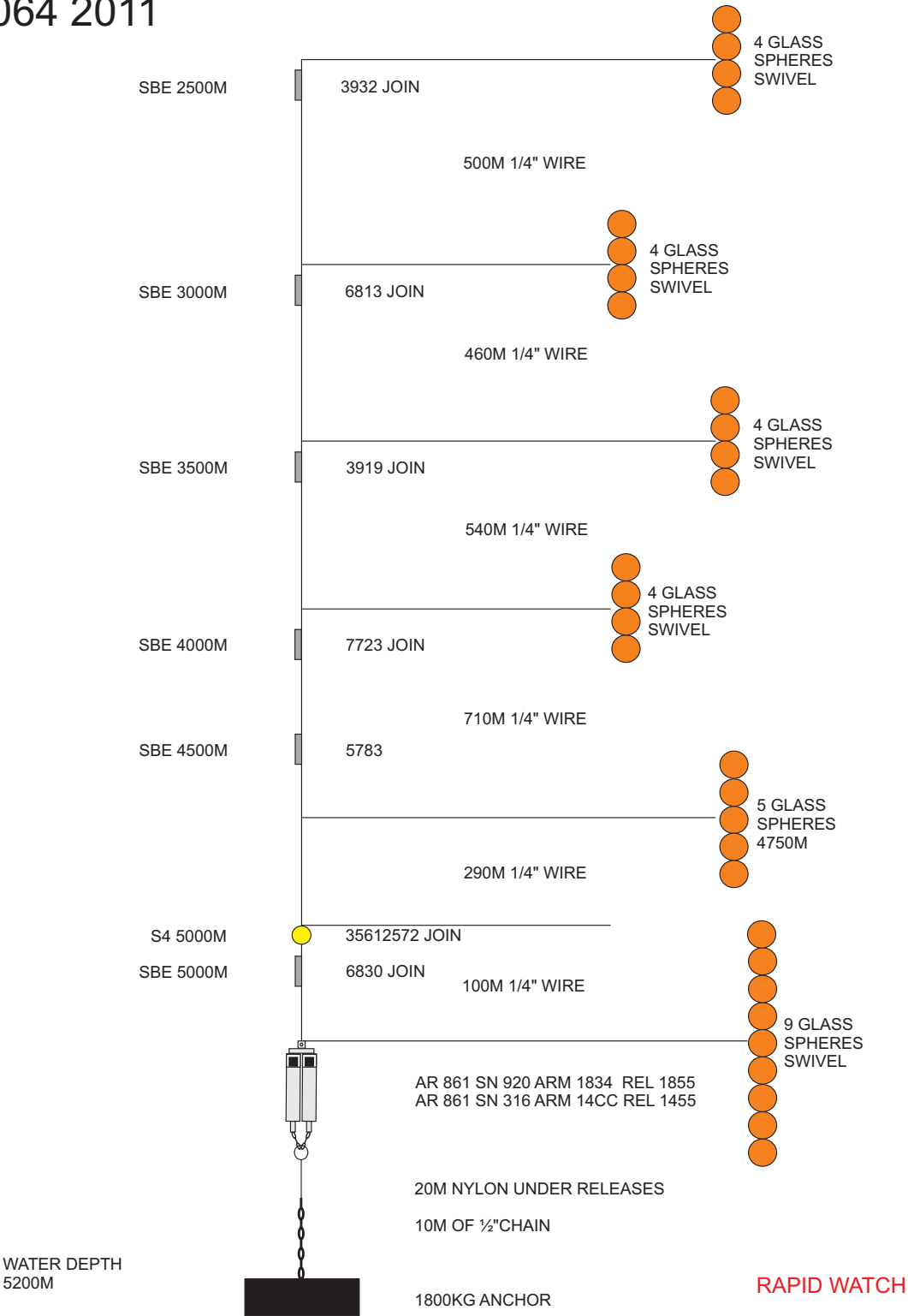
MAR1L7
AS DEPLOYED
JC064 2011



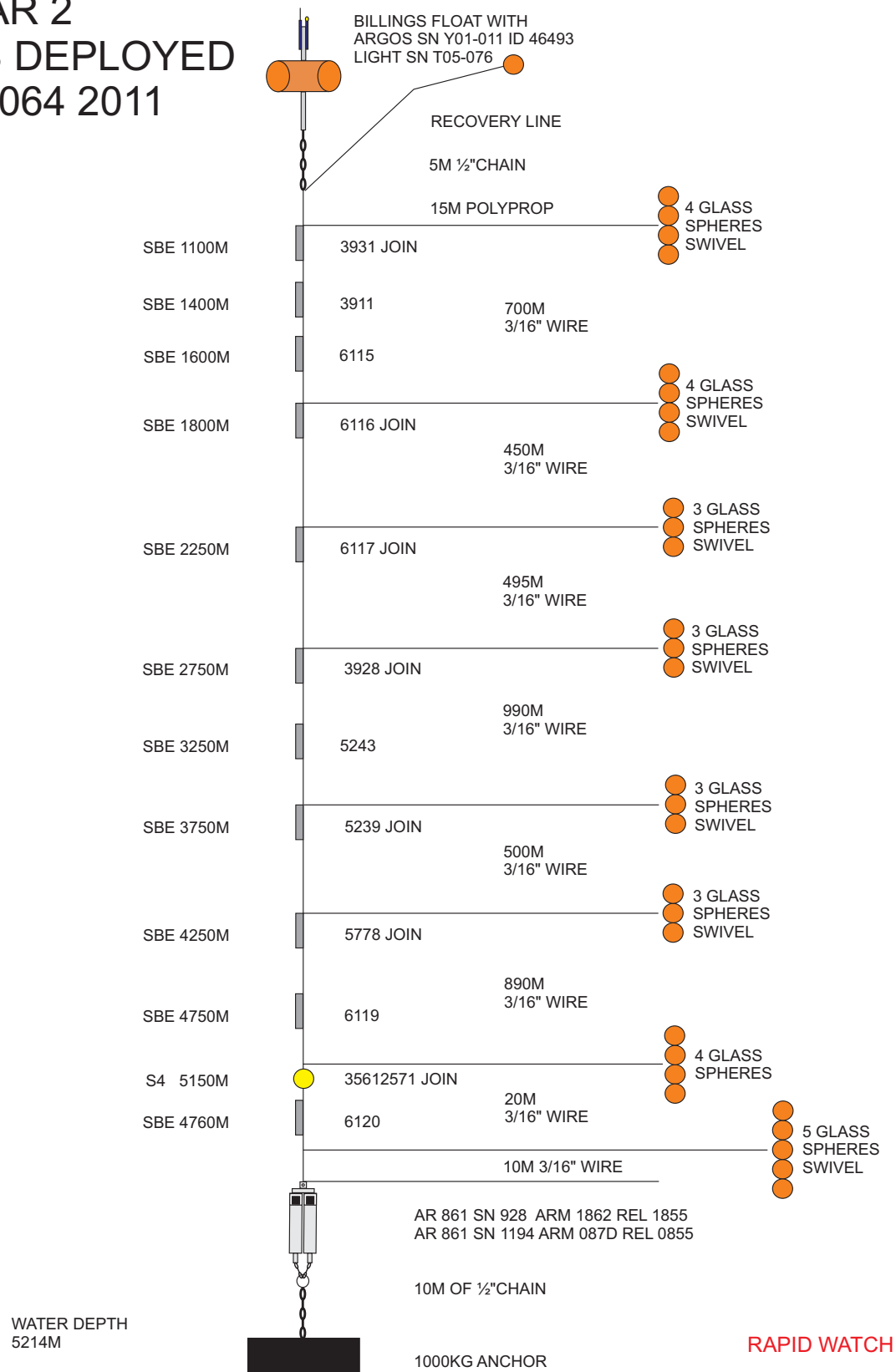
MAR 1
AS DEPLOYED
JC064 2011



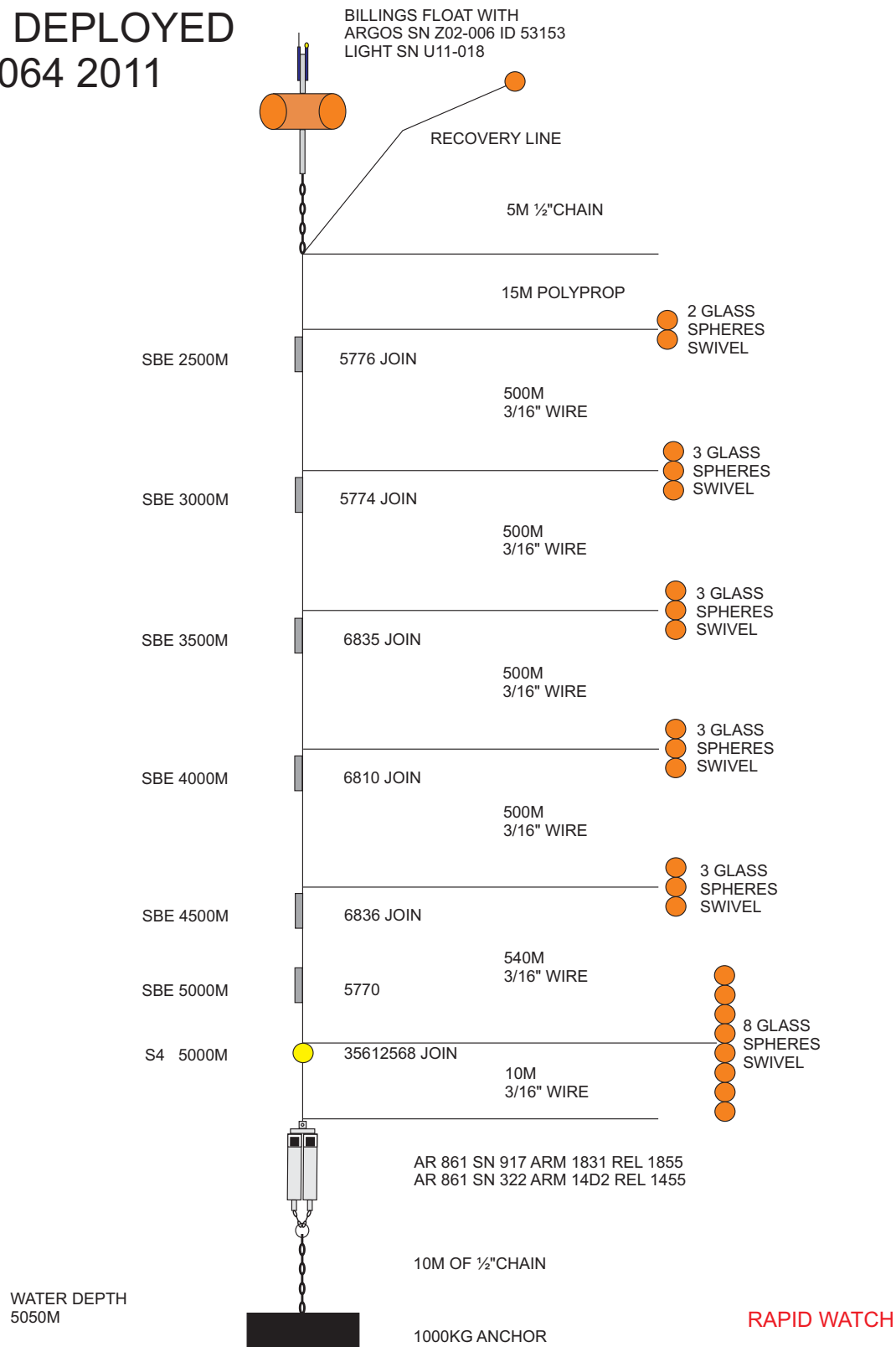
MAR 1
AS DEPLOYED
JC064 2011



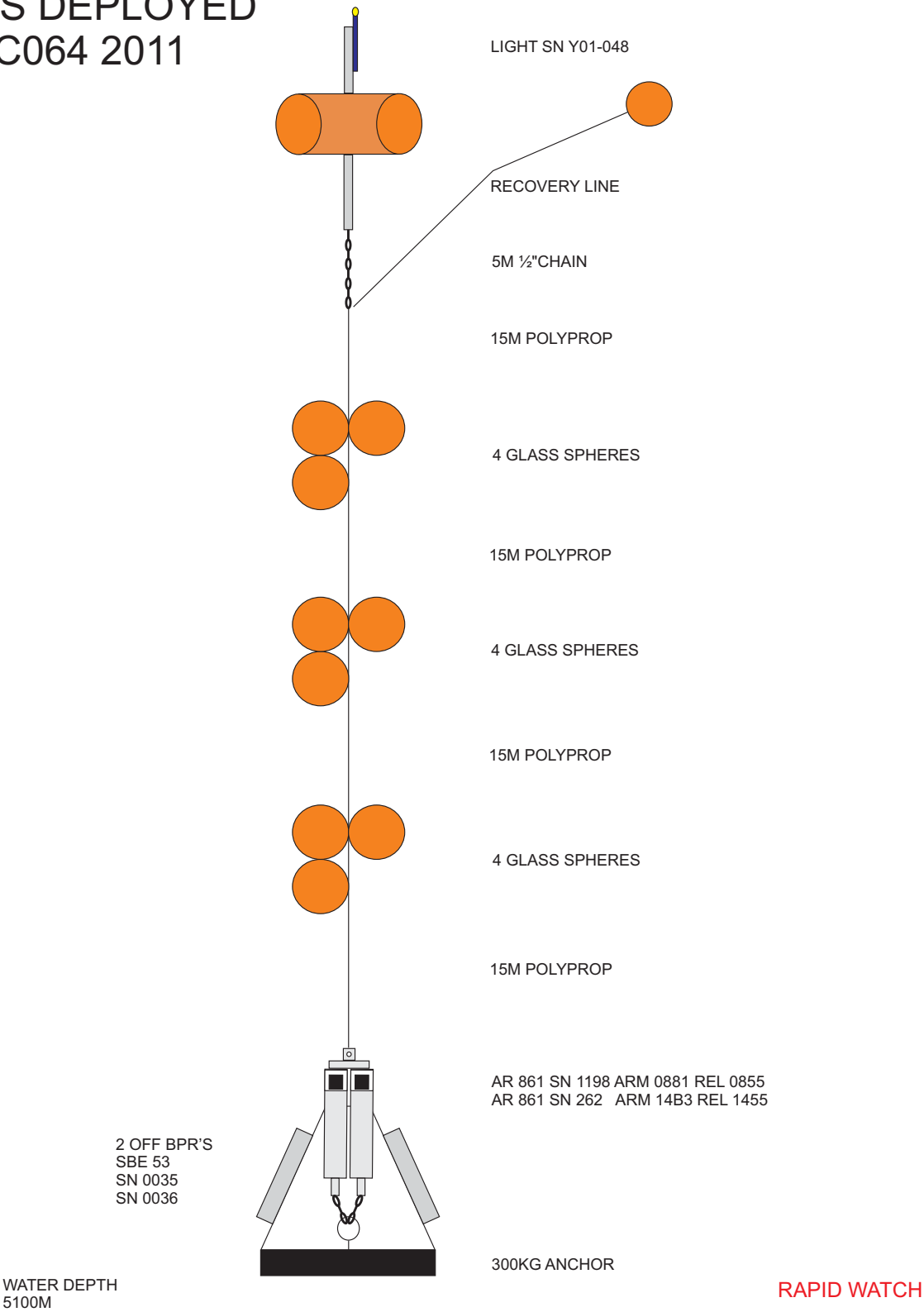
MAR 2
AS DEPLOYED
JC064 2011



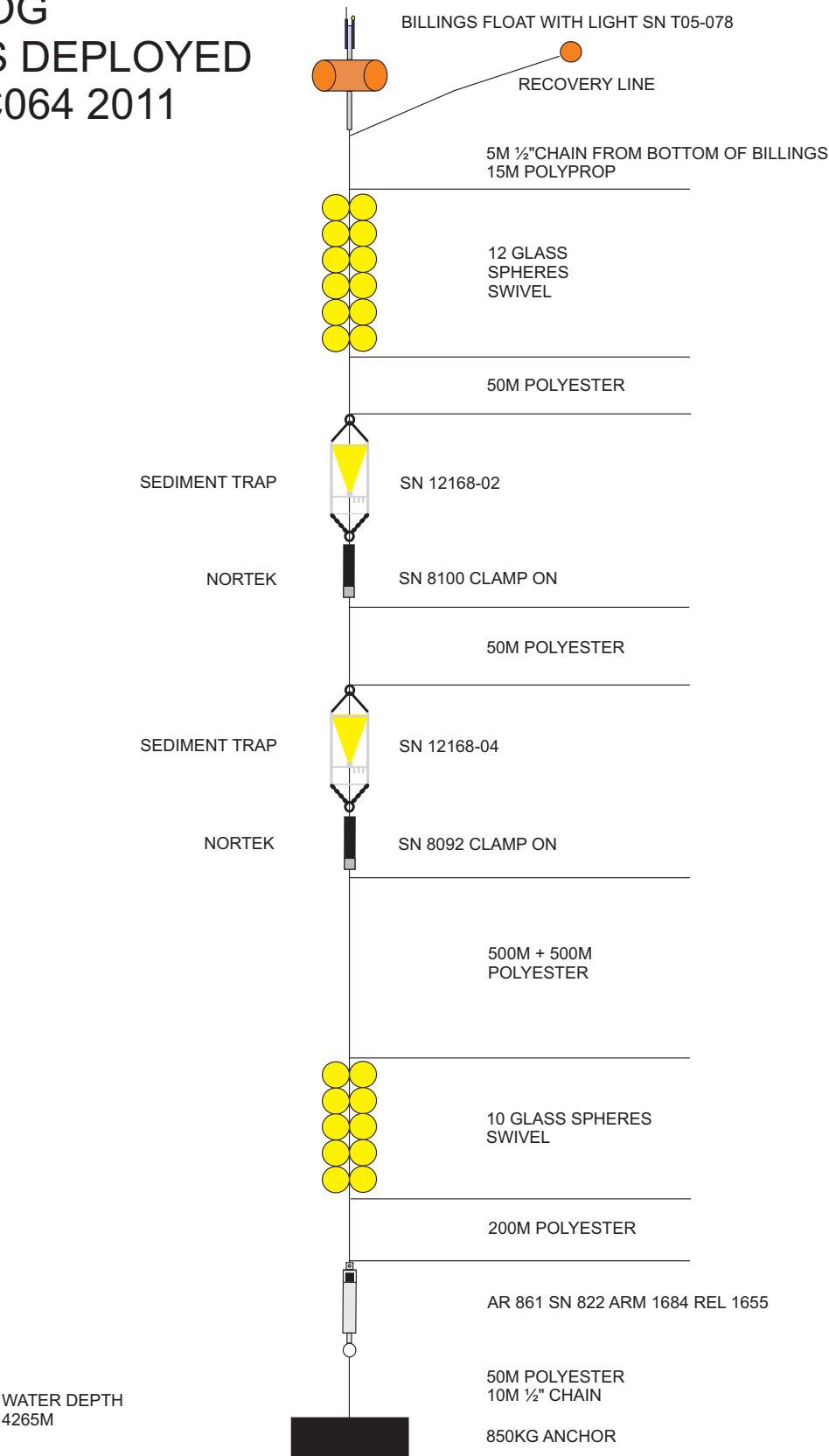
MAR 3
AS DEPLOYED
JC064 2011



MAR3L7
AS DEPLOYED
JC064 2011



NOG
AS DEPLOYED
JC064 2011



I Mooring Recovery Logsheets

RECOVERY

CRUISE	JC064	MOORING	EB1L6
Date	1238 161411	DOY	259
Site Arrival Time	1332		
Setup Distance (nm)	15nm 2.56nm		

AKA EBL3

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
13:43	23° 47.47'	-24° 08.24'	4705	4738

End

Time	Lat	Lon	Depth (u/c)	Depth corr
15:25	23° 49.16'	-24° 06.38'	5056	5099

Release s/n	Arm	Release
262	14B3	
316	14C1	

Ascending @ $\approx 60 \text{ m/min}$

[illegible]

not moved from seabed

- no response

61 m/min	60 m/min
56 m/min	56 m/min

EB1L6 AKA EBL3				Date	GMT
	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float, light & flag				18 36 18 16
2	5m chain				"
3	Recovery line				"
4	4 glass spheres				"
5	15m polyprop				"
6	4 glass spheres				18 21
7	15 m of polyprop				"
8	BPR1	5083	392		18 25
9	BPR2	5083	419		"
10	AR1				"
11	AR2				"
12	Tripod, anchor (300kg)				"

RECOVERY

CRUISE JC064

MOORING

EB1

Date 16/9/11

DOY 259

Site Arrival Time 0758

Setup Distance (nm) 0.5

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
09:39	23° 45.72'	-24° 09.41'	5043	5085

End

Time	Lat	Lon	Depth (u/c)	Depth corr
13:25	23° 47.44'	-24° 08.28'	—	5065

→ Swath data used. Ea 600m was too noisy

Release s/n	Arm	Release
822	1684	
921	1835	

Ascending @ $\approx 89 \text{ m/min}$

[illegible]

release sent
 { 81 m/min
 { 97 m/min

EB1				Date	
	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Trimsyn recovery float and line				09:39
2	3xTrimsyn floats				09:41
3	50m of 4mm wire (red)				
4	SBE at top join	50	✓5240	Heavy fouling (pumps clear)	09:41
5	24" syntactic, argos, light	100	82952		09:46
6	65m of 4mm wire (red)				
7	SBE at top join	100	✓5241	Medium fouling (pumps clear)	09:46
8	37" steel sphere, argos light ✓	170	60211		09:56
9	325m 5mm wire				
10	SBE at top join	170	✓5762	Dragged along track	09:56
11	SBE	250	✓5763		10:04
12	SBE	325	✓5766		10:06
13	SBE	400	✓5767		10:08
14	4 glass + swivel	510			10:11
15	290m 3/16" wire (black)				
16	SBE	600	5768		10:16
17	4 glass + swivel	805		Tangled	10:22
18	330m 3/16" wire (black)				
19	SBE at top join	800	✓5770		10:22
20	SBE	1000	✓5771		10:30
21	4 glass + swivel ✓	1135	/		10:34
22	400m of 3/16" wire (black)				
23	SBE	1200	✓5773		10:38
24	Sontek	1500	D301V		10:46
25	4 glass	1540			10:49
26	750m of 3/16" wire (black)			damaged at bottom	
27	SBE	1600	✓5774		10:56
28	SBE	2000	✓4774		11:07
29	4 glass + swivel	2300		tangled	11:16
30	1000m of 3/16" wire (black)			damaged at top	
31	SBE	2500	✓5776		11:26
32	SBE	3000	✓5778		11:41
33	4 glass spheres + swivel	3300		tangled	12:05
34	600m 1/4" wire			New drum	12:28
35	SBE	3500	✓5779		12:42
36	4 glass spheres	3900			12:43
37	590m 1/4" wire				
38	SBE	4000	✓5780		12:46
39	4 glass spheres	4500		tangled	13:01
40	430m 1/4" wire				
41	SBE	4500	✓5781		13:05
42	60m 1/4" wire				
43	20+40m, 1/4" wire				
44	SBE	5000	✓4710		13:18
45	RCM	5000	✓395		13:18
46	8 glass + swivel	5050			13:23
47	AR1		921		13:23
48	AR2		822		13:23
49	Anchor (1450kg)	5090			

NB: Double barrel with its own hydraulic power pack hauls at 50m/min when plumbed into the ship's hydraulics we usually get 60m/min.

RECOVERY

CRUISE	JC064	MOORING	EBH1L7
Date	6/10/11	DOY	299
Site Arrival Time	12-10		
Setup Distance (nm)			

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
12:13	27° 16' 41	-15° 24.50	2940	2942

End

Time	Lat	Lon	Depth (u/c)	Depth corr
13-41	27° 16.21'	-15° 24.80'		2940

Release s/n	Arm	Release
820	1686	
281	1439	

Ascending @ $\approx 65 \text{ m/min}$

12:11:30 3119 3119

[illegible]

Army : 1686

$\left. \begin{array}{l} \{ 60 \text{ m/min} \\ \{ 70 \text{ m/min} \end{array} \right\}$

$$\begin{array}{r} 7 \overline{) 300} \\ 44 \end{array}$$

ARM: 14B9

$\eta @ \text{surface}$

13.50.

EBH1L7				Date	
	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float, light & flag			Dragged @ 13.25 / 4. Helon deck	13.31
2	5m chain				
3	Recovery line			{ Tangled	13.29
4	4 glass spheres				13.29
5	15m polyprop				
6	4 glass spheres				13.37
7	15 m of polyprop				
8	BPR1		✓0060		13.41
9	BPR2		✓0064		13.41
10	AR1		281		13.41
11	AR2		829		13.41
12	Tripod, anchor (300 kg)				"

1st

RECOVERY

CRUISE	JC064	MOORING	EBH1L8
Date	6/10/11	DOY	279
Site Arrival Time	1056		
Setup Distance (nm)	0.5		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
10:56	27° 16.35'	150° 24.63'	2954	2957

End

Time	Lat	Lon	Depth (u/c)	Depth corr
12:08	27° 16.38'	-15° 24.54'	2945	2947

Release s/n	Arm	Release
282	143A	
354	14EA	

Ascending @ ~ 68 m/min

[illegible]

772 m/min
 764 m/min
 757 m/min
 755 m/min E74 1147

EBH1L8				Date	6/10/11
Mooring Element	Depth (m)	Serial num	Comment	Time o/b	
1 Billings float, light & flag				12.00	1st
2 5m chain					
3 Recovery line			11.56 Grappd.		
4 3 glass spheres				12.00	
5 15m polyprop					
6 3 glass spheres				12.05	
7 15 m of polyprop			3 glass spheres + 15m polyprop	12.12	last
8 BPR1		✓ 396		12.08	
9 BPR2		✓ 397		"	
10 AR1		✓ 282		"	
11 AR2		✓ 354		"	
12 Tripod, anchor (300 kg)					

3 glass spheres

on surface 11.43 ish

RECOVERY

CRUISE	JC064	MOORING	EBH1
Date	6/10/11	DOY	279
Site Arrival Time	0500		
Setup Distance (nm)	0.5		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
08:24	27° 16.10'	-15° 24.90'	2985	2988

End

Time	Lat	Lon	Depth (u/c)	Depth corr
10:53	27° 16.37'	-15° 24.61'	2994	2997

Release s/n	Arm	Release
1200	0883	
827	1689	

Ascending @ ~ 60 m/min

[illegible]

but echo on

180 min →
160 min →

1 ~~17~~ m/min 25 m/min
 1 18 m/min
 1 18 m/min ETA 0940
 2 16 m/min ETA 1022
 2 33 m/min ETA 0945
 2 14 m ETA ~~0945~~ 1005
 1 5.7 m/min
 1 7 m/min
 ETA 1054

EBH1

Date

Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1 Argos float with light			Graded @ 1017	10.28
2 Recovery line and float				
3 5m chain				
4 15m polyprop				
5 2 glass spheres with swivel ✓	2500		Tangled	10.27
6 250m of 8mm polyester				
7 SBE at top join	2500	✓ 3215		10.27
8 2 glass spheres				10.41
9 150m of 8mm polyester				
10 RCM at bottom join	2900	✓ 301		10.48
11 100m of 8mm polyester				
12 SBE at bottom join	3000	✓ 3244		10.53
13 3 glass + swivel, 1m chain				10.53
14 AR		1200	Dropped on deck	10.53
15 AR		827		10.53
16 Anchor (500kg)				

1st

RECOVERY

CRUISE	JC064	MOORING	EBH1L6
Date	13/04/11	DOY	256
Site Arrival Time	0958		
Setup Distance (nm)	4 cables		

AKA EBL4

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
11:15	27° 17.29'	-15° 26.17'	2997	3000

End

Time	Lat	Lon	Depth (u/c)	Depth corr
11:31	27° 17.43'	15° 26.24'	2994	2997

Release s/n	Arm	Release
322	14D2	

Ascending @ 65 m/min

[illegible]

ARM: 1402

REL: 1455

65 m/min 65 m/min
~~70 m/min~~ 65 m/min
 70 m/min 65 m/min

sta 10.55

66777

EBH1L6				Date	
	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float, light & flag			} All tangled	11:25
2	5m chain				
3	Recovery line				11:15
4	2 glass spheres				11:20
5	15m polyprop				
6	3 glass spheres				11:27
7	15 m of polyprop				
8	BPR1	3010	✓395		11:31
9	AR1		322		"
10	Tripod, anchor (300kg)				"

RECOVERY

CRUISE	JC064	MOORING	EBH1
Date	13/09/10	DOY	
Site Arrival Time	06.16		
Setup Distance (nm)			

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
07:13	27° 16.73'	-15° 25.57'	3013	3016

End

Time	Lat	Lon	Depth (u/c)	Depth corr
07:47:21	27° 17.10'	-15° 25.79'	3005	3008

Release s/n	Arm	Release
1864		
930	1864	

Ascending @ $\sim 93 \text{ m/min}$

[illegible]
$$s/n = 930$$

RELEASE OK

$\left\{ \begin{array}{l} 101 \text{ m/min} \\ 85 \text{ m/min} \end{array} \right.$

eta 06-50

EBH1

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float with light				07:23
2	5m chain				
3	Recovery line and float				07:13
4	6 glass spheres with swivel	2500		} Tangled	07:24
5	250m of 8mm polyester				
6	SBE at top join	2500	5787	Scratched and hi / Dragged on deck	07:24
7	2 glass				07:37
8	150m of 8mm polyester				
9	RCM at bottom join	2900	426		07:43
10	100m of 8mm polyester				
11	SBE at bottom join	3000	5786		07:47
12	3 glass + swivel, 1m chain				07:47.21
13	AR				07:47
14	Anchor (500kg)				07:47

RECOVERY

CRUISE	JC064	MOORING	EBH2
Date	12/09/11	DOY	255
Site Arrival Time	1620		
Setup Distance (nm)	0.5		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
1623	27° 36.37'	~14° 12.72'	2022	2022

End

Time	Lat	Lon	Depth (u/c)	Depth corr
17 32	27° 36.95'	-14 12.80'	2021	2021

Release s/n	Arm	Release
819	1681	

Ascending @ 74 m/min

[illegible]

74 m / m

EBH2

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float with light				17:09
2	5m chain				
3	Recovery line and float				17:03
4	2 glass spheres with swivel			} tangled	17:11
5	200m of 8mm polyester				
6	SBE at top join	1600	4473		17:11
7	2 glass				17:20
8	100m of 8mm polyester				
9	SBE at top join	1800	5775		17:21
10	RCM at bottom join	1900	443		17:27
11	100m of 8mm polyester				
12	SBE at bottom join	2000	4475		17:32
13	3 glass + swivel, 1m chain				17:32
14	AR				17:32
15	Anchor (500Kg)				

RECOVERY

CRUISE	JC064	MOORING	EBH3
Date	12/09/2011	DOY	255
Site Arrival Time	10:01		
Setup Distance (nm)	0.42		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
10:06	27°48.08	13°45.06	1420	1422

End

Time	Lat	Lon	Depth (u/c)	Depth corr
11:33	27° 48.93	-13° 44.66	1423	1425

Release s/n	Arm	Release
253	14 AA	

Ascending @ 60 m/min

[illegible]

49 m/min
60 m/min

EBH3

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float with light			light not working	10.56
2	5m chain				
3	Recovery line and float				10.53
4	2 mini trymsyn (2000m rated)				11.00
5	100m of 8mm polyester				
6	SBE at top join	900	4708		11.04
7	2 mini trymsyn			} tangled together	11.09
8	100m of 8mm polyester				
9	SBE at top join	1000	4709	4709	11.09
10	2 mini trymsyn				11.17
11	100m of 8mm polyester				
12	SBE at top join	1100	5782		11.19
13	2 mini trymsyn				11.22
14	100m of 8mm polyester				
15	SBE at top join	1200	4711		11.23
16	RCM at bottom join	1300	444		11.29
17	100m of 8mm polyester				
18	SBE at bottom join	1400	4715	light fouling on casing	11.33
19	3 glass + swivel, 1m chain				11.33
20	AR		253		11.33
21	Anchor (500kg)				

1st on

RECOVERY

CRUISE	JC064	MOORING	EBH4L1
Date	11/1/11	DOY	254
Site Arrival Time	1630		
Setup Distance (nm)	3ca		

AKA EBL5

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
1631	27°51.85'	73°31.03'	N/A	N/A

End

Time	Lat	Lon	Depth (u/c)	Depth corr
1706	27°52.09	-13°31.05	1014	1018

Release s/n	Arm	Release
917	1831	

Ascending @ 62 m/min

[illegible] $\{ 62 \text{ m/min}$

EBH4L1				Date 11/09/11	
	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float, light & flag			} light fouling	16.58
2	2x12" Glass + mast				16.38
3	1m chain				
4	Recovery line				
5	2 glass spheres			Does not exist	17.02
6	15m polyprop				
7	3 glass spheres				17.02
8	15 m of polyprop				
9	BPR1	1005	40		17.06
10	AR1				
11	Tripod, anchor (300kg)				

RECOVERY

CRUISE	JC064	MOORING	EBH4
Date	11/9/11	DOY	252
Site Arrival Time	0500		
Setup Distance (nm)	0.5		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
07:07	27° 50.823	-13° 32.662	1060.89	1064

End

Time	Lat	Lon	Depth (u/c)	Depth corr
08:06	27° 51.1974	-13° 32.35	1059.4	1063

Release s/n	Arm	Release
923	1837	
1147	0880	

Ascending @ $\approx 65 \text{ m/min}$

[illegible]

release ok	61m/min	69m/min
------------	---------	---------

EBH4

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float with light			light not working	07.15
2	5m chain			mild fouling	07.14
3	Recovery line and float			first on	07.07 first on
4	1 glass sphere	290			07.20
5	100m 4mm wire				
6	SBE	325	4719	clean, imp	7.24
7	100m 4mm wire				
8	SBE	400	4718	clean, imp, magnet missing	7.26
9	SBE	500	4720	@ join clean	7.32
10	2 glass + swivel	500			
11	200m 3/16" wire				
12	SBE	600	4721	mild fouling	7.41
13	SBE at bottom join	700	6824	✓	7.44
14	2 glass + swivel	700			7.48
15	350m of 3/16" wire				
16	SBE	800	6825	✓	7.57
17	4 glass + swivel, 1m chain				
18	AR 1 & 2			923 + 897	0806
19	Anchor (500kg)				

RECOVERY

CRUISE	JC064	MOORING	EBH5
Date	08/21/11	DOY	254
Site Arrival Time	0824		
Setup Distance (nm)	0.5		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
09:17	27° 50.64	-13° 32.84	1070.15	1070

End

Time	Lat	Lon	Depth (u/c)	Depth corr
10:07	27° 51.22'	-13° 32.69'	1076-29	1081

Release s/n	Arm	Release
821	i683	
1203	0986	

Ascending @ $\approx 60 \text{ m/min}$

[illegible]

58 m/min / 63 m/min

EBH5

Date

Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1 Billings float with light			7 Heavy fouling	09:26
2 5m chain + swivel			7 light not working	"
3 Recovery line and float			Heavy fouling	09:17
4 40m of 4mm wire				
5 SBE at top join	107	6826	medium fouling	09:30
6 2 glass	146			09:32
7 295m of 5mm wire				
8 SBE	175	6827		09:35
9 SBE	250	3282, 3382		09:38
10 2 glass + swivel	442			09:43
11 290m of 3/16" wire				
12 Sontek S4	442	35612577		09:43
13 2 glass	734			09:54
14 310m of 3/16" wire				
15 RCM at top join	734	507		09:54
16 Sontek	934	D303	9389 (on top of 1 that has been)	10:01
17 5 glass + swivel, 1m chain	1045			10:07
18 AR x 2				10:07
19 Anchor (500kg)				

S4 35612577

0943

RECOVERY

CRUISE	JC064	MOORING	EBHi
Date	0625 Thu 15 th	DOY	258
Site Arrival Time			
Setup Distance (nm)			
0.5			

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
07:40	24° 56.10'	-21° 16.41'	4473	4499

End

Time	Lat	Lon	Depth (u/c)	Depth corr
08:23	74° 56.73'	-21° 16.20'	4474	4500

Release s/n	Arm	Release
1198	0881	

Ascending @ 72 m/min

[illegible] 742 r/min

EBHi

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float with light				07:47
2	5m chain				
3	Recovery line and float				7:40
4	2 glass spheres with swivel	2500		} Tangled	07:47
5	500m of 8mm polyester				
6	SBE at top join	3500	✓ 5783		07:47
7	2 glass				08:05
8	400m of 8mm polyester				
9	SBE at top join	4000	✓ 5784	} Tangled	08:05
10	RCM at bottom join	4400	✓ 399		08:18
11	100m of 8mm polyester				
12	SBE at bottom join	4500	✓ 5785		08:23
13	4 glass + swivel, 1m chain				
14	AR		1198		08:23
15	Anchor (500kg)				

RECOVERY

CRUISE	JC064	MOORING	EBP1
Date	16-09-2011	DOY	25
Site Arrival Time	16:20		
Setup Distance (nm)	4 cables, closed to 0 nm		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
18:30	23° 49,16'	-24° 06,37'	5059	5102

End

Time	Lat	Lon	Depth (u/c)	Depth corr
18:44	23° 49,51'	-24° 06,29'	5059	5102

CLEAR	TELEM	BEACON	XPND	RELEASE

	Mooring Element	Serial num	Comment
	Recovery float & line		VHF ch 77 @ 156.875 MHz
	2 PIES	136	

EBP1_2_200832

EBP1

Serial Number 136

XPND	69	section 5-5	ACS commands
TELEM	65	section 8.2	Recovery
BEACON	73		
RELEASE	8		
CLEAR	76		

weight in air 36 kgs

Time of pings [timing]

XPND [check range]

Release at 1600

1. Listening in remote, Rx 12 kHz. Did not detect IES pings at 10 min intervals. ∴ no clock drift check possible. No response to XPND command
2. Sent release command repeatedly for ~45 mins. At 1636 finally heard pinging at 4s intervals indicating release in progress.
3. Ascent verified on 'Line recorder'
4. surfaced at 1822, heard on VHF & spotted.

RECOVERY

CRUISE JC064

MOORING **MARO**

Date 26/9/11

DOY 269

Site Arrival Time 1019

Setup Distance (nm)

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
10:16	25° 05.84'	-52° 00.45'	5523	5586

End

Time	Lat	Lon	Depth (u/c)	Depth corr
12.23	25° 06.67'	-52° 00.92'	5443	5503

Ascending @ $\approx 60 \text{ m/min}$

ARM

14CE

[illegible]

261 ml/min

$\Delta 6.2 \text{ m/min}$
 155 m/min

ETA surface
1140 ~ 0940

ETA surface
1145.

	Mooring Element	Depth	Serial num	Comment	Time o/b
	Recovery float and				12.04
1	line				
2	Join				12.10
3	3 Glass spheres				
	Top join 125m of				
4	10mm polyester				
5	SBE (at top join)	5100	✓ 4306		12.10
	Bottom join 125m of				
6	10mm polyester				
	Top join 125m of				
7	10mm polyester				
8	SBE (at top join)	5225	✓ 6127		12.18
	Bottom join 125m of				
9	10mm polyester				
	2 glass spheres +				
10	swivel ✓			glass spheres imploded	12.23
	Top join 50m of				
11	10mm polyester				
12	SBE (at top join)	5350	✓ 4307	hit the ground	12.23
	Bottom join 50m of				
13	10mm polyester				
14	Join				
15	Current Meter SA	5400	✓ 35612574		12.32
16	Join				
	Top join 70m of				
17	10mm polyester				
18	SBE (at bottom join)	5475	✓ 6128		12.30
19	SBE (at bottom join)	5475	✓ 4466	hit the ground	12.30
	Bottom join 70m of				
20	10mm polyester				
	6 glass spheres +				
21	swivel				12.30
22	Join				
	20m of 10mm				
23	polyester				
24	Join				
25	Acoustic Release				12.23
26	Acoustic Release				12.23
27	BPR 1	5500	0391		12.23
28	BPR 2	5500	0003		12.23
29	Anchor hook				

last package

RECOVERY

CRUISE JC064

MOORING

MAR1L5

Date 25/9/11

DOY 268

Site Arrival Time 0815

Setup Distance (nm) 0.5 nm

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
08-28	24° 12.01'	-49° 44.80'	5176	5226

End

Time	Lat	Lon	Depth (u/c)	Depth corr
10.14	24° 12,30'	-49° 44,30'	5175	5225

Release s/n	Arm	Release
370	14 FA	
216	EC 47	

As casting @ 63 m/min

[illegible]

- 1 64 m/min
- 1 62 m/min
- 1 63 m/min

 768 m/min

MAR1L5

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time i/b
1	Billings float, light & flag			imploded	10:06
2	5m chain				
3	Recovery line				10:01
4	4 glass spheres				10:06
5	15m polyprop			Rope damaged, half cut	
6	4 glass spheres				10:11
7	15 m of polyprop				
8	BPR1		420		10:14
8	BPR2		393		"
9	AR1		370		"
10	AR2		216		"

RECOVERY

CRUISE JC064

MOORING **MAR1**

Date 24/9/2011

DOY 267

Site Arrival Time 09:30

Setup Distance (nm)

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
09.39	24° 09,82'	-49° 43,82'	5145	5194

End

Time	Lat	Lon	Depth (u/c)	Depth corr
14 25	24° 10.66'	-49° 40.93'	5151	5201

Ascending @ $\sim 95 \text{ m/min}$

S/N 1194

ARM

[illegible]

$I_{100m/min}$
 $I_{91m/min}$

S/N 1199

ARM

MAR1

Date

GMT

	Mooring Element	Depth	Serial num	Comment	Time o/b
1	Recovery float and line			mild fouling	11:00
2	3 trymsin floats				11:06
3	40 m 4mm wire				"
4	SBE (at top join)	50	6331	heavy fouling	"
5	Syntactic				
6	Argos + light sphere	90			
7	1m chain				
8	60m 4mm wire				11:12
9	SBE	100	✓ 3902		
10	37" + Argos + light + swivel, 1m chain	150			11:18
11	630m 5mm wire				
12	SBE	175	✓ 4068		11:22
13	SBE	250	✓ 6121		11:24
14	SBE	325	✓ 6129		11:27
15	SBE	400	✓ 4722		11:29
16	SBE	600	✓ 4071	Heavy tangle with 5mm and 3/16 wire	11:38
17	8 glass + swivel	787			11:45
18	990m 3/16" wire				
19	SBE (at top join)	800	✓ 6122	} Tangle	11:45
20	SBE	1000	✓ 4072		11:53
21	SBE	1200	✓ 6828		11:58
22	Sontek	1500	D320 ✓		12:04
23	SBE	1600	✓ 7468	Hit the vessel	12:16
24	8 glass	1793		} small tangle	12:16
25	700m 3/16" wire				
26	SBE	2000	✓ 6123		12:29
27	4 glass + swivel	2509			12:43
28	500m 1/4" wire				
29	SBE (at top join)	2500	✓ 4178		12:44
30	4 glass	3017			13:00
31	460m 1/4" wire				
32	SBE (at top join)	3000	✓ 6124	} Tangled	13:00
33	4 glass + swivel	3484			13:17
34	540m 1/4" wire			New drum	
35	SBE (at top join)	3500	✓ 4180		13:17
36	4 glass	4032			
37	710m 1/4" wire				
38	SBE (at top join)	4000	✓ 6327		13:42
39	SBE	4500	✓ 4305	Clamp broken	14:00
40	5 glass	4750			14:06
41	290m 1/4" wire			} tangled	
42	SBE (at top join)	4995	✓ 6126		14:20
43	100m 1/4" wire				
44	S4 at top join	5000	✓ 35612576		14:20
45	9 glass + swivel	5151			14:25.06
46	AR				14:25.03
47	AR				
48	Anchor (1800 kg)				

RECOVERY

CRUISE JC064

MOORING MAR2

Date 24/9/11

DOY 207

Site Arrival Time 1508

Setup Distar	0.5 mm
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Start

Time	Lat	Lon	Depth (u/c)	Depth corr
15.14	24° 11.71'	-49° 45.89'	5181	5231

End

Time	Lat	Lon	Depth (u/c)	Depth corr
19.47	24° 11.98'	-49° 43.57'	5177	5227

Release s/n	Arm	Release
920	1834	

Ascending @ 105 m/min

[illegible]

Sent release, no response

release OK

$I = 105 \text{ m/min}$

MAR2

Date

GMT

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float with light				16.58
2	5m chain				
3	Recovery line and float				16.45
4	4 glass spheres with swivel ✓			} tangled	16.58
5	Join: Top of 700m 3/16" wire				
6	SBE at join	1100	✓ 4070		16.58
7	SBE at mark	1400	✓ 4468		17.12
8	SBE (no mark)	1600	✓ 3934		17.18
	Join: Bottom of 700m 3/16" wire				
9	4 glass spheres with swivel	1787		} tangled	17.24
10	Join: Top of 450m 3/16" wire				"
11	SBE at join	1800	✓ 6137		"
	Join: Bottom of 450m 3/16" wire				
12	3 glass spheres	2244			17.41
	Join: Top of 495m of 3/16" wire				"
14	SBE at join	2250	✓ 6320		"
	Join: Bottom of 495m 3/16" wire				
16	3 glass spheres with swivel	2745			17.57
	Join: Top of 990m of 3/16" wire				
18	SBE at join	2750	✓ 6322		17.57
20	SBE at mark	3250	✓ 4470		18.13
	Join: Bottom of 990m of 3/16" wire				
22	3 glass spheres with swivel	3741		} Tangled/New drum	18.27
	Join: Top of 500m of 3/16" wire				
24	SBE at join	3750	✓ 6323		18.27
	Join: Bottom of 500m of 3/16" wire				
26	3 glass spheres with swivel	4246		} Tangled	18.57
	Join: Top of 890m of 3/16" wire				
28	SBE at join	4250	✓ 6325		18.57
29	SBE at mark	4750	✓ 6326		19.29
	Join: Bottom of 890m of 3/16" wire				
31	4 glass spheres with swivel ✓	5142		} Tangled 2 glass spheres injected	19.41
32	Join: Top of 20m of 3/16" wire				
33	S4 current meter at join	5150	✓ 35612565		19.41
34	SBE at mark	5160	✓ 4471		19.44
35	Join: Bottom of 20m of 3/16" wire			} Tangled	
36	5 glass spheres with swivel ✓	5170			19.44
37	Join: Top of 10m of 3/16" wire				
38	Join: Bottom of 3/16" wire				
39	Acoustic release				19.47.47
40	10m 1/2" chain				
41	Anchor	5200			

RECOVERY

CRUISE	JC064	MOORING	MAR3L5
Date	27/9/2011	DOY	264
Site Arrival Time			
Setup Distance (nm)			

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
15 10	25° 23,32'	-49° 38,44'	4820	4860

End

Time	Lat	Lon	Depth (u/c)	Depth corr
16 51	25° 26.83'	-49° 14.71'	4323	4258

Release s/n	Arm	Release
928	1862	1855
826	1688	1655

Ascending @ 74 m/min

[illegible]

72 m/min	74 m/min
eta 16	20 GRT
74 m/min	74 m/min

MAR3L5

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float, light & flag				16 43
2	5m chain				
3	Recovery line				16 37
4	4 glass spheres			Tangled	16 43
5	15m polyprop				
6	4 glass spheres				16 48
7	15 m of polyprop				
8	BPR1	5041	✓ 13		16 51
8	BPR2	5041	✓ 38		16 51
9	AR1		13 → 928		16 51
10	AR2		826		16 51

RECOVERY

CRUISE JC064

MOORING

MAR3

Date 21/8/11

DOY 264

Site Arrival Time 0400

Setup Distan	0.5 nm
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Start

Time	Lat	Lon	Depth (u/c)	Depth corr
0747	23° 51.29'	-41° 06.38'	4967	5007

End

Time	Lat	Lon	Depth (u/c)	Depth corr
11 24	23° 51.60	-41° 03.99'	5040	5082

Release s/n	Arm	Release
1202	0885	
922	1836	

Ascending @ 90,7 m/min

[illegible]

790.7 m/min

ETA SURFVAL 0819

MAR3

		Date	
Mooring Element	Depth (m)	Serial num	Comment
1 Billings float with light			09:10
2 5m chain			
3 Recovery line and float			09:01
4 2 glass spheres with swivel	2500		Tangled 09:10
5 Join: Top of 500m 3/16"			
6 SBE at join	2500	✓ 6215	Hit billings 09:10
7 Join: Bottom of 500m 3/16"			
8 3 glass spheres	3000		
9 Join: Top of 500m 3/16"			Tangled 09:45
10 SBE at join	3000	✓ 3933	09:31
11 Join: Bottom of 500m 3/16"			
12 3 glass spheres	3500		
13 Join: Top of 500m 3/16"			
14 SBE at join	3500	✓ 6333	Extremely scratched + tangled 09:59
15 Join: Bottom of 500m 3/16"			
16 3 glass spheres + swivel	4000		
17 Join: Top of 500m 3/16"			
18 SBE at join	4000	✓ 6332	Small damage 09:59
19 Join: Bottom of 500m 3/16"			
20 3 glass spheres	4500		tangled with previous package 10:18
21 Join: Top of 540m 3/16"			
22 SBE at join	4500	✓ 4472	Broken clamp 10:18
23 SBE at mark	5000	✓ 7363	11:21
24 Join: Bottom of 540m 3/16"			
25 S4	5015	35612564	Tangled 11:22
26 8 glass spheres with swivel	5017		11:22
27 10m 3/16"			
28 AR1			11:24.07
29 AR2			11:24.07
30 10m of 0.5" chain			
31 Anchor (1000kg)	5050		

In surface it was really tangled. Billings (no1) were tangled with S4 and 8 glass spheres (no. 25 & no. 26). It untangled when starting the recovery.

5 lines tangled together → stuck with tape and cut at some parts

RECOVERY

CRUISE	MOORING	NOGST
JC064 Date 21 Apr 2011	DOY 264	
Site Arrival Time 1800		
Setup Distance (nm) 0.4nm		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
1829	23° 46.13'	41° 05.81'	4220	4241

End

Time	Lat	Lon	Depth (u/c)	Depth corr
1928	23° 46.22'	-41° 04.91'	4303	4326

Release s/n	Arm	Release
926	1860	1855

Ascending @ —

[illegible]

accidentally fired by senior technician @	17.15 ship's time
---	-------------------

[illegible]

NOGST

Date

Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1 Billings float, light & flag				18:29
2 5m chain				
3 Recovery line				18:23
4 15m polyprop				
5 12 glass spheres			/ Tangled	18:29
6 50m polyprop				
7 Sediment trap	3000	12432-04		18:37
8 RCM current meter	3000	✓ 423		18:37
9 50m polyprop				
10 Sediment trap	3000	12432-05		18:45
11 RCM current meter	3000	✓ 642	Hit vessel	18:45
12 500m polyprop				
13 500m polyprop				
14 10 glass spheres				19:15
15 200m polyprop				
16 AR				19:27.5
17 Anchor (850kg)				

J Mooring Deployment Logsheets

DEPLOYMENT

CRUISE	JC064	MOORING	EB1L8
Date	17/07/11	DOY	
Site Arrival Time	16:21		
Setup Distance (nm)	1 cable		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
16.30	23° 47.43'	-24° 06.82'	5053	5096

End

Time	Lat	Lon	Depth (u/c)	Depth corr
16:33:26	23° 47' 47"	24° 6' 80"	5050	5088

(swath)
(x690m)

Release s/n	Arm	Release
253	14AA	
930	1864	

Descending at 51 m/min

[illegible]

$$\begin{array}{r} 4600 \\ \underline{50} \\ 92 \text{ min} \end{array}$$

$\{-51 \text{ m/min}$

EB1L8			Date	GMT
Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1 Billings float, light				16.30
2 5m chain				"
3 Recovery line				"
4 15m polyprop				"
5 3 glass spheres				16.31
6 15m polyprop				"
7 3 glass spheres				16.32
8 15 m of polyprop				"
9 3 glass spheres				"
10 15m polyprop				"
11 BPR1	416		0012	"
12 BPR2	418		0058	"
13 AR1	930			"
14 AR2	253	14AA		"
15 Tripod, anchor (300kg)				16.33.26

88016

DEPLOYMENT

CRUISE **JC064** **MOORING** **EB1**

Date	17/9/11	DOY	260
------	---------	-----	-----

Site Arrival Time 08 45
Setup Distance (nm) 4.8 nm

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
08 47	23° 43.43	-24° 13.13	5079	5122

End

Time	Lat	Lon	Depth (u/c)	Depth corr
125830	23.7577	24.1591	5049	5097

Release s/n	Arm	Release
1203	0886	
1197	0880	

Descending @ 93 m/min

[illegible]

echo sounder on

② - 93 m/min

9.4V

11

 $V = 12.7$

S/N = 1203, 155530, 0, 0 @ WP3
155700, 0, 0
155800, 0, 0

S/n = 1197, 165000, 7760, 7761 @ ^{EBL} L8
165100, 7760, 7761

S/n = 1203, 165300, 7760, 7760 @ EB1L8

15/6-0

EB1			Date	17/9/4	GMT
Mooring Element	Depth (m)	Serial num	Comment	Time o/b	
1 Trimsyn recovery float and line				08.47	0.5 kn
2 3x Trimsyn floats				"	
3 50m of 4mm wire (red)				"	0.8 kn
4 SBE at top join	50	✓ 5486		08.49	
5 24" syntactic, argos, light	100			08.55	
6 65m of 4mm wire (red) yellow				"	
7 SBE at top join	105	✓ 3891		08.59	
8 37" steel sphere, argos light	170			09.07	
9 325m 5mm wire				"	
10 SBE at top join	175	✓ 5484		09.09	
11 SBE	250	✓ 6904			
12 SBE	325	✓ 6805		09.16	
13 SBE	400	✓ 5789		09.20	
14 4 glass				09.25	
15 290m 3/16" wire (black)					
16 SBE	600	✓ 5247		09.29	
17 4 glass				09.37	
18 330m 3/16" wire (black)					
19 SBE at top join	800	✓ 5245		09.38	
20 SBE	1000	✓ 6113		09.45	
21 4 glass + swivel				09.51	
22 400m of 3/16" wire (black)					
23 SBE	1200	✓ 5244		09.54	
24 Sontek	1500	D273		10.01	
25 4 glass				10.08	
26 750m of 3/16" wire (black)					
27 SBE	1600	3912 6814		10.11	
28 SBE	2000	✓ 3206		10.23	
29 4 glass + swivel				10.33	
30 1000m of 3/16" wire (black)					
31 SBE	2500	✓ 6114		10.41	
32 SBE	3000	✓ 3266		10.55	
33 4 glass spheres + swivel				11.03	
34 600m 1/4" wire					
35 SBE	3500	6814 6811		11.11	
36 4 glass spheres				11.24	
37 590m 1/4" wire white					
38 SBE	4000	✓ 6815		11.27	
39 4 glass spheres + swivel				11.43	
40 430m 1/4" wire					
41 SBE at top join	4500	✓ 4549		11.44	
42 60m 1/4" wire					
43 20+40m, 1/4" wire					
44 RCM at top join	5000	✓ 303		12.04	
45 SBE at top join	5000	✓ 3225		12.05	
46 8 glass + swivel			towing on release hook 1 on port	12.17	
47 AR1		1203	crane	"	
48 AR2		1197		"	
49 Anchor (1450kg)	5093		lifting on release hook 2	12.58.50	

12.22 @ 0.6 nm from drop point

2009 4 hrs.
2010 3 hrs 20 mins

Bridge 8 cables @ 12.24 coming up to 1 1/2 kn.

⊙

DEPLOYMENT

CRUISE	JC064	MOORING	EBH1L7
Date	06/10/2011	DOY	279
Site Arrival Time			
Setup Distance (nm)			

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
18 07	27°08.30'	-15° 22.25'	2996	2999

End

Time	Lat	Lon	Depth (u/c)	Depth corr
18:12:16	27° 08,34'	-15° 22,23'	2997	3000

Release s/n	Arm	Release
824	1686	
281	1439	

Descending @ —

[illegible]

EBH1L7				Date	
	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float, light & flag				18:08:06
2	5m chain				
3	Recovery line				18:08
4	3 glass spheres				18:09:02
5	15m polyprop				
6	3 glass spheres				18:09:42
7	15 m of polyprop				
8	BPR1		60		
9	BPR2		64		
10	AR1		824		
11	AR2		281		
12	Tripod, anchor (300 kg)				18:12:16

3 glass spheres

9 glass - 3x3

18:10:18

DEPLOYMENT

CRUISE	JC064	MOORING	EBH1L8
Date	06 / 10 / 2011	DOY	279
Site Arrival Time			
Setup Distance (nm)			

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
18:32	27° 08.09'	-15° 21.84'	3003	3006

End

Time	Lat	Lon	Depth (u/c)	Depth corr
18:36:54	27° 08,12'	-15° 21,85'	3002	3005

Release s/n	Arm	Release
282	14BA	
354	14EA	

Descending @ 50 m/min

[illegible]

50 m/min

EBH1L8				Date	
	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float, light & flag				18.32.20
2	5m chain				
3	Recovery line				18.32.08
4	3 glass spheres + swivel				18.33
5	15m polyprop				
6	3 glass spheres				18.34
7	15 m of polyprop				
8	BPR1		✓ 396		18.36.53
9	BPR2		✓ 397		"
10	AR1		✓ 282		"
11	AR2		✓ 354		"
12	Tripod, anchor (300 kg)				"

3 glass spheres + 15m polyprop

18.35

DEPLOYMENT

CRUISE	JC064	MOORING	EBH1L8
Date	13/08/14	DOY	256
Site Arrival Time	12:23		
Setup Distance (nm)	1 cable		

.....
Start

Time	Lat	Lon	Depth (u/c)	Depth corr
12:25	27° 16.44	-15° 24.67	2957	2960

End

Time	Lat	Lon	Depth (u/c)	Depth corr
12:31:00	27° 16.48	-15 24.61	2954	2957

Release s/n	Arm	Release
282	143A	
354	14EA	

Descending @ $\sim 50 \text{ m/min}$

[illegible]

ARM 143A

HAPPY IT'S
going down.

$\gamma - 56 \text{ m/min}$
 $\gamma - 50 \text{ m/min} \quad 46 \text{ m/min}$

27-28

EBH1L8			Date	
	Mooring Element	Depth (m)	Serial num	Comment
1	Billings float, light & flag			
2	5m chain			
3	Recovery line			
4	3 glass spheres			
5	15m polyprop			
6	3 glass spheres			
7	15 m of polyprop + 3 glass			
8	BPR1		396	
9	BPR2		397	
10	AR1		282	
11	AR2		354	
12	Tripod, anchor (kg)			

12:26

12:25

12:26

12:27

12:28

12:29:00

12:29:00

12:31

12:31:00

DEPLOYMENT

CRUISE	JC064	MOORING	EBH1
Date	6/10/11	DOY	179
Site Arrival Time	16:43		
Setup Distance (nm)			

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
16:43	27° 08.46'	-15° 22.79'	2994	2997

End

Time	Lat	Lon	Depth (u/c)	Depth corr
16:58:29	27° 08.61'	-15° 22.66'	2994	2997

Release s/n	Arm	Release
827	1689	
1200	0883	

Descending @ 106 m/min

[illegible] 2106 m/min

EBH1

Date

Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1 Argos float with light				16.44.18
2 Recovery line and float				16.43.40
3 5m chain				
4 15m polyprop				
5 2 glass spheres with swivel ✓	2500	✓ 3215		16.45
6 250m of 8mm polyester				
7 SBE at top join	2500	✓ 3215		16.46
8 2 glass spheres				16.50
9 150m of 8mm polyester				
10 RCM at bottom join	2900	✓ 301		16.53
11 100m of 8mm polyester				
12 SBE at bottom join	3000	✓ 3244		16.56
13 1/2 glass + swivel, 1m chain				16.58.29
14 AR		✓ 1200		16.58.29
15 AR		✓ 827		16.58.29
16 Anchor (500kg)				//

DEPLOYMENT

CRUISE	JC064	MOORING	EBH1
Date	13-09-2011	DOY	256
Site Arrival Time	08:30		
Setup Distance (nm)	2 cables		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
08:45	27° 16.61'	-15° 24.74'	2973	2976

End

Time	Lat	Lon	Depth (u/c)	Depth corr
09:04:31	27° 16.73'	-15° 24.65'	2985	2988

Release s/n	Arm	Release
1200	0883	
827	1689	

Descending @ 106 m/min

[illegible]

ARM: 0883

1, ~~63 m/min~~
1, 107 m/min
1, 106 m/min

vertical.

ARM: 1689

vertical

EBH1

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Argos float with light		W03-096		08.45.45
2	Recovery line and float				08.45
3	5m chain				
4	15m polyprop				
5	2 glass spheres with swivel ✓	2500			08.46
6	250m of 8mm polyester				
7	SBE at top join	2500	✓ 3215		08.46
8	2 glass spheres ✓				08.55
9	150m of 8mm polyester				
10	RCM at bottom join	2900	✓ 301		08.59
11	100m of 8mm polyester				
12	SBE at bottom join	3000	✓ 3244		09.04
13	3 glass + swivel, 1m chain ✓				"
14	AR		827 1200	AKM 0883	09.04.31
15	AR		827		"
16	Anchor (500kg)				"

09 04 30

BPR & AR from ladder will be the yesterday's ones

DEPLOYMENT

CRUISE	JC064	MOORING	EBH2
Date	12/09/11	DOY	
Site Arrival Time			
Setup Distance (nm)	3 cables		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
10' 26	27° 36.73'	-14° 12.79'	2022	2022

End

Time	Lat	Lon	Depth (u/c)	Depth corr
18 41	27° 36.88'	-14° 12.65'	2019	2019

Release s/n	Arm	Release
1242	08AF	
927	1561	

Descending @ ≈ 90 m/min

[illegible]

NEZEL 08AF
NEZEL 08AF

② 2000 m

{ echo sonar on

vertical

122	
131	m/min
145	77 m/min
166	84 m/min

vertical] 91 m/min
"]
"] 88 m/min
15 (but final depth)

EBH2

Date

Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1 Argos float with light				18.26
2 Recovery line and float				18.27
3 5m chain				
4 15 m polyprop				
5 2 glass spheres with swivel				
6 200m of 8mm polyester				
7 SBE at top join	1600	3230		18.27
8 2 glass spheres				18.34
9 100m of 8mm polyester				
10 SBE at top join	1800	3224		18.34
11 Sontek at bottom join	1900	D332		18.36
12 100m of 8mm polyester				
13 SBE at bottom join	2000	3265		18.41
14 3 glass + swivel, 1m chain				18.41
15 AR		1242		
16 AR		927		
17 1m chain				
18 Anchor (500kg)				18.41.14

DEPLOYMENT

CRUISE	JC064	MOORING	EBH3
Date	12-09-2011	DOY	255
Site Arrival Time			
Setup Distance (nm)	2 cables		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
12:59	27° 48.30'	-13° 44.92'	1419	1421

End

Time	Lat	Lon	Depth (u/c)	Depth corr
13:31	27° 48.45'	-13° 44.81'	1419	1421

Release s/n	Arm	Release
925	1839	
908	1822	

Descending @ $\approx 120 \text{ m/min}$

[illegible]

- 115 m/min
- 120 m/min
- 124 m/min

EBH3

Date

Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1 Argos float with light			No argos deployed	12:54
2 Recovery line and float				12:59
3 5m chain				
4 15m polyprop				
5 2 mini trymsyn + swivel				13:00
6 100m of 8mm polyester				13:00
7 SBE at top join	900	3907		13:00
8 2 mini trymsyn				13:04
9 100m of 8mm polyester				
10 SBE at top join	1000	6802		13:04
11 2 mini trymsyn				13:07
12 100m of 8mm polyester				
13 SBE at top join	1100	6801	Dropped on deck	13:07
14 2 mini trymsyn				13:10
15 100m of 8mm polyester				
16 SBE at top join	1200	6800		13:10
17 Sontek at bottom join	1300	D298		13:13
18 100m of 8mm polyester				
19 SBE at bottom join	1400	6799	Hit the deck twice when deploying	13:16
20 3 glass + swivel, 1m chain				13:31
21 AR		414	} Dropped on deck from high height. Replaced for: 925 908	"
22 AR		911		"
23 1m chain				"
24 Anchor (500kg)				13:31-34

DEPLOYMENT

CRUISE	JC064	MOORING	EBH4L3
Date	05/10/2011	DOY	278
Site Arrival Time	19:05		
Setup Distance (nm)			

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
19:05	27° 51.82'	-13° 30.84'	992	996

End

Time	Lat	Lon	Depth (u/c)	Depth corr
19:10:07	27° 51.86'	-13° 30.85'	994	998

Release s/n	Arm	Release
922	1836	
926	1860	

Descending @ ~ 45 m/min

[illegible]

245 m/min

 236 m/min

346m / min

EBH4L3			Date	
Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1 Billings float, light			Y01-015 1046484 [Aragos]	19:06
2 5m chain			W03-084 [light]	19:05
3 Recovery line and float				
4 15m polyprop				
5 3 glass spheres				19:06
6 15m polyprop				
7 3 glass spheres				19:07
8 15m polyprop				
9 3 glass spheres				19:07
10 15m polyprop				
11 BPR1		0005		31
12 BPR2		0013		
13 AR1		926		
14 AR2		922		
15 Tripod, anchor (300kg)				19:10.07

DEPLOYMENT

CRUISE	JC064	MOORING	EBH4L3
Date	12/19/11	DOY	255
Site Arrival Time	0600		
Setup Distance (nm)	0		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
07 29	27° 52.10'	-13° 30.86'	1003	1007

End

Time	Lat	Lon	Depth (u/c)	Depth corr
073255	27° 52.12'	-13° 20.85'	1003	1007

Release s/n	Arm	Release
282	14 BA	
354	14 EA	

Descending rate \rightarrow NO descending
0 m/min

[illegible]

Releant

OK

Redmond

EBH4L3			
	Mooring Element	Depth (m)	Serial num
1	Billings float, argos & light	argos: Y	01008
2	5m chain	light: Z	02023
3	15m polyprop		
4	4*17" glass		
5	15m polyprop		
6	4*17" glass		
7	15m polyprop		
8	4*17" glass		
9	15m polyprop		
10	BPR1		282
11	BPR2		384
12	AR1		396
13	AR2		397
14	Tripod, anchor (300kg)		

46485

396

397

282 - 14BA

394 - 14EA

After deployment Billings float / recovery float remained on surface.
Ranges confirmed mooring has not sunk. Anchor released, proceeded with recovery.

All unboard by 083430

The tripod-AR-BPR setup will be used for EBH1L8 instead.
When redeploying EBH4L3, change S/n

DEPLOYMENT

CRUISE	JC064	MOORING	EBH4
Date	11/09/11	DOY	
Site Arrival Time	11:10		
Setup Distance (nm)	8 cables		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
12.05	27° 50.199	-13° 33.0708	1061	1065

End

Time	Lat	Lon	Depth (u/c)	Depth corr
13.05.55	27°51.0112	130°32.442	1058	1062

Release s/n	Arm	Release
264	14B5	
906	1820	

Descending rate: —

[illegible]

Vbatt 9.3V
Vbatt 9.3V

EBH4

Date

Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1: Argos float with light			101-009 10 46491 / 202-021 46HT	1205
2: Recovery line and float				"
3: 5m chain				
4: 15m polyprop				
5: 1 glass sphere				
6: 100m 4mm wire				
7: SBE at top join	325	3233		1210
8: 100m 4mm wire				
9: SBE at top join	400	3258		1216
10: 2 glass + swivel	500			1224
11: 200m 3/16" wire				
12: SBE at top join	500	✓3254		1225
13: SBE	600	✓3219		1229
14: SBE at bottom join	700	✓3221		1233
15: 2 glass	700			1236
16: 350m of 3/16" wire				
17: SBE	800	✓3222		1240
18: 4 glass + swivel, 1m chain				
19: AR	861	264		1305
20: AR		906		
21: 1m chain				
22: Anchor (500kg)				130555

↑
THIS WAY
UP

DEPLOYMENT

CRUISE	JC064	MOORING	EBH5
Date	11/9/11	DOY	
Site Arrival time			
Setup Distance (nm)	1.1		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
1420	27° 49.653	13° 33.222	1068	1072

End

Time	Lat	Lon	Depth (u/c)	Depth corr
15 23.00	27° 50.563	13° 32.648	1057	1061

Release s/n	Arm	Release
249	14A6	
256	14AD	

Descending rate: —

ARM
14 A6

14AD

[illegible]

9.2

vbatt 9.2

Float from recovered
EBH5

EBH5

Date

Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1 Argos float with light			255 10 42747 / 202-022 LIGHT	1420
2 Recovery line and float				
3 5m chain				
4 15m polyprop				
5 40m of 4mm wire				
6 SBE at top join	100	3223		1423
7 2 glass + swivel	175		increased speed to 1 km	1428
8 295m of 5mm wire				1429
9 SBE	175	3228		"
10 SBE	250	3269		1431
11 2 glass + swivel	450			
12 290m of 3/16" wire				
13 RCM at top join	450	305		1441
14 2 glass	750			1458
15 310m of 3/16" wire			WIRE caught in capstan	1458
16 Sontek at top join	750	D278		1500
17 Sontek	950	D295	CHANGED TO D322	1508
18 5 glass + swivel, 1m chain				1523
19 AR		249		1523
20 AR		256		1523
21 1m chain				
22 Anchor (500kg)				1523

wire coating repaired @ 14.45

DEPLOYMENT

CRUISE	JC064	MOORING	EBHi
Date	15/4/11	DOY	258
Site Arrival Time	08:46		
Setup Distance (nm)	0.5 nm		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
0933	24° 55.98'	-21° 16.39'	4475	4502

End

Time	Lat	Lon	Depth (u/c)	Depth corr
1034 47	24° 56.44'	-21° 16.08'	—	4505

→ No reasonable $\approx 600\text{m}$ depth data. Swath corrected depth:

Release s/n	Arm	Release
819	1681	
923	1837	

Descending @ 104 m/min

4505 m

[illegible]

$\{-104 \text{ m/min}$

EBHi

Date

Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1 Argos float with light		✓ 01-028	Billings	0933
2 Recovery line and float				
3 5m chain				
4 15m polyprop				
5 2 glass spheres with swivel	3500			0934
6 500m of 8mm polyester				11
7 SBE at top join	3500	3232	✓	11
8 2 glass	4000			0948
9 400m of 8mm polyester				11
10 SBE at top join	4000	3234	✓	11
11 RCM at bottom join	4400	302	✓	1000
12 100m of 8mm polyester				
13 SBE at bottom join	4500	3905	✓	1005
14 4 glass + swivel, 1m chain				
15 AR		819		
16 AR		923		
17 1m chain				
18 Anchor (500kg)				100347

DEPLOYMENT

MOORING MARO

DOY 269

.....

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
22.59	25° 00.60'	-52° 00.44'	5532	5595

End

Time	Lat	Lon	Depth (u/c)	Depth corr
23:24:10	25° 06.28'	-52° 00.61'	-	5529

SWATH
DATA (no ea 600m data
available)

Release s/n	Arm	Release
826	1688	
1199	0982	

Descending @ 80 m/min

[illegible]

at range of 0.5 nm
} 80 m/min / 80 m/min

MARO

	Mooring Element	Depth	Serial num	Comment	Time o/b
1	Billings, argos + light		Y02-055 12 93793 / Y01-017		2259
2	Recovery line				
3	5m chain, swivel, polyprop				
4	2 Glass spheres				
	Top join 125m of 10mm polyester				
6	SBE (at top join)	5100	5764	4711 IMP	2301
	Bottom join 125m of 10mm polyester				
7	polyester				
	Top join 125m of 10mm polyester				
8	SBE (at top join)	5225	6808	5764	2305
	Bottom join 125m of 10mm polyester				
10	2 glass spheres + swivel				
	Top join 50m of 10mm polyester				
12	SBE (at top join)	5350	5771		2308
	Bottom join 50m of 10mm polyester				
14	S4	5400	35612578		2310
	Top join 70m of 10mm polyester				
16	SBE (at bottom join)	5475	4709	IMP	2311
18	SBE (at bottom join)	5475	4715		"
	Bottom join 70m of 10mm polyester				"
19	2 glass spheres + swivel			8 glass	2312
20	Join				
22	20m of 10mm polyester				
23	Acoustic Release		826		
24	Acoustic Release		1199		
25	BPR 1	5500	390	0632 SBE53	
26	BPR 2	5500	32	0418 SBE53	
27	Anchor 600kg	5500			232410

DEPLOYMENT

CRUISE JC064

MOORING

MAR1L7

Date 25/09/11

DOY 268

Site Arrival Time 2050

Setup Distance (nm) 0.1

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
205230	24° 11.52'N	69 46.76'W	5172	5222

End

Time	Lat	Lon	Depth (u/c)	Depth corr
205710	26° 11.57'N	49° 44.71'W	5132	5272

Release s/n	Arm	Release
1202	0885	
921	1835	

Descending @ ~ 200 m/min

[illegible]

4187 m/min

4218 m/min / 224 m/min

MAR1L7

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float, light & flag		701-019		205230
2	5m chain				
3	Recovery line				
4	3 glass spheres				2054
5	15m polyprop				
6	3 glass spheres				2055
7	15 m of polyprop				
8	3 glass spheres				205530
8	15 m of polyprop				
9	BPR1		033		
10	BPR2		034		
11	AR1		1202		
12	AR2		921		205710

DEPLOYMENT

CRUISE JC064

MOORING MAR1

Date 25/09/11

DOY 268

Site Arrival Time 1130

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
11:47	24° 06.6'	-49° 48.08'	4952	4996

End

Time	Lat	Lon	Depth (u/c)	Depth corr
15:54:09	24° 10.08'	-49° 44.81'	5165	5215

Descending @
~ 180 m/min

[illegible]

S/N 920
S/N 316
44 Day

Adam:
Anna

$$\Delta \phi$$

12

A3

- 200 m/min
- 180 m/min
- 160 m/min

Anchor on seabed approx. 24.1655°N , 49.75°W

MAR1

Date

Mooring Element	Depth	Serial num	Comment	Time o/b
1 Recovery float and line				11:47
2 3 trymsin floats				11:49
3 40 m 4mm wire				
4 SBE (at top join)	50	6335		11:51
5 24' Syntactic, argos, light	90			11:56
6 60m 4mm wire				
7 SBE	100	6321		11:58
8 37" + Argos + light + swivel, 1m chain	150	3702		12:03
9 630m 5mm wire				
10 SBE	175	6324		12:08
11 SBE	250	4721		12:12
12 SBE	325	5485		12:15
13 SBE	400	6806		12:18
14 SBE	600	6807		12:24
15 8 glass + swivel	787			12:34
16 990m 3/16" wire				
17 SBE (at top join)	800	4717		12:36
18 SBE	1000	6809		12:42
19 SBE	1200	4708, 6010		12:48
20 Sontek	1500	D295		13:00
21 SBE	1600	5784		13:03
22 8 glass	1793			13:14
23 700m 3/16" wire				
24 SBE	2000	6812		13:22
25 4 glass + swivel	2509			13:39
26 500m 1/4" wire				
27 SBE (at top join)	2500	3932		13:40
28 4 glass	3017			13:56
29 460m 1/4" wire				
30 SBE (at top join)	3000	6813		13:57
31 4 glass + swivel	3484			14:12
32 540m 1/4" wire				
33 SBE (at top join)	3500	3919		14:13
34 4 glass	4032			14:32
35 710m 1/4" wire				
36 SBE (at top join)	4000	7723		14:33
37 SBE	4500	5783		14:49
38 5 glass	4750			
39 290m 1/4" wire				
40 SBE (at top join)	4995	6830	At bottom join, just before S4. Below S4	15:15
41 100m 1/4" wire				
42 S4 at top join	5000	35612572		15:13
43 9 glass + swivel	5151			15:27
44 AR		920	ARM: 1834	15:28
45 AR		316	ARM: 14CC	15:28
46 Anchor (1800 kg)				15:54.03

DEPLOYMENT

MOORING

MAR2

Date 25/9/21

DOY 268

Site Arrival Time 1630

Setup Distar: ~~Zentrum~~ 1.7m

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
17:05	24° 09,16'	-49° 47,05'	5043	5089

End

Time	Lat	Lon	Depth (u/c)	Depth corr
19:37:01	24° 11.10'	-49° 45.39'	5166	5216

Release s/n	Arm	Release
1194	0871D	
928	1862	

Descending @ $\sim 150 \text{ m/min}$

[illegible]

echo rounder 5

$\sim 150 \text{ m/min}$
descent

Anchor on seabed approx. 24.1775°N , 49.763°W

MAR2

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float with light ARGOS		129416		1705
2	5m chain				
3	Recovery line and float				
4	4 glass spheres with swivel				1707
5	Join: Top of 700m 3/16" wire				
6	SBE at join	1100	✓ 3931		1708
7	SBE at mark	1400	✓ 3911		1718
8	SBE (No mark)	1600	✓ 6115		1726
8	Join: Bottom of 700m 3/16" wire				
9	4 glass spheres with swivel	1787			1732
10	Join: Top of 450m 3/16" wire				
11	SBE at join	1800	✓ 6116		1733
12	Join: Bottom of 450m 3/16" wire				
13	3 glass spheres	2244			1747
14	Join: Top of 495m of 3/16" wire				
15	SBE at join	2250	✓ 6117		1749
16	Join: Bottom of 495m 3/16" wire				
17	3 glass spheres with swivel	2745			1804
18	Join: Top of 990m of 3/16" wire				
19	SBE at join	2750	✓ 3928		1806
20	SBE at mark	3250	✓ 5243		1821
	Join: Bottom of 990m of 3/16" wire				
21	wire				
22	3 glass spheres with swivel ✓	3741			1837
23	Join: Top of 500m of 3/16" wire				
24	SBE at join	3750	✓ 5239		1838
	Join: Bottom of 500m of 3/16" wire				
25	wire				
26	3 glass spheres with swivel ✓	4246			1854
27	Join: Top of 890m of 3/16" wire				
28	SBE at join	4250	✓ 5778		1855
29	SBE at mark	4750	✓ 6119		1909
	Join: Bottom of 890m of 3/16" wire				
30	wire				
31	4 glass spheres with 5m chain	5142			1923
32	Join: Top of 20m of 3/16" wire				
33	S4 current meter at join	5150	✓ 35612571		1923
34	SBE at mark	5160	✓ 6120		1924
	Join: Bottom of 20m of 3/16" wire				
35	wire				
36	5 glass spheres with swivel	5170			1927
37	Join: Top of 10m of 3/16" wire				
38	Join: Bottom of 3/16" wire				
39	Acoustic release X2	1194	ARM 0870		1936
40	10m 1/2" chain	928	ARM 1862		1936
41	Anchor	5200			1937:01

DEPLOYMENT

MOORING

MAR3L7

DOY 265

.....

.....

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
09:22	23° 51.90'	-41° 05.68'	5007	5048

End

Time	Lat	Lon	Depth (u/c)	Depth corr
09 25 (00)	23° 51.91'	-41° 5.64'	5013	5054

Release s/n	Arm	Release
1198	0881	
262	1433	

Descending @ 47/min

[illegible]

1453

47 ml/min

47 m/min

MAR3L7

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
	1 Billings float, light & flag			X01-048 [confirmed on]	0922
	2 5m chain				
	3 Recovery line				
	4 3 glass spheres				0923
	5 15m polyprop				
	6 3 glass spheres				0923 45
	7 15 m of polyprop				092430
7.1 →	8 BPR1	35	0036		
	8 BPR2	36	0035		
	9 AR1		1198	ARM 0881	
	10 AR2		262		
	11 Anchor				0925

7.1 3 glass

DEPLOYMENT

CRUISE	JC064	MOORING	MAR3
Date	21/9/2011	DOY	264
Site Arrival Time			
Setup Distar	1.8 km		

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
124500	23° 51.4'	41° 10.4'	4005	4021

End

Time	Lat	Lon	Depth (u/c)	Depth corr
144335	23° 51.4'	41° 5.91'	5019	5061

Release s/n	Arm	Release
917	18 31	
322	1402	

Descending @ 108 m/min

[illegible]

ARM: 1831 917
Ding 1844

(echo sounders on)
vertical
vertical

MAR3

Date

	Mooring Element	Depth (m)	Serial num	Comment	Time o/b
1	Billings float with light				12:45
2	5m chain				
3	Recovery line and float				12:45
4	2 glass spheres with swivel	2500			12:47
5	Join: Top of 500m 3/16"				
6	SBE at join	2500	✓ 5776		12:49
7	Join: Bottom of 500m 3/16"				13:10
8	3 glass spheres	3000			
9	Join: Top of 500m 3/16"				
10	SBE at join	3000	✓ 5774		13:11
11	Join: Bottom of 500m 3/16"				
12	3 glass spheres	3500			13:28
13	Join: Top of 500m 3/16"				
14	SBE at join	3500	✓ 6835		13:29
15	Join: Bottom of 500m 3/16"				
16	3 glass spheres + swivel	4000			13:45
17	Join: Top of 500m 3/16"				
18	SBE at join	4000	✓ 6810		13:46
19	Join: Bottom of 500m 3/16"				
20	3 glass spheres	4500			14:02
21	Join: Top of 540m 3/16"				
22	SBE at join	4500	✓ 6836		14:03
23	SBE at mark	5000	✓ 5770		14:20
24	Join: Bottom of 540m 3/16"				
25	S4	5015	55612568		14:24
26	8 glass spheres with swivel	5017			14:26
27	10m 3/16"				
28	AR1	917			14:43
29	AR2	322			14:43
30	10m of 0.5" chain				
31	Anchor (1000kg)	5050			14:43:35

DEPLOYMENT

CRUISE	D259 J8064	MOORING	NOGST
Date	22/9/204	DOY	265
Site Arrival Time			
Setup Distance (nm)			

Start

Time	Lat	Lon	Depth (u/c)	Depth corr
10 47 00	23° 45.63'	-41° 06.76'	4214	4234

End

Time	Lat	Lon	Depth (u/c)	Depth corr
1204 44	23° 46.26'	41° 5.93'	4226	4247

Release s/n	Arm	Release
822	1684	

descending @ 80 m/min

[illegible]

9.5 V
9.5 V
"
28 min

NOGST

Time D/B

	Mooring Element	Depth (m)	Serial num
1	Billings float, light & flag	10 47	
2	5m chain		
3	Recovery line		
4	15m polyprop		
5	12 glass spheres	10 50	
6	50m polyprop		
7	Sediment trap	10 56	
8	REM current meter NORTEK	11 03	8100
9	50m polyprop		
10	Sediment trap	11 08	
11	REM current meter NORTEK	11 13	8092
12	500m polyprop		
13	500m polyprop		
14	10 glass spheres	11 46	
15	200m polyprop		
16	AR	11 58	822
17	Anchor (850kg)	1204:44	

References

- Bindoff, N. L., Willebrand, J., Artale, V., Cazenave, A., Gregory, J., Gulev, S., Hanawa, K., Quere, C. L., Levitus, S., Nojiri, Y., Shum, C. K., Talley, L., & Unnikrishnan, A. (2007). *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, chap. Observations: Oceanic Climate Change and Sea level. Cambridge University Press.
- Cunningham, S. A., Kanzow, T., Rayner, D., Baringer, M. O., Johns, W. E., Marotzke, J., Longworth, H. R., Grant, E. M., Hirschi, J. J.-M., Beal, L. M., Meinen, C. S., & Bryden, H. L. (2007). Temporal Variability of the Atlantic Meridional Overturning Circulation at 26.5°N. *Science*, 317(5840), 935–938.
- Emery, W. J. (2004). *Data analysis and methods in physical oceanography*.
- Firing, E. (1991). *Acoustic Doppler Profiling Measurements and Navigation*.
- Kanzow, T., & Coauthors (2007). Observed flow compensation associated with the MOC at 26.5°N in the Atlantic. *Science*, 317, 938–941.
- RDI (1996). *Principles of operation. A practical primer..*